Forest Hydrology: Lect. 7

Contents

- Water level and discharge measurement
- Water stage measurement;
- Rating curve.

Water level and discharge

Q= discharge, volume of water passing a river section per unit time.

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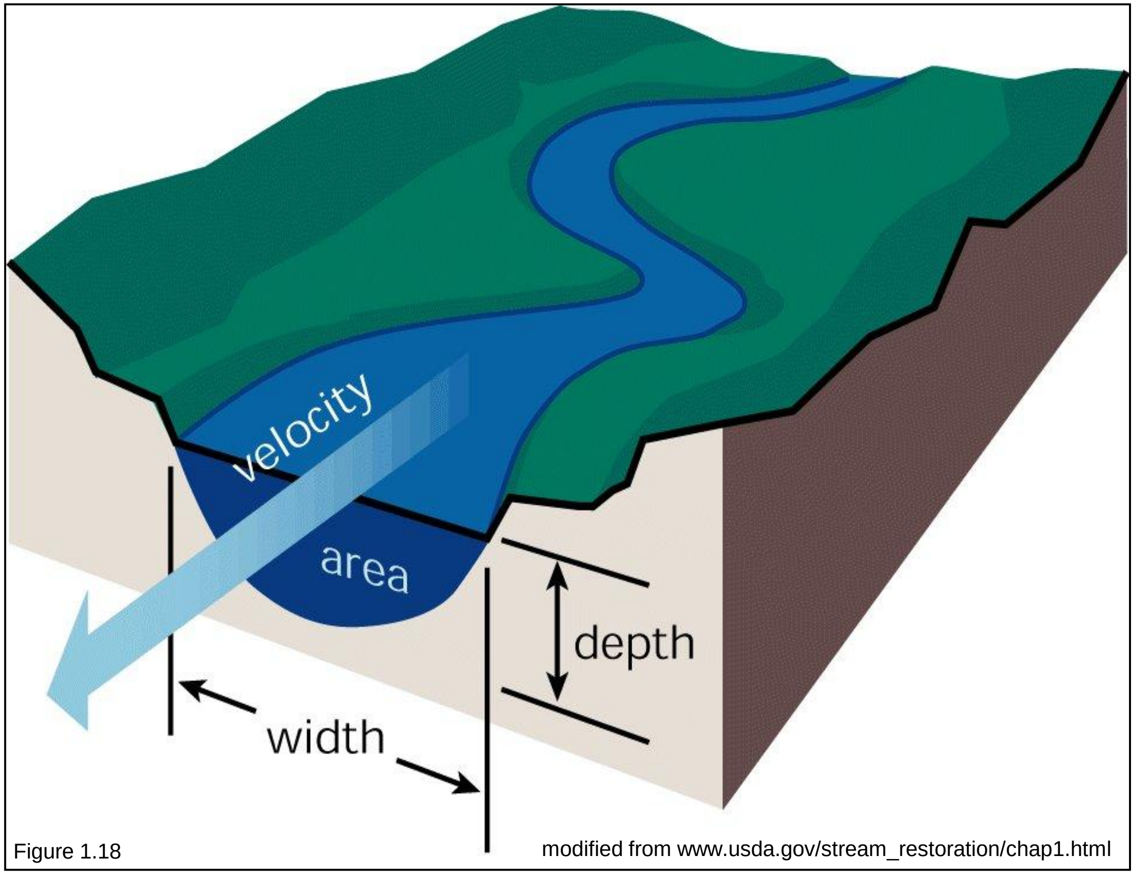
V= velocity
A= area
Q=VA



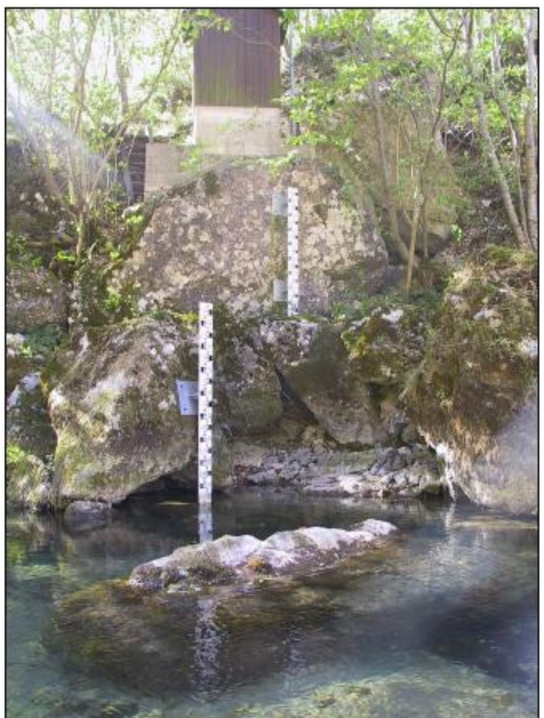
Water level and discharge

- Discharge cannot be measured continuously in time (with normal instrumentation).
- To make things easy, we measure the *river stage* (how high the water level in the river is).
- We use a *rating curve* to relate the discharge to the river stage.

- In the lecture, we will see:
- First: how to measure the river water level;
- Second: how to compute a rating curve;
- Third: how the rating curve can be used, in combination with river stage, to estimate the discharge.

Measurement of water level: staff gage

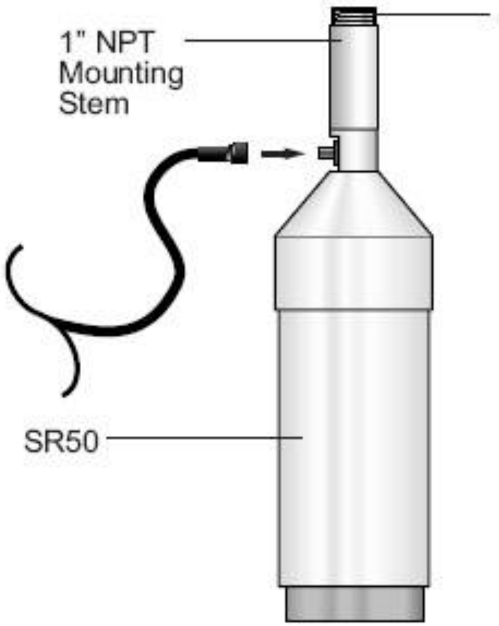
- Staff gages provide a quick and easy visual indicator of water level.
- Every water level monitoring station should include a staff gage from which the height of the water may be visually and easily compared to any data logger's reported measurement (photos taken at Posina Stancari)



Measurement of water level: pressure transducers

- Pressure sensors perform liquid level measurement by having the sensor submerged at a fixed level under the water surface. The pressure sensor measures the equivalent hydrostatic pressure of the water above the sensor, using this to calculate the total liquid depth.

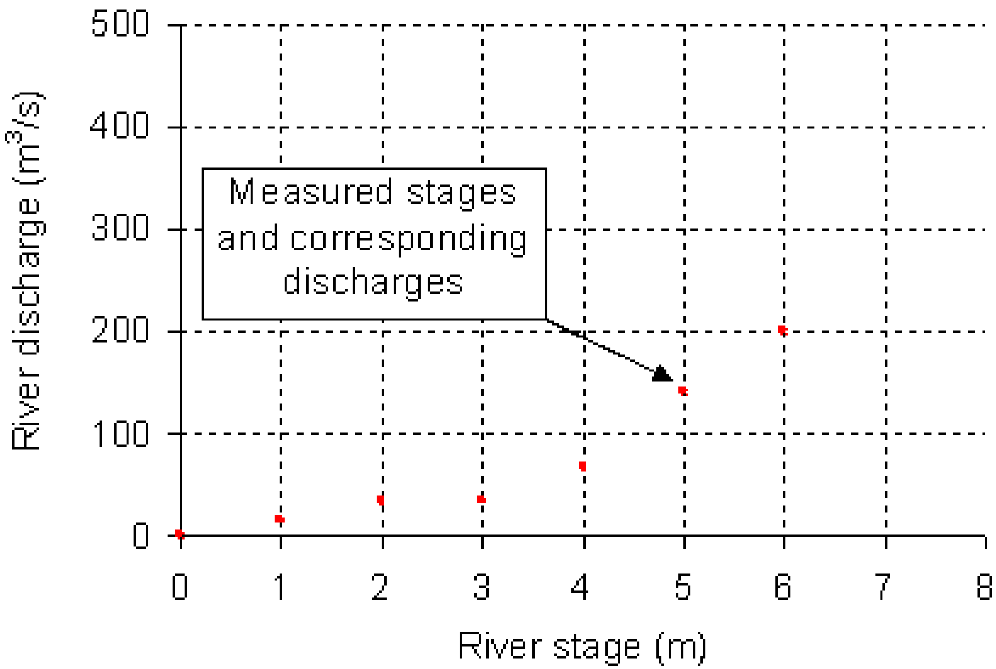
Measurement of water level: ultrasonic devices



- The ultrasonic sensors mount above the water and measure the time of travel for a sound wave to reflect and return to the sensor. These sensors are the least accurate of all the streamgauge sensors but offer simplicity in installation when mounting to a bridge or structure above the water.

Measurement of discharges - 1

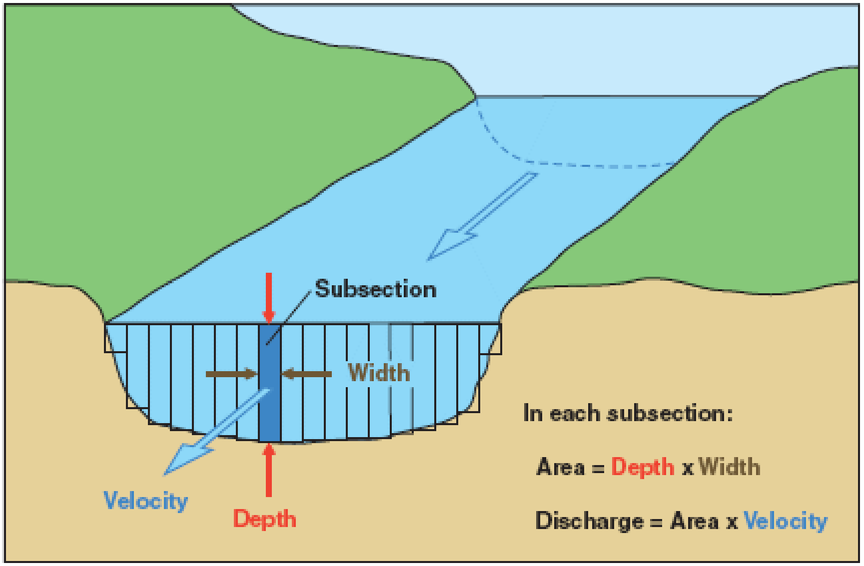
➢ Field campaigns are carried out periodically to record contemporaneous measures of river stage and discharge in steady flow conditions. Such measures allow the localization of discrete points (discharge *Q* – water level *h*) that belongs to the rating curve.

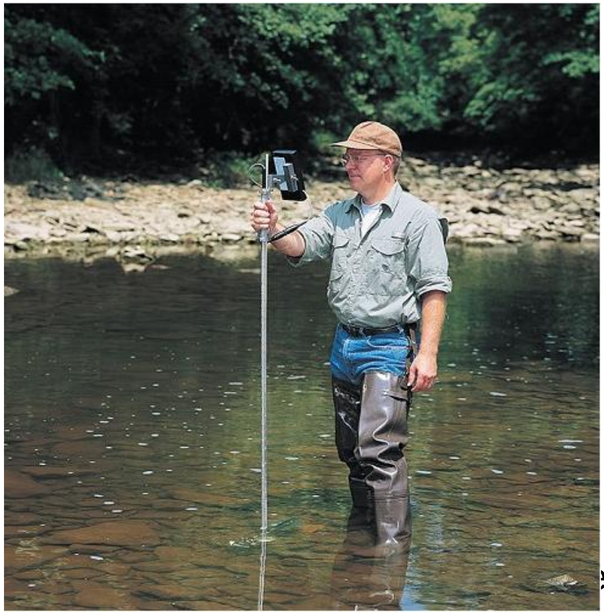


Measurement of discharges - 2

Current meter method:

The most common method for measuring discharge is the mechanical current-meter method. In this method, the stream channel cross section is divided into numerous vertical subsections (diagram). In each subsection, the area is obtained by measuring the width and depth of the subsection, and the water velocity is determined using a current meter (picture below). The discharge in each subsection is computed by multiplying the subsection area by the measured velocity. The total discharge is then computed by summing the discharge of each subsection.





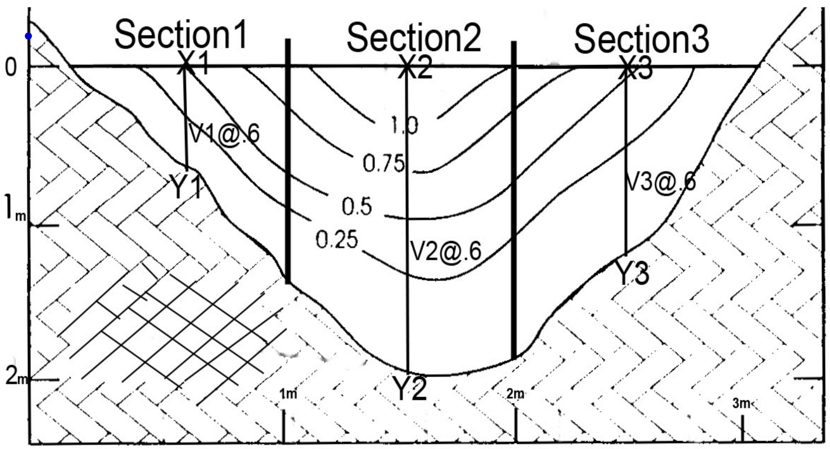
Measurement of streamflow velocity

Streamflow velocity

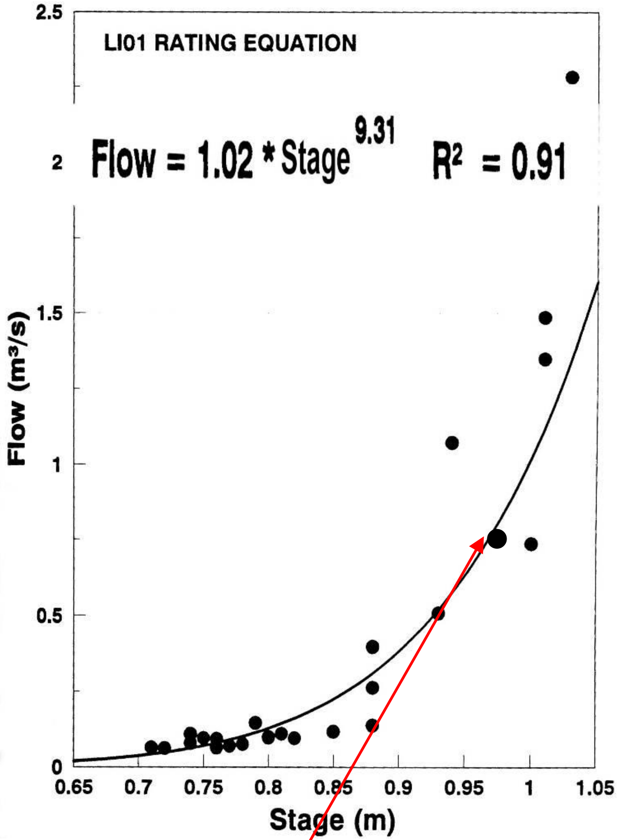
The velocity of the streamflow is measured using a current meter. The current meter has a wheel of six metal cups that revolve around a vertical axis. An electronic signal is transmitted by the meter on each revolution allowing the revolutions to be counted and timed. Because the rate at which the cups revolve is directly related to the velocity of the water, the timed revolutions are used to determine the water velocity. The current meter is designed to be attached to a wading rod for measuring in shallow waters or to be mounted just above a weight suspended from a cable and reel system for measuring in fast or deep water.

Rating curve development

The rating curve may be obtained based on the stage-discharge experimental points by using a power regression (see example). Velocity is taken at 0.6 stage.

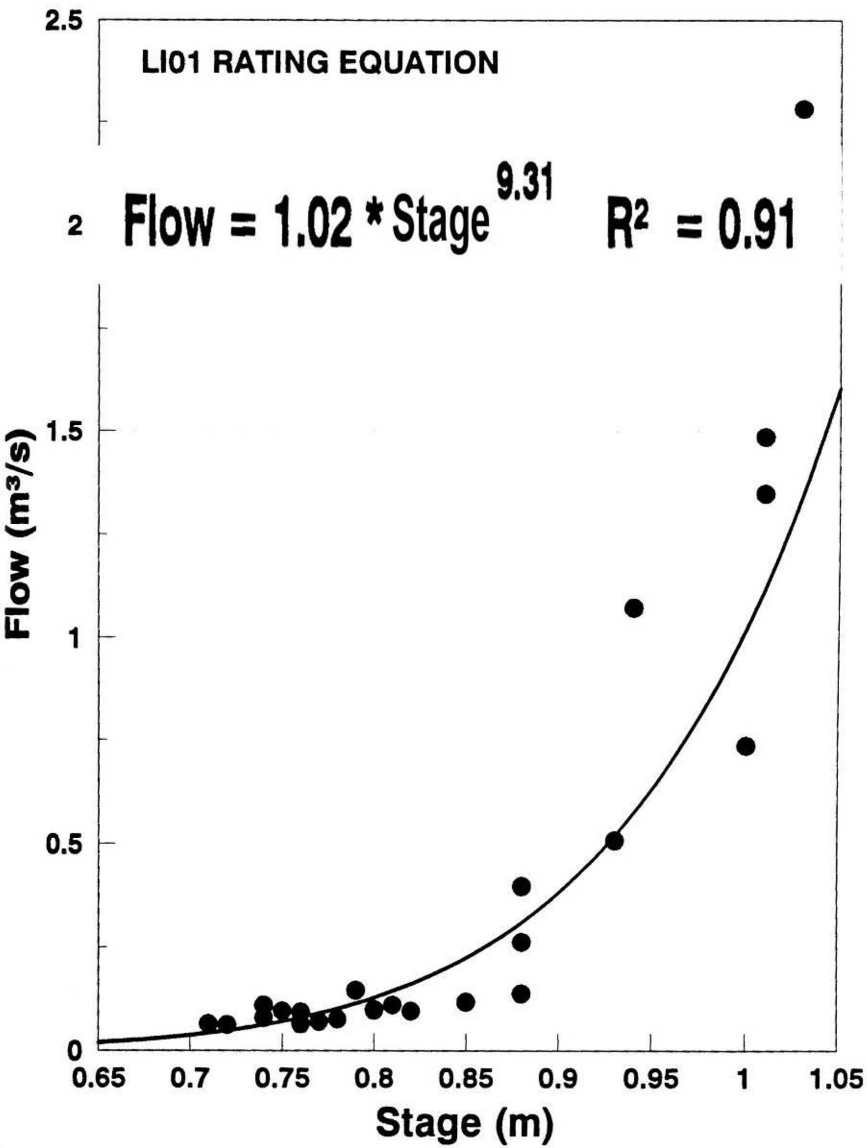


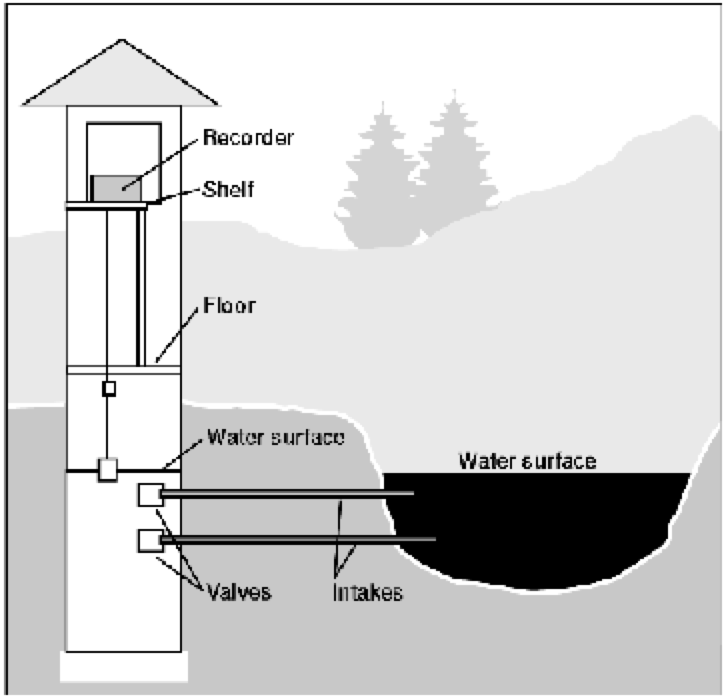
Flow total = (X1*Y1*V1)+(X2*Y2*V2)+(X3*Y3*V3)



Section	Width (m)	Area (m^2)	Vel@.6 (m/s)	Flow (m^3/s)
1	1m	0.7	0.20	0.14
2	1m	2.0	0.25	0.50
3	1m	1.3	0.15	0.20
Total				0.84 m^3/s

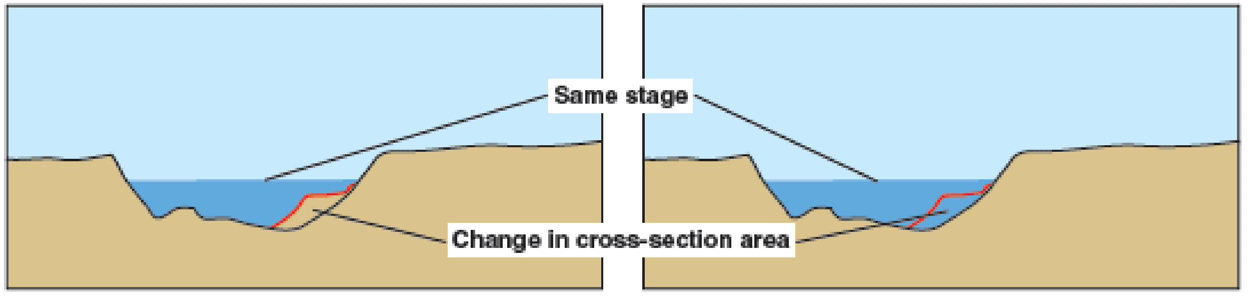
Rating equations and stage recorders allow continuous flow monitoring





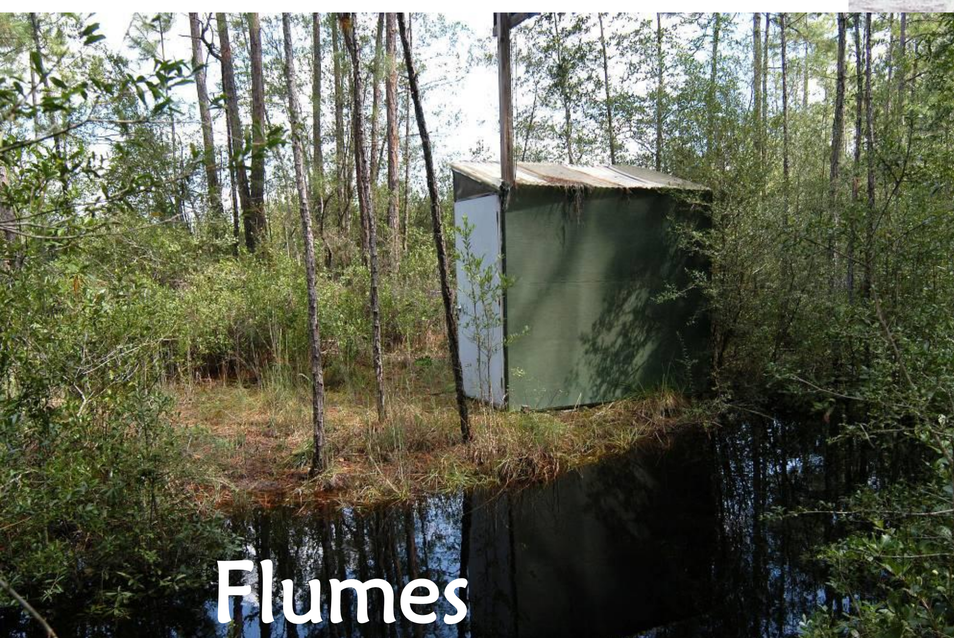
Checking rating equations

The development of an accurate stage-discharge relation requires numerous discharge measurements at all ranges of stage and streamflow. In addition, these relations must be continually checked against on-going discharge measurements because stream channels are constantly changing. Changes in stream channels are often caused by erosion or deposition of streambed materials, seasonal vegetation growth, debris, or ice. An example of how erosion in a stream channel increases a cross-sectional area for the water, allowing the river to have a greater discharge with no change in stage, is shown in the diagram below. New discharge measurements plotted on an existing stage-discharge relation graph would show this, and the rating could be adjusted to allow the correct discharge to be estimated for the measured stage.



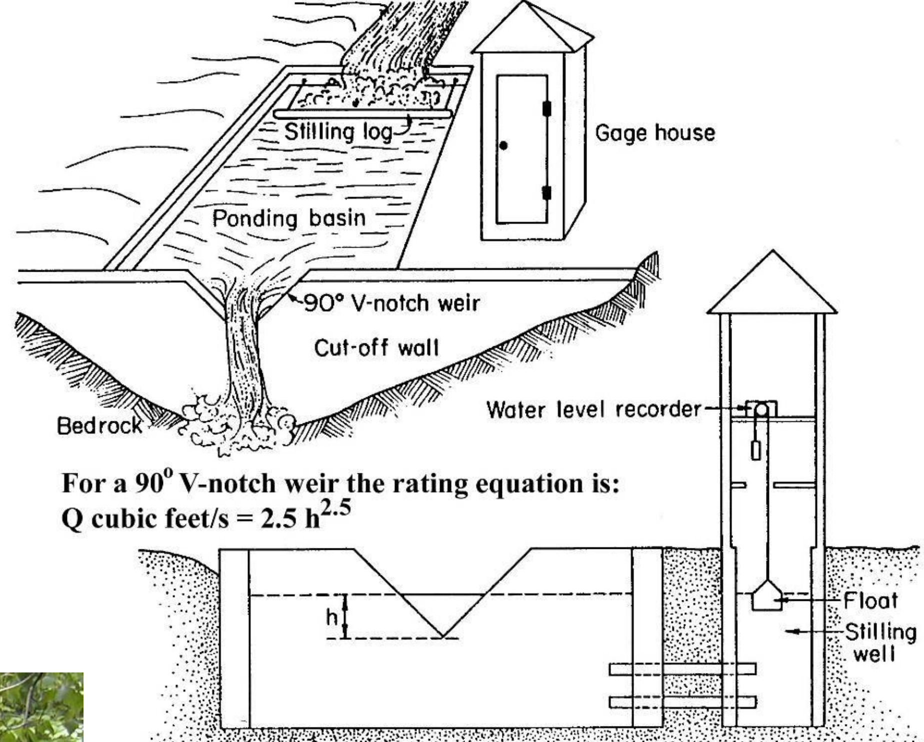
Erosion of part of a channel results in an increased cross-sectional area in the diagram on the right and the potential for conveying a larger quantity of water at the same stage.

Primary Devices for small rivers (where we can build a measuring structure)



Primary Devices

Weirs



For a 90° V-notch weir the rating equation is:
Q cubic feet/s = 2.5 h$^{2.5}$