



Indirect Methods of Streamflow Measurement Formulas

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List of 33 Indirect Methods of Streamflow Measurement Formulas

Indirect Methods of Streamflow Measurement C

Flow Measuring Structures C

fx
$$\mathrm{Q}_{\mathrm{f}} = \mathrm{k} \cdot (\mathrm{H}^{\mathrm{n}_{\mathrm{system}}})$$

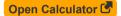
Open Calculator 🕑

ex
$$35.96325 \mathrm{m^3/s} = 2 \cdot \left((3 \mathrm{m})^{2.63}
ight)$$

2) Free Flow Discharge under Head using Submerged Flow over Weir 🕑

$$\mathbf{X} egin{aligned} \mathbf{Q}_1 &= rac{\mathbf{Q}_{\mathrm{s}}}{\left(1 - \left(rac{\mathrm{H}_2}{\mathrm{H}_1}
ight)^{\mathrm{n}} - \{\mathrm{head}\}
ight)^{0.385}} \end{aligned}$$

ex
$$20.00667 \text{m}^3/\text{s} = rac{19 \text{m}^3/\text{s}}{\left(1 - \left(rac{5 \text{m}}{10.01 \text{m}}
ight)^{2.99 \text{m}}
ight)^{0.385}}$$





3) Head over Weir given Discharge 🕑

$$f_{\mathbf{X}} \mathbf{H} = \left(\frac{Q_{f}}{k}\right)^{\frac{1}{n_{system}}}$$

$$e_{\mathbf{X}} 2.800161 \mathrm{m} = \left(\frac{30.0 \mathrm{m}^{3}/\mathrm{s}}{2}\right)^{\frac{1}{2.63}}$$

$$f_{\mathbf{X}} \mathbf{H} = \left(\frac{30.0 \mathrm{m}^{3}/\mathrm{s}}{2}\right)^{\frac{1}{2.63}}$$

fx
$$\mathbf{Q}_{\mathrm{s}} = \mathbf{Q}_{1} \cdot \left(1 - \left(rac{\mathrm{H}_{2}}{\mathrm{H}_{1}}
ight)^{\mathrm{n}} - \{\mathrm{head}\}
ight)^{0.38}$$

ex
$$18.99366 \text{m}^3/\text{s} = 20 \text{m}^3/\text{s} \cdot \left(1 - \left(\frac{5\text{m}}{10.01\text{m}}\right)^{2.99\text{m}}\right)^{0.385}$$

Slope-Area Method 🕑

5) Eddy Loss 🚰

$$oldsymbol{h}_{\mathrm{e}} = (\mathrm{h}_1 - \mathrm{h}_2) + \left(rac{\mathrm{V}_1^2}{2 \cdot \mathrm{g}} - rac{\mathrm{V}_2^2}{2 \cdot \mathrm{g}}
ight) - \mathrm{h}_{\mathrm{f}}$$

$$\overbrace{15.96939}{=} (50\mathrm{m} - 20\mathrm{m}) + \left(\frac{(10\mathrm{m/s})^2}{2 \cdot 9.8\mathrm{m/s^2}} - \frac{(9\mathrm{m/s})^2}{2 \cdot 9.8\mathrm{m/s^2}}\right) - 15$$





Open Calculator 🕑

6) Frictional Loss

$$\textbf{fx} \mathbf{h}_{f} = (h_1 - h_2) + \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g} \right) - h_e \textbf{Open Calculator}$$

$$\textbf{ax} \ 30.43339 = (50\text{m} - 20\text{m}) + \left(\frac{\left(10\text{m/s}\right)^2}{2 \cdot 9.8\text{m/s}^2} - \frac{\left(9\text{m/s}\right)^2}{2 \cdot 9.8\text{m/s}^2}\right) - 0.536$$

7) Head loss in Reach 🕑

fx
$$\mathbf{h}_l = \mathbf{Z}_1 + \mathbf{y}_1 + \left(rac{\mathbf{V}_1^2}{2\cdot\mathbf{g}}
ight) - \mathbf{Z}_2 - \mathbf{y}_2 - rac{\mathbf{V}_2^2}{2\cdot\mathbf{g}}$$

Open Calculator 🕑

$$2.469388m = 11.5m + 14m + \left(\frac{\left(10m/s\right)^2}{2 \cdot 9.8m/s^2}\right) - 11m - 13m - \frac{\left(9m/s\right)^2}{2 \cdot 9.8m/s^2}$$

Non-Uniform Flow 🕑

8) Area of Channel with known Conveyance of Channel at Section 1 🕑

fx
$$A_1 = \frac{K_1 \cdot n}{R_1^{\frac{2}{3}}}$$

ex $494.221m^2 = \frac{1824 \cdot 0.412}{(1.875m)^{\frac{2}{3}}}$

Open Calculator 🕑



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9) Area of Channel with known Conveyance of Channel at Section 2 🕑

fx
$$A_2 = \frac{K_2 \cdot n}{R_2^{\frac{2}{3}}}$$

ex $477.7378m^2 = \frac{1738 \cdot 0.412}{(1.835m)^{\frac{2}{3}}}$

10) Average Conveyance of Channel for Non-Uniform Flow

fx
$$\mathrm{K}_{\mathrm{avg}} = \sqrt{\mathrm{K}_{1}\cdot\mathrm{K}_{2}}$$
 Open Calculator C

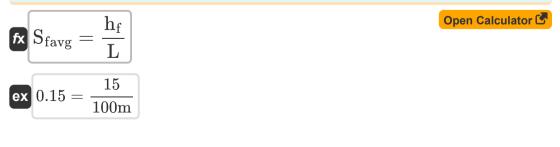
ex
$$1780.481 = \sqrt{1824 \cdot 1738}$$

11) Average Energy Slope given Average Conveyance for Non-Uniform Flow

fx
$$\mathbf{S}_{\mathrm{favg}}=rac{\mathbf{Q}^2}{\mathbf{K}^2}$$
 ex $0.140625=rac{\left(3.0\mathrm{m}^3/\mathrm{s}
ight)^2}{\left(8
ight)^2}$

Open Calculator 🕑

12) Average Energy Slope given Frictional Loss 🖸







Open Calculator

13) Conveyance of Channel at End Sections at 1 🚰

fx
$$\mathbf{K}_1 = \left(rac{1}{n}
ight) \cdot \mathbf{A}_1 \cdot \mathbf{R}_1^{rac{2}{3}}$$

ex
$$1823.184 = \left(\frac{1}{0.412}\right) \cdot 494 \mathrm{m}^2 \cdot (1.875 \mathrm{m})^{\frac{2}{3}}$$

14) Conveyance of Channel at End Sections at 2 🚰

fx
$$\mathbf{K}_2 = \left(rac{1}{n}
ight) \cdot \mathbf{A}_2 \cdot \mathbf{R}_2^{rac{2}{3}}$$

ex
$$1738.954 = \left(\frac{1}{0.412}\right) \cdot 478 \mathrm{m}^2 \cdot (1.835 \mathrm{m})^{\frac{2}{3}}$$

15) Conveyance of Channel for Non-Uniform Flow for End Section 💪

fx
$$K_2 = rac{K_{avg}^2}{K_1}$$
 ex $1737.061 = rac{{(1780)}^2}{{1824}}$

16) Conveyance of Channel for Non-Uniform Flow for End Sections

fx
$$K_1 = \frac{K_{avg}^2}{K_2}$$

ex $1823.015 = \frac{(1780)^2}{1738}$

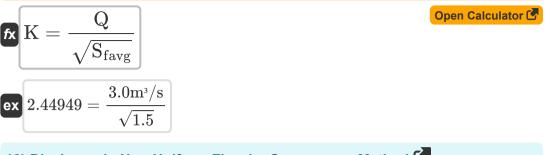




Open Calculator

Open Calculator 🕑

17) Conveyance of Channel given Discharge in Non-Uniform Flow 🕑



18) Discharge in Non-Uniform Flow by Conveyance Method

fx
$$\mathbf{Q} = \mathrm{K} \cdot \sqrt{\mathrm{S}_{\mathrm{favg}}}$$
 Open Calculator C

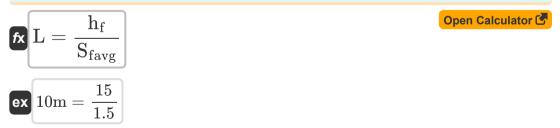
19) Frictional Loss given Average Energy Slope

fx
$$\mathbf{h}_{\mathrm{f}} = \mathbf{S}_{\mathrm{favg}} \cdot \mathbf{L}$$
 Open Calculator \mathbf{C}

ex $150 = 1.5 \cdot 100 \mathrm{m}$

ex $9.797959 \mathrm{m}^3/\mathrm{s} = 8 \cdot \sqrt{1.5}$

20) Length of Reach given Average Energy Slope for Non-Uniform Flow





Eddy Loss 🗹

21) Eddy Loss for Abrupt Contraction Channel Transition

fx
$$\mathbf{h}_{e}=0.6\cdot\left(rac{V_{1}^{2}}{2\cdot g}-rac{V_{2}^{2}}{2\cdot g}
ight)$$
 Open Calculator C

ex
$$0.581633 = 0.6 \cdot \left(\frac{(10 \text{m/s})^2}{2 \cdot 9.8 \text{m/s}^2} - \frac{(9 \text{m/s})^2}{2 \cdot 9.8 \text{m/s}^2} \right)$$

22) Eddy Loss for Abrupt Expansion Channel Transition 🕑

fx
$$\mathbf{h}_{\mathrm{e}}=0.8\cdot\left(rac{\mathrm{V}_{1}^{2}}{2\cdot\mathrm{g}}-rac{\mathrm{V}_{2}^{2}}{2\cdot\mathrm{g}}
ight)$$

ex
$$0.77551 = 0.8 \cdot \left(\frac{(10 \text{m/s})^2}{2 \cdot 9.8 \text{m/s}^2} - \frac{(9 \text{m/s})^2}{2 \cdot 9.8 \text{m/s}^2} \right)$$

23) Eddy Loss for Gradual Contraction Channel Transition 🕑

$$\begin{aligned} & \mathbf{fx} \mathbf{h}_{e} = 0.1 \cdot \left(\frac{V_{1}^{2}}{2 \cdot g} - \frac{V_{2}^{2}}{2 \cdot g} \right) \\ & \mathbf{ex} \end{aligned} \\ & \mathbf{0.096939} = 0.1 \cdot \left(\frac{\left(10 \text{m/s}\right)^{2}}{2 \cdot 9.8 \text{m/s}^{2}} - \frac{\left(9 \text{m/s}\right)^{2}}{2 \cdot 9.8 \text{m/s}^{2}} \right) \end{aligned}$$



Open Calculator 🕑

Open Calculator

24) Eddy Loss for Gradual Expansion Channel Transition 🕑

$$f_{\mathbf{X}} \mathbf{h}_{e} = 0.3 \cdot \left(\frac{\mathbf{V}_{1}^{2}}{2 \cdot \mathbf{g}} - \frac{\mathbf{V}_{2}^{2}}{2 \cdot \mathbf{g}} \right)$$

$$e_{\mathbf{X}} 0.290816 = 0.3 \cdot \left(\frac{(10 \text{m/s})^{2}}{2 \cdot 9.8 \text{m/s}^{2}} - \frac{(9 \text{m/s})^{2}}{2 \cdot 9.8 \text{m/s}^{2}} \right)$$
25) Eddy Loss for Non-uniform Flow

fx
$$\mathbf{h}_{\mathrm{e}} = \mathrm{K}_{\mathrm{e}} \cdot \left(rac{\mathrm{V}_{1}^{2}}{2 \cdot \mathrm{g}} - rac{\mathrm{V}_{2}^{2}}{2 \cdot \mathrm{g}}
ight)$$

$$\begin{array}{c} \begin{array}{c} \bullet \end{array} 0.95 = 0.98 \cdot \left(\frac{\left(10 \mathrm{m/s} \right)^2}{2 \cdot 9.8 \mathrm{m/s^2}} - \frac{\left(9 \mathrm{m/s} \right)^2}{2 \cdot 9.8 \mathrm{m/s^2}} \right) \end{array}$$

Uniform Flow

26) Area of Channel with known Conveyance of Channel 🕑

fx
$$A = \frac{K}{r_{H}^{\frac{2}{3}}} \cdot \left(\frac{1}{n}\right)$$
ex
$$40.66151 \text{m}^{2} = \frac{8}{(0.33 \text{m})^{\frac{2}{3}}} \cdot \left(\frac{1}{0.412}\right)$$

Open Calculator 🕑

Open Calculator 🕑





27) Conveyance of Channel Open Calculator $\mathbf{K} = \left(rac{1}{n} ight) \cdot \mathbf{A} \cdot \mathbf{r}_{\mathrm{H}}^{rac{2}{3}}$ ex $13.90892 = \left(\frac{1}{0.412}\right) \cdot 12.0 \mathrm{m}^2 \cdot (0.33 \mathrm{m})^{\frac{2}{3}}$ 28) Conveyance of Channel given Energy Slope Open Calculator fx $\mathrm{K}=\sqrt{rac{\mathrm{Q}^2}{\mathrm{S}_{\mathrm{c}}}}$ ex $8.017837 = \sqrt{\frac{(3.0 \text{m}^3/\text{s})^2}{0.140}}$ 29) Discharge for Uniform Flow given Energy Slope Open Calculator fx $\mathrm{Q} = \mathrm{K} \cdot \sqrt{\mathrm{S_{f}}}$ ex $2.993326 \text{m}^3/\text{s} = 8 \cdot \sqrt{0.140}$ 30) Energy Slope for Uniform Flow 🖸 Open Calculator fx $\mathrm{S_{f}}=rac{\mathrm{Q}^{2}}{\mathrm{\kappa}^{2}}$ ex $0.140625 = \frac{(3.0 \text{m}^3/\text{s})^2}{(8)^2}$





Open Calculator

Open Calculator

31) Frictional Loss given Energy Slope 🕑

fx
$$\mathbf{h_f} = \mathbf{S_f} \cdot \mathbf{L}$$

ex $14 = 0.140 \cdot 100 \mathrm{m}$

32) Hydraulic Radius given Conveyance of Channel for Uniform Flow 🕑

fx
$$\mathbf{r}_{\mathrm{H}} = \left(\frac{\mathrm{K}}{\left(\frac{1}{\mathrm{n}}
ight) \cdot \mathrm{A}}
ight)^{\frac{3}{2}}$$

ex
$$0.143949 \mathrm{m} = \left(\frac{8}{\left(\frac{1}{0.412} \right) \cdot 12.0 \mathrm{m}^2} \right)^{\frac{3}{2}}$$

33) Length of Reach by Manning's Formula for Uniform Flow

fx
$$L = \frac{h_f}{S_f}$$
 Open Calculator C $107.1429m = \frac{15}{0.140}$

9





Variables Used

- A Cross-Sectional Area (Square Meter)
- A₁ Area of Channel Section 1 (Square Meter)
- A₂ Area of Channel Section 2 (Square Meter)
- g Acceleration due to Gravity (Meter per Square Second)
- H Head over Weir (Meter)
- **h**₁ Height above Datum at Section 1 (*Meter*)
- H₁ Upstream Water Surface Elevation (Meter)
- h₂ Height above Datum at Section 2 (Meter)
- H₂ Downstream Water Surface Elevation (Meter)
- h_e Eddy Loss
- h_f Frictional Loss
- hI Head Loss in Reach (Meter)
- k System Constant k
- K Conveyance Function
- K₁ Conveyance of Channel at End Sections at (1)
- K₂ Conveyance of Channel at End Sections at (2)
- Kavg Average Conveyance of Channel
- Ke Eddy Loss Coefficient
- L Reach (Meter)
- n Manning's Roughness Coefficient
- n_{head} Exponent of Head (Meter)
- n_{system} System Constant n
- **Q** Discharge (Cubic Meter per Second)





- Q1 Free Flow Discharge under Head H1 (Cubic Meter per Second)
- **Q**_f Flow Discharge (Cubic Meter per Second)
- **Q**_s Submerged Discharge (Cubic Meter per Second)
- R₁ Hydraulics Radius of Channel Section 1 (Meter)
- R₂ Hydraulics Radius of Channel Section 2 (Meter)
- **r_H** Hydraulic Radius (Meter)
- Sf Energy Slope
- S_{favg} Average Energy Slope
- V1 Mean Velocity at End Sections at (1) (Meter per Second)
- V2 Mean Velocity at End Sections at (2) (Meter per Second)
- **y₁** Height above Channel Slope at 1 (Meter)
- **y**₂ Height above Channel Slope at 2 (Meter)
- Z1 Static Heads at End Sections at (1) (Meter)
- Z₂ Static Head at End Sections at (2) (Meter)



Constants, Functions, Measurements used

- Function: **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: 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



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- Area-Velocity and Ultrasonic Method of Streamflow Measurement Formulas
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