Streamflow

It is a flow channel into which the surface runoff from a specified basin drains. The classic concept of streamflow generation by overland flow. Only a certain portion of the watershed regularly contributes overland flow to streams, and no more than about 10%of watersheds contribute overland flow. A second important concept of surface runoff generation is water moving through a shallow soil horizon without reaching the zone of saturation, called interflow.

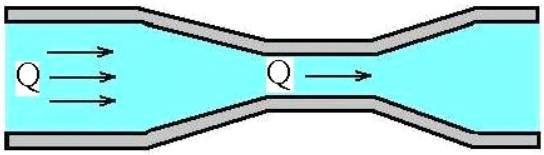
1-Streamflow measurement:

Indirect means. (uniform sections)	Direct means. (non uniform sections)
1-Structures(Weir, Flume and Gates) 2-slope-area. 3- By formulas.	1-Area velocity 2-Dillution technique 3-Electromagnetic 4-Ultra sonic

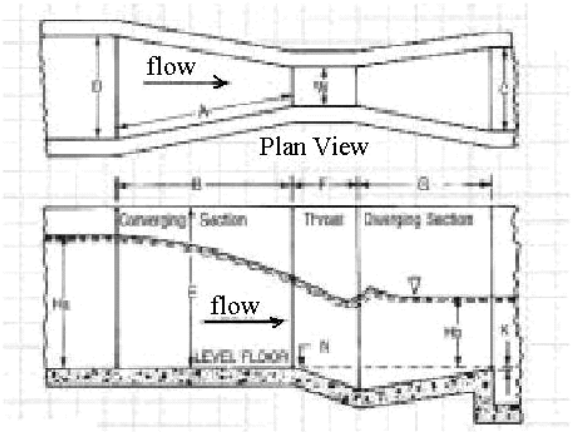
1-Indirect means

1-1.Structures

1.1.1 Flume: by venture flume



Flow Through a Venturi Flume



Top & Side View of a Parshall Flume

$A1=b_1*y1$
$A2=b_2*y_2$
$A_1 V_1=A_2 V_2$
$V_1= A_2V_{1/}A_1$ ……1

$$\frac{P_1}{\gamma} + \frac{V1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V2^2}{2g} + Z_2$$ ……..2Bernoulli

$$Qth=\frac{A_1A_2}{\sqrt{A_{1-A_2}}}\sqrt{2g\,(Y_2 - Y_1)}$$

$Qact=c_d*Q_{th}$.

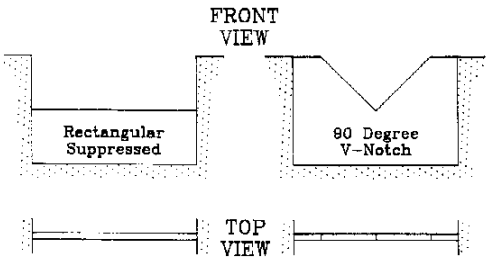
C_d=0.95-0.99

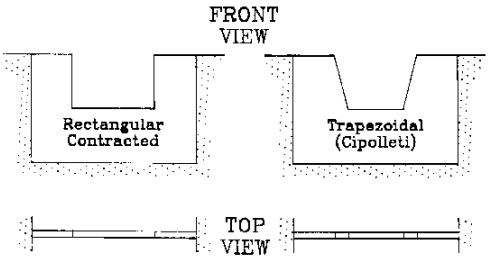
1.1.2-Weirs

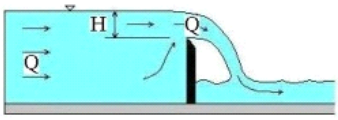
It is a notch in a wall built across a stream,it may be rectangular,trapezoidal, or triangular.

It may be a board built parallel to the stream flow @ the floor of the channel

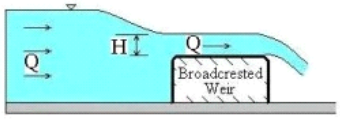
Or maybe a sharp-crested weir







Flow Over a Sharp Crested Weir



Flow Over a Broad Crested Weir

1.1.3 The gates (have been studied during the 2nd stage)

1.2-Slope area method:_If we assume a longitudinal section of flow in a river between two sections 1 and 2 , then by applying the energy equation to sections 1 and 2:

$Z_1+y_1+\frac{V_1^2}{2g}=Z_2+y_2++\frac{V_2^2}{2g}$

Take into consideration the head loss h, and after the equation becomes simple

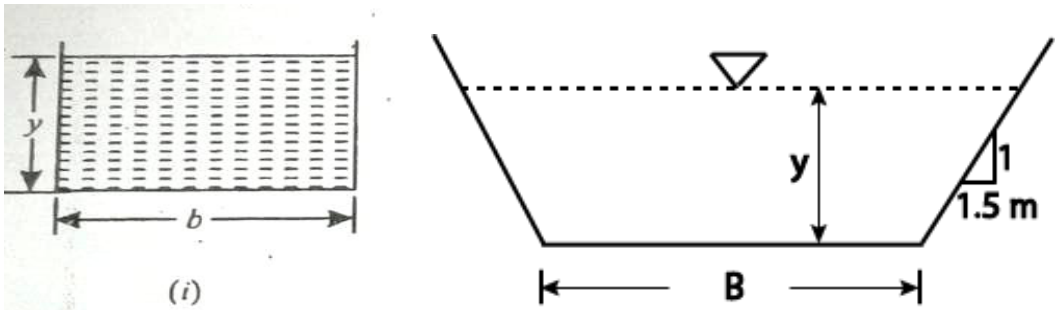
$H=K_e\left(\frac{V_1^2}{2g}-\frac{V_2^2}{2g}\right)$

Where $K=\frac{1}{n}*AR^{2/3}$

1.3- Formulas:

The main formulas to measure the flow in uniform sections are Manning's and Chazy's equations, also the most appropriate sections are the rectangular and trapezoidal sections

Manning's: $Q= 1/n *R^{2/3} S^{1/2} A$		Chazy's: $Q=C AR^{1/2}S^{1/2}$
n and C are roughness coefficients A: cross section area R: Hydraulic radius=A/P P wetted perimeter S: bed slope		
	Rectangular	Trapezoidal
Area A	$b * y$	Y(zy+b)
Wetted perimeter. p	$b + 2y$	$2y\sqrt{z^2 + 1} + b$



2- Direct methods :

2.1- Area velocity method:
It is the measurement of the stream flow in the site, it depends on data that should be calculated as stream water level, water velocity, and the distance from the river bank to that section of the river.

2.1.1- stream level measurement.
The measurement of the streamflow level is called the stage.

Water stage: the stage of a river is defined as its water–surface elevation measured above a datum. This datum can be sea level (MSL)or any arbitrary datum connected independently to MSL.
The simplest way to measure river stage is by :

a-staff gage:a scale set so that a portion of it is always immersed in the water. The gage may be attached to a bridge pier or other structure.

Other types of manual gages are:

b-- **suspended-weight gage:** lowered from a bridge or other overhead structure until it reaches the water surface, by subtracting the length of the line paid out from the elevation of a fixed reference point on the bridge, the water elevation can be determined.

c- recording gage.
d-crest gage.
e-float gage.
f-bubble gage.

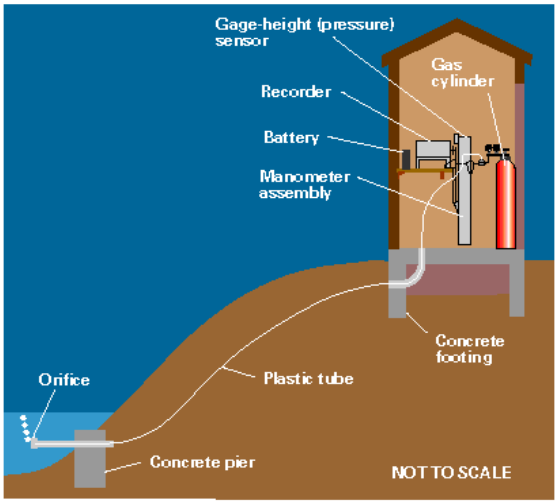
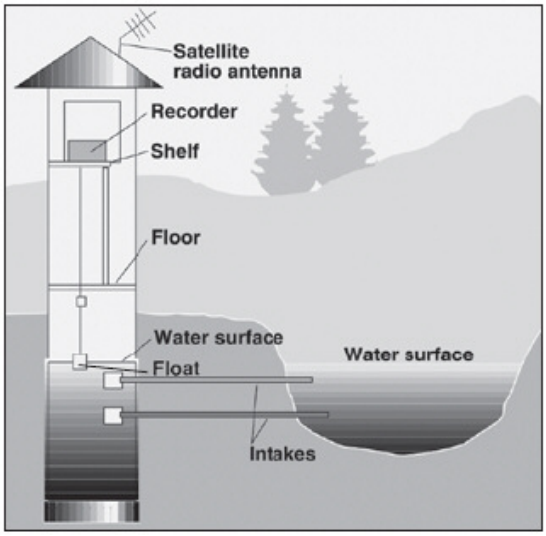


Figure 1. Typical bubble-gage installation, circa 1980.

Bubble gage



floating gage

2.1.2. Stream section velocity:

a- Current meter:
It is a device as shown in the figure used to measure the velocity in the water.

Vi: is a velocity @ each section in the river measured @ one point @ each distance of (0.6 D)from the surface of water or two points @(0.2 & 0.8 D)from the surface.

$$V\ av.= \frac{V@0.2+V@0.8}{2}$$

2.1.3- Calculation of streamflow

a-Mean section

$$Q=\sum \frac{V_i+V_{i+1}}{2} \quad \frac{d_i+d_{i+1}}{2} \ *(b_{i+1} - b_i)$$

b-Midsection:

$$Q=\sum V_i * d_i * \frac{(b_{i+1}-b_{i-1})}{2}$$

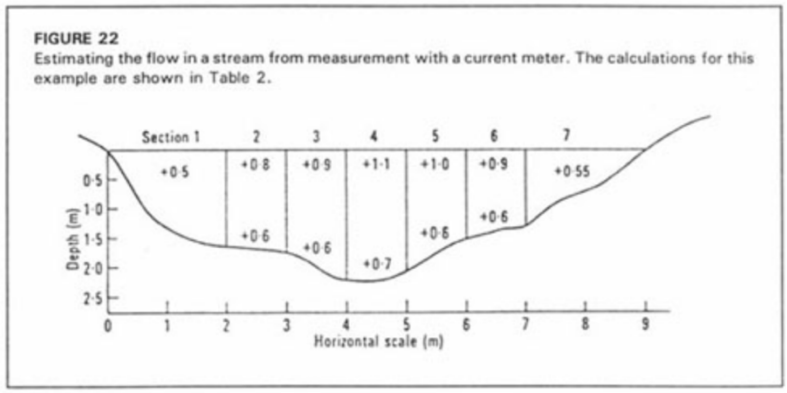


FIGURE 22
Estimating the flow in a stream from measurement with a current meter. The calculations for this example are shown in Table 2.

TABLE 2
Calculation of steamflow from current meter readings

1	2	3	4	5	6	7	8
Section	Flow velocity (m/s)			Depth (m)	Width (m)	Area (m^2) 5 x 6	Flow (m^3/s) 4 x 7
	0.2D	0.8D	Mean				
1	-	-	0.5	1.3	2.0	2.6	1.30
2	0.8	0.6	0.7	1.7	1.0	1.7	1.19
3	0.9	0.6	0.75	2.0	1.0	2.0	1.50
4	1.1	0.7	0.9	2.2	1.0	2.2	1.98
5	1.0	0.6	0.8	1.8	1.0	1.8	1.44
6	0.9	0.6	0.75	1.4	1.0	1.4	1.05
7	-	-	0.55	0.7	2.0	1.4	0.77
						TOTAL	9.23

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Examples

Ex1.

Compute the stream flow discharge for the measurement data below

Distance(m)	0	15	25	35	45	55
Velocity(m/s)	0	0.5	0.7	1	0.6	0
Depth(m)	0	3	4	6	5	0

Mean sec.

$$Q=\sum \frac{V_i+V_{i+1}}{2} \quad \frac{d_i+d_{i+1}}{2} * (b_{i+1} - b_i)$$

$$Q=\frac{0.5+0}{2} * \frac{3+0}{2} *(15-0)+ \frac{0.5+0.7}{2} * \frac{3+4}{2} *(25-15) + \frac{1+0.7}{2} * \frac{6+4}{2} *(35-25) + \frac{0.6+1}{2} * \frac{5+6}{2} *(45-35) + \frac{0+0.6}{2} * \frac{0+5}{2} *(55-45)= \quad m^3/s$$

Distance(m)	0	15	25	35	45	55
Velocity(m/s)	0	0.5	0.7	1	0.6	0
Depth(m)	0	3	4	6	5	0

Mid sec.

$Q=\sum V_i * d_i * \frac{(b_{i+1}-b_{i-1})}{2}$

Q=0.5*3*(25-0)+0.7*4*(35-15)+1*6*(45-25)+0.6*5(55-35)= m^3/s

Ex.2

A trapezoidal channel lined with concrete,c=130,B=10 m,side slope=1:1,depth=5m, channel slope =0.0004,find discharge?

$Q=c\ A\ \sqrt{RS}$

$A=B\ Y+Z\ Y^2$,

R=A/P,

$P=B+2Y^{2=}24.1$ m

R=75/24.1=3.11m

$Q=130*75*3.11^{0.5} * 0.0004^{0.5} = 343\ m^3$

2.2 -Dilution technique

It is a chemical method by applying a tracer powder(non-dissolved) with stream flow till it dilutes, and then the discharge is calculated.

2.3-Electromagnetic.:

It is based on Faraday's principle that an EMF is included in the conductor when it cuts a normal magnetic field.

2.4-Ultrasonic method

By using the ultrasound to calculate the velocity and then the discharge