FLOW MEASUREMENT IN NATURAL STREAMS – FLOAT METHOD – CURRENT METER.

Streamflow discharge is defined as the volume rate of flow of water that includes any substances dissolved or suspended in the water. Discharge is usually expressed in units of cubic feet per second (cfs or ft3/sec). With rare exception, stream discharge is not measured directly, but is computed indirectly from velocity and water level (stage) measurements. If the mean water velocity normal to the direction of flow (V) and the crossectional area (A) of water flow is known, then the discharge (Q) can be computed as Q=VA. As previously discussed in Lesson 1, determining the mean stream velocity is a labor intensive activity, and usually only performed to establish or refine a relationship between stage, which is easy to measure, and discharge. The discharge rating is a relationship between the stage and discharge or between stage, discharge, slope, rate of change of state, or other factors.

Developing a stage-discharge relationship for a stream requires a set of observed flow (discharge) measurements. Discharge measurements are made at each gaging station to determine the discharge rating for that site. Discharge measurements are initially made are made frequently over a wide range in stages. Periodic measurements are then made (usually monthly) to validate the rating or to identify any changes in the rating caused by changes in the stream channel or stream bed.

Determining Discharge Using Current Meters

The most common approach to determining discharge is the so called conventional current-meter method. The method is based on determining the mean streamflow velocity and flow cross sectional area; the product of these variables determines the stream discharge. The hydrographer measures stream depth and velocity at selected intervals across a stream's cross section. The hydrographer may be wading, or supported by a cableway, bridge, ice cover, or a boat. Depth and position measurements are made with simple surveying or sounding equipment. A device known as a current meter (described in a section below) measures the stream velocity.

Measurement Instruments and Equipment used with Current Meter Methods

The purpose of the following sections is to present a brief summary of the more commonly used instruments for the measurement of stream velocity for computing stream discharge using a current meter method. Sections will include a discussion of different types of current meters and miscellaneous other equipment used for depth and position measurements.

Current Meters

A current meter is an instrument that measures the velocity of flowing water. While there are several types of current meters, they all have a blade or cup that spins when the meter is placed in flowing water. The current meter is based on the principle that the velocity of water is proportional to the angular velocity of the meter's rotor. The velocity of water at a given point can be determined by counting the number of revolutions of the rotor during a specified or measured interval of time. The number of revolutions of the rotor is obtained using an electrical circuit through the contact chamber. Contact points in the chamber complete an electrical circuit at selected revolution frequencies. Contact chambers are made that have contact points that complete the circuit twice per revolution, once per revolution, or once per five revolutions. The electrical impulse generates an audible click in the headphones or alternatively, registers a unit on a counting device. The time intervals during which meter revolutions are counted are usually timed with a stopwatch.

Natural streams and artificial channels normally experience turbulent flow. Local eddying always accompanies turbulent flow. Local eddying results in pulsations in the velocity at a point. An example is shown in Figure 5.3 that depicts the pulsations in a laboratory flume for two different mean velocities. Note that the greater the magnitude of the pulsations, relative to the mean at the lower velocity, explains why point current meter observations should cover a longer period when low velocities are being measured. At high velocities, pulsations have a minor impact. Typically, velocities are observed from periods ranging from 40 to 70 seconds. The rational for the interval is based on the observation that pulsations are random. Furthermore, since velocity measurements are made at 25 to 30 verticals, usually with two observation being made in each vertical, there is little likelihood that the pulsations will bias discharge data. Longer periods of current meter observation are not made for two reasons. First, it is desirable to complete a discharge measurement prior to a change in stream stage. And secondly, the use of longer operational periods significantly increases the operating cost of a large number of gaging stations.

Current meters are classified according to their rotors. Vertical-axis rotors, which have cups or vanes, operate in lower velocities than horizontal axis meters. Their bearings are also protected from silty water. The rotor is also repairable in the field without impacting the rating, and the single rotor serves for the entire range of velocities.

In contrast, the horizontal rotor meters disturbs less flow because of the axial symmetry with the flow direction. The rotor is less likely to be entangled with debris, and the bearing friction is less than for vertical axis rotors since the bending moments on the rotor are eliminated.