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TECHNICAL OPERATING PROCEDURE

PROCEDURE TITLE:

Procedures for Conducting Stream Discharge Measurements

APPLICABILITY:

Procedure applies to the determination of discharge conducted prior to the application of lampricides to streams.

PRINCIPLE:

Prior to a lampricide treatment it is necessary to measure stream discharge at various sites throughout a watershed in order to calculate application rates of lampricide at pre-selected locations. Discharge measurements can also be used to estimate the amount of dilution along the course of the stream in order to determine whether additional lampricide applications are required to maintain SMLC throughout the treatment area.

SAMPLE COLLECTION AND PRESERVATION:

Not applicable

EQUIPMENT REQUIRED:

Current meters
- Price (AA)
- Price (Pygmy)
- Teledyne Gurley (665G)
- Flo-Mate model 200

Top-setting wading rod
Bridge board
Sounding reel
Weight
Miscellaneous
- Measuring tape
- Stop watch
- Staff gauge
- Data recording sheets

POTENTIAL INTERFERENCES:

The ideal gauging site provides a good perpendicular cross section of the stream flow, an even bottom contour (not necessarily flat), good flow from bank to bank, no obstructions and a relatively solid bottom. Any conditions encountered that are detrimental to the ideal site can interfere with the accuracy of the discharge measurement. These include obstructions such as logs and boulders, aquatic vegetation, undercut banks, shallow water, riffle areas, turbidity and lighting conditions, dead water areas, eddies, soft substrate, bridges and culverts, multiple stream channels and wind.

SAFETY:

Gauging in deep or swift water may be hazardous. An uneven bottom, soft, loose or slippery substrate, turbidity, and obstructions may increase the danger. A general rule of thumb, which has been used in the past, is arrived at through the product of depth (m) and velocity (m/sec). Generally speaking, if the stream bed is firm and provides good footing, the product of these two factors should be slightly less than 0.6 for safe conditions. Avoid potentially dangerous situations such as deep pools, waterfalls, etc. immediately downstream of the gauging site. Automobile traffic is a consideration while conducting bridge board measurements; if traffic is too heavy another site is chosen.

DISPOSAL:

Not applicable

REAGENTS:

Not applicable

PROCEDURES:

I. General Principles:

Stream discharge may be defined as the volume of water moving through a cross section of stream per unit of time and is expressed as cubic feet per second (cfs) or cubic meters per second (cms). The procedure described here is the velocity-area technique whereby the computed discharge of a stream is the product of the cross-sectional area and the average velocity.

The cross section of the stream at the measurement site is divided into sufficient sections so that the depth measurements will develop an accurate profile of the bed, and the velocity

measurements are made close enough to obtain an accurate representation of velocities in each of the sections. The width of the individual sections will largely depend on the overall width of the stream, the unevenness of the stream bed and the variation of velocities across the channel.

It is important to space the sections more closely where the depths and velocities are more variable in order to define accurately the discharge for any given section. Ideally, a minimum of 10 sections is used, depending on stream width, and each section contributes no more than 10% of the total discharge. These criteria may not be possible for very small streams where a smaller number of measurements may be sufficient if the measurement between sections is less than 1 ft (0.3 m). Alternatively, a Pygmy meter (a smaller version of the customary Price 622 AA) may be used in order to obtain a greater number of sampling points.

Mean velocities are to be determined in each of the measured sections. The 0.2 and 0.8 depth method is normally used when obtaining the mean velocity in a vertical velocity curve. This is based on both mathematical theory and on studies of actual observations from numerous vertical velocity curves. For measurements where the depths are less than a specified value (about 0.7 m) observations are made at the 0.6 depth. Experience has shown that the use of the 0.2 and 0.8 depth method in shallow streams places the current meter too close to the water surface and the stream bed to give reliable results.

II. Site Selection Criteria:

The discharge metering site should be in a safe location, with a firm bottom and depth of less than 1 meter. The metering cross section is perpendicular to the general direction of flow and located in a reach of river where the bed and banks are straight and uniform for about 5 times the section's width upstream and 2 times downstream. The stream bed cross section is as uniform as possible and free from vegetation, boulders, logs, etc.

III. Conducting the Measurement:

A staff gauge is used to accurately relate the discharge measurement to the water depth at the time of the measurement. It is essential that the placement of the gauge is reasonably close to the metering site and that it is positioned to accommodate changes in water level without being washed out, inundated or left high and dry and so that it can be readily checked from shore. The staff gauge is set and the initial staff gauge reading is recorded. The reading is checked again at the end of measurements to insure that no change in water level has occurred.

A. Standard (wading) measurement.

Stream discharge is measured by using a current meter attached to a wading rod that has depth measurement capability (IOP:001.x). To begin a measurement, a tape measure (graduated in either 1/10th foot or 1/10th meter increments) is placed across the stream. If not familiar with the site, it is advisable to make a preliminary crossing before stringing the tape. Anchor one end at the initial point and proceed across the stream at right angles to the direction of the current.

While wading across the stream, an overall impression of the depths and velocities can be obtained. This is a good time to look for rocks and debris which can be removed from the stream bed to improve the measuring site. Remove weeds for a distance of about 3 times the depth from the area upstream and downstream from the site. On smaller streams it may be possible to construct small dikes to cut off sections of shallow flows and dead water. After any modifications of this sort, be certain to allow sufficient time for conditions to stabilize before proceeding with the measurement.

Record the distance between the edge of the water and the end of the measuring tape. If

there is a vertical drop at the edge, an observation of depth and velocity is made. Move to the position selected as the next vertical gauging site and record the distance. Observe and record the depth. Depths are measured by reading the level of the water surface on the rod when the base plate rests on the stream bed. The current meter is set to the correct depth to obtain and record the velocity. This procedure is repeated until the stream is traversed and the measurement is completed. The total discharge for the site is the sum of the discharges from the individual sections.

The position of the operator with respect to the current meter is important when making a discharge determination by wading. The operator is to the side and downstream of the meter to avoid influencing the measurement of velocity. Studies indicate that the position that has minimal effect on the operation of the current meter is when the operator stands facing either shore and is no less than 16 inches (0.4 m) downstream and to the side of the current meter.

B. Bridge board measurement

Measurement of stream velocity through the use of a bridge board is fundamentally the same as the measurement technique outlined under III. A. Standard (wading) measurement. This method is often substituted for the standard method of measurement when stream depth or velocity does not allow wading.

Whether to measure the stream velocity from the upstream or downstream side of a bridge is decided onsite. Advantages exist for conducting measurements on either side of the bridge; all factors must be considered:

1. Upstream
   a. Hydraulic characteristics at the upstream side of bridge openings usually are more favorable.
   b. Approaching drift can be seen and be more easily avoided.
   c. The streambed at the upstream side of the bridge is not likely to scour as badly as at the downstream side.

2. Downstream
   a. Vertical angles are more easily measured because the sounding line will move away from the bridge.
   b. The flow lines of the stream may be straightened out by passing through a bridge opening with piers.

3. Physical conditions
   a. Location of the walkway
   b. Traffic hazards
   c. Accumulation of trash and driftwood on piles and piers

To begin a measurement, a tape measure (graduated in either 1/10th foot or 1/10th meter increments) is placed across the bridge between points corresponding to the locations of the stream banks (vertical from end point of tape on bridge to edge of bank). If there is a vertical drop at the edge of the stream, the first observation of depth and velocity is made at this point.

Use either a hand line or a sounding reel supported by a bridge board or a portable crane to suspend the current meter and sounding weight from the bridge. The size of the sounding weight used in current meter measurements depends on the depth and velocity in a cross section of the stream. A rule of thumb is that the size of the weight in pounds should be greater than the maximum product of velocity and depth in the cross section. If

insufficient weight is used the sounding line will be dragged at an angle downstream. If debris is flowing or if the stream is shallow and swift, use a heavier weight than the rule designates. The Price type-AA current meter is generally used to make velocity measurements. The depth is measured with a sounding reel and the velocity is measured by setting the meter at the proper position in the vertical.

1. Depth measurement
   a. Lower the meter so the center of the current meter rotor is at the surface of the water then set the indicator on the reel to zero.
   b. Lower the weight and meter to the streambed and observe the reading on the ***main*** scale. This reading added to the distance from the bottom of the weight to the center of the current meter rotor provides the total depth.

2. Velocity measurement
   a. Move the current meter to the 0.8 position by raising the weight and meter until the hand on the indicator is on the total depth on the ***graduated*** scale. Record the velocity reading.
   b. Set the meter to the 0.2 position by raising the weight and meter until the indicator on the ***main*** scale is pointing at 0.2 x the total depth. Record the velocity reading. Move to the next position (vertical) and repeat.

REFERENCES:

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This procedure has been reviewed and approved by the undersigned representatives of the U.S. Fish and Wildlife Service and Fisheries and Oceans Canada.

REVIEWED/APPROVED Jessica M. Barber Digitally signed by JESSICA BARBER Date: 2020.03.10 11:28:12 -04'00' DATE _____
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