Please note that the Washington State Department of Ecology’s Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.
### SOP Revision History

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1.0 **Purpose and Scope**

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for Estimating Streamflow for wade able streams, culverts, and other volumetric measurements such as pipes, drain tiles, or seeps. Additional stream discharge measurement techniques may be found in the following SOPs: *Measuring and Calculating Stream Discharge* (EAP056) or *Measuring Stream Discharge from a Bridge* (EAP060). Consider requesting Ecology’s Freshwater Monitoring Unit assistance for measuring streamflow where conditions are beyond the techniques presented in this SOP.

2.0 **Applicability**

2.1 This document should be used for wade able streams, culverts, and other volumetric measurements such as pipes, drain tiles, or seeps.

3.0 **Definitions**

3.1 Fixed Point Averaging (FPA) - An average of velocities over a fixed period of time.

3.2 Reference Point (RP) - A fixed point or datum on the bridge or other structure from which a measurement can be made to the surface of the water under for all flow conditions.

3.3 Staff Gage - A graduated measuring device securely fixed to a permanent structure in the streambed from which river stage height can be read directly to the 100th of a foot.

4.0 **Personnel Qualifications/Responsibilities**

4.1 Trained in safety procedures for work in streams.

5.0 **Equipment, Reagents, and Supplies**

5.1 Flow/current meter. Currently the Directed Studies Unit uses two types of flow meters, the Marsh-McBirney® and the Swoffer®. Also of interest is the Acoustic Doppler current profiler (ADCP) if available.

5.2 Wading Rod designed to measure water depth and position the current meter at 0.2, 0.6, and 0.8 of the total stream depth

5.3 Field notebook or other recording device

5.4 Measuring Tape (100 ft or long enough to span the width of the stream)

5.5 2 Stakes

5.6 Clamps with attached springs (for clamping the measuring tape to the stakes)

5.7 Life Vest/Personal floatation device (PFD)

5.8 Hip or Chest Waders
5.9 Staff gage (if used) and equipment for installation
5.10 Tape down (if used)
5.11 Container (such as a bucket) and stop watch (both used for volumetric measurements)

6.0 Summary of Procedure

6.1 Selecting a Representative Cross Section to Measure Discharge

6.1.1 Selecting a suitable stream cross section for measuring discharge is very important and cannot be over emphasized. Site selection is, in most cases, the most important factor in developing accurate flow information. The limitations of a poor cross section can not be overcome by the ability of the individual taking the measurement. It is often not possible to find the ideal site, but try to find a reasonably accessible site that meets criteria to the maximum extent possible. Use the following criteria for deciding which cross section to use:

6.1.1.1 The stream reach should be relatively straight and uniform for a long enough distance to provide uniform flow through the measuring section (preferably 200-300 feet upstream and downstream of the measurement site). The site should be free of large eddies, slack water, and excessive turbulence.

6.1.1.2 The stream channel should have minimal vegetative growth and be relatively stable (free from major seasonal scouring or deposition of bed material).

6.1.1.3 The stream bed should be relatively uniform with only minor irregularities (few or no large cobble or boulders).

6.1.1.4 The stream channel should be confined to a single course, or multiple channels should have optimal characteristics. Braided channels tend to develop during low flow conditions (typically August-October).

6.1.1.5 The stream bank should be stable and able to contain the maximum stream discharge (floods) when the site will be accessed during the study period.

6.1.2 If these criteria are met, the cross section should be relatively stable under most conditions and the streamflow should be smooth (non-turbulent) and parallel (perpendicular to the cross-section). It is, however, unrealistic to assume all stream cross sections will meet all of these criteria. Therefore, complete and accurate field notes describing the cross section and noting how well the site meets these criteria are vital when determining the relative accuracy of the discharge measurement.

6.2 Site preparation

6.2.1 Ideally, the cross section to be measured will meet all of the selection criteria, however, some will not. In general work with what is available and do not make large scale channel modifications if any. If the cross section selected is compromised by excessive aquatic plants, the presence of woody debris, or has minor irregularities in the stream bed (rocks and manageable boulders), an attempt should be made to minimize their
impact on flow measurements. This may require physical removal of interference and minor alterations of the streambed. However be mindful not to disturb fish and wildlife habitat keeping impacts on the stream bed and riparian area to a minimum. After the cross section has been cleared, inspect the stream banks to ensure they are confining enough to provide a distinct edge. Do not modify the cross section while velocity measurements are being conducted. Modifying the cross section after velocity measurements have begun may alter the flow characteristics and therefore compromise the accuracy of your measurement.

6.3

**Dividing the stream channel into segments**

6.3.1

Channel geometry, substrate, and other stream features cause horizontal variability across the stream. Because most stream velocity and bottom contours vary as you proceed across the stream channel, the cross section is divided into manageable segments.

6.3.2

At the cross section stretch a measuring tape (tagline) across the stream. The tagline should be perpendicular to the stream flow.

6.3.3

Anchor the tape with stakes or to surrounding vegetation. The clamps may be used to anchor the tape to the stakes.

6.3.4

Note width of the stream channel and divide into conveniently measurable segments. Segments in the thalweg should have shorter distances between measuring point than segments where less discharge is apparent. The total number of segments should be large enough to ensure no more than 10% of the total flow is contained in any one segment (preferably 5%). In general 20 or more velocity measuring points will achieve 5% or less of discharge in any given segment. A minimum of 0.3 feet is required between measuring points.

6.4

**Measuring stream velocity of the stream segments**

6.4.1

Stream velocities not only vary horizontally across the stream transect, but vertically as well. Currently two methods are used to address vertical variability within a segment; one applies with stream depths less than 2.0 feet and the other for streams over 2.0 feet (Ecology’s Freshwater Monitoring Unit cutoff is 1.5 feet instead of 2.0 feet). For stream segments under 2.0 feet in depth, the velocity is measured at sixth-tenths below the water’s surface (six-tenths method). For streams with depths greater than 2.0 feet, the velocity is measured at two-tenth and eight-tenths of the depth and the results are averaged (two-tenths/eight-tenths method). In situations where stage is changing significantly during the course of the measurement, the six-tenth method should be applied at all depths. The idea is to get the measurement finished quickly and limit the loss of accuracy caused by rapidly changing stage.
6.5 **Measuring Water Depths and Velocities**

6.5.1 Record site information in the field notes.

6.5.2 Measure and record stage gage readings or tape down (if available).

6.5.3 Select a suitable stream cross section for measurement.

6.5.4 Determine which safety requirements are warranted based on in-stream conditions. Do not proceed if the conditions are not deemed safe such as deep swift moving water, soft muddy bottom, or steep slippery banks.

6.5.5 Prepare cross section as necessary.

6.5.6 Stretch measuring tape (tagline) across the stream channel perpendicular to streamflow and note total stream wetted width.

6.5.7 Divide stream width into approximately 20 segments with no more than 5 to 10 % estimated flow in any one segment. Consider reducing the number of segments under rapidly changing stage conditions. Visually determine where segments should be reduced or expanded based on anticipated streamflow velocities and depths. For example shorten the segment where high velocities occur and lengthen the segment where low velocities may occur. Also decrease segment size when measuring close to boundaries (i.e., boulders, logs, near bridge pilings etc). The two-tenth and eight-tenths methods may also be use near or behind stream obstructions.

6.5.8 Turn current meter on and make sure settings are correct (See Appendix A for current meter instructions).

6.5.9 Note at what bank the measurements begin (either left bank or right bank). Left and right bank is determined when facing downstream. Begin the flow measurement by recording the number on the measuring tape that corresponds with the wetted edge of the stream. Record a zero value for the depth if the wetted edge is not a vertical boundary. If the wetted edge is a vertical boundary with depth and velocity then the velocity at the wetted edge should be estimated. Because velocity cannot be measured accurately at a vertical boundary, the velocity can be estimated by measuring the mean velocity at a distance from the boundary equal to the depth at the boundary (Rantz, 1982).

6.5.10 Measure the depth and length of the first vertical by reading the water level (stream depth) on the wading rod and number on the tape. The “vertical” refers to the point in the cross-section where depth and velocity are measured. To get a representative water depth reading, take into account the water mounding on the upstream side of the wading rod and any transient variation in the water level. Look for a reading of the central tendency that represents conditions around the rod for the segment you selected. Record the stream depth and number on the measuring tape. Always stand downstream and to the side of the wading rod so your presence in the water doesn’t create a local backwater that affects the velocity reading.

6.5.11 Adjust the wading rod to the proper depth and reset/clear the meter to begin averaging stream velocities.
6.5.12 For stream depths < 2.0 feet, use the scale on the wading rod to place the meter sensor at six-tenths (0.6) depth. Basically the stream depth measurement value will correspond with the same number on flow rod. For example the flow rod should be set 1.2 for a stream depth of 1.2 feet.

6.5.13 For stream depths > 2.0 feet, adjust the wading rod so that the meter sensor is at half the total depth for the eight-tenths (0.8) depth and double the total depth for two-tenths (0.2) depth. For example if the stream depth is 2.5 feet, the current meter should be positioned at 1.25 and 5.0 on the wading rod in order to measure eight-tenths and two-tenths depths respectively.

6.5.14 After the velocity meter has completed its averaging interval, record the velocity in the proper column in field notes.

6.5.15 If the velocity measurement is a negative number, turn the flow meter 180° to face downstream to check if here too is a negative number. If both directions are negative record a zero velocity value. If the downstream measurement is positive, then record this velocity as a negative number. This will capture any back eddies that can cause significant error when calculating streamflow.

6.5.16 Proceed across the stream, repeating steps 10-15 at each vertical segment until the entire wetted width is accounted for.

6.5.17 Measure and record the stage height (if available).

6.6 Measuring Water Depths and Velocities from a Bridge

6.6.1 Refer to the EAP Freshwater Monitoring Unit’s SOP for Measuring Discharge from a Bridge (EAP060).

6.7 Measuring Water Depths and Velocities from a Boat.

6.7.1 Refer to the EAP Freshwater Monitoring Unit’s SOP for Measuring Discharge from a Boat (EAP056).

6.8 Calculating Stream Discharge

6.8.1 The midsection method is used to calculate stream flow based on United States Geological Survey (USGS) technique (Rantz, 1982). The equations comprising the midsection method are written into a variety of computer programs. Ecology’s Directed Studies Unit uses an Excel® spreadsheet to calculate stream discharge.
6.8.2 Although computation of discharge by hand is virtually unnecessary, an understanding of the midsection calculation method can influence strategies and decisions while conducting discharge measurements. The midsection calculation method involves summing the discharges of the individual cells comprising the cross section using the following equation:

$$q_x = v_x \left( \frac{(b_{(x+1)} - b_{(x-1)})}{2} \right) d_x$$

where for segment ‘x’:
- \(b_{(x+1)}\) = distance from initial point to next vertical (feet),
- \(b_{(x-1)}\) = distance from initial point to preceding vertical (feet),
- \(d_x\) = depth of water at vertical x (feet)
- \(v_x\) = mean velocity at cell x (feet per second)
- \(q_x\) = discharge through cell x (cfs)

6.9 Float Method to Estimate Velocity

6.9.1 When usual flow measurement methods cannot be used, a neutrally buoyant object can be used to estimate velocity. The object can be an orange, a plastic sample bottle partially filled with water, or any other practical semi-buoyant object. This method is not recommended for estimating discharge used to calculate loads in a Total Maximum Daily Load study. However this method is more intended for remote streams where overnight backpacking is necessary where hauling all the necessary discharge equipment is too difficult.

6.9.2 Locate a straight stretch of stream

6.9.2.1 Select two cross-sections within the stretch, measure (or estimate) their cross-section area and distance between them. Sites should be far enough apart that float movement between sites exceeds 20 seconds.

6.9.2.2 Release the float at the upstream site and record the time it takes to reach the downstream site. Repeat at least twice (more if the times are variable) and average the measurements. To increase accuracy, release the float at different places across the width of the stream.

6.9.2.3 Calculate the velocity as distance traveled divided by average travel time.

6.9.2.4 Calculate the adjusted (true mid-depth) mean velocity of the water by multiplying the surface velocity by 0.85.

6.9.2.5 Calculate discharge by multiplying velocity by the average cross-sectional area.

6.10 Measuring Flow from Pipes or Culverts

6.10.1 Volumetric Measurements
6.10.1.1 In this method, discharge is calculated by observing the time required to fill a container such as a bucket or 1 liter bottle of a known volume (also known as a “bucket flow”). Note the container does not have to be filled completely as long as a known volume is captured at a known time this will give a discharge volume over time. A limiting factor of this technique is that it can only be used with small discharges (i.e., where all of the flow can be caught in one container). This technique can also be used to estimate discharge over a weir or at any place where flow is concentrated into a narrow stream.

6.10.1.2 Place bucket or other container below the discharge.

6.10.1.3 Time how long it takes to fill the container. Repeat three times (or more if there are large differences between results). Record the volume and time.

6.10.1.4 Another volumetric measurement technique is to measure the volume of discharge over a fixed time. This will require using a graduated container to measure discharge volume. Mark the side of a bucket at graduated volume intervals. For example add one liter water to a bucket and mark the water level and volume in liters. Next add an additional liter, mark the water level and volume repeating these steps until the entire bucket is marked. The bucket can now be used as a graduated container.

6.10.1.5 Fill the bucket over a fixed amount of time and record the volume. Repeat three times (or more if there are large differences between results). Record the volume and time.

6.10.1.6 Calculate discharge as the volume of the container divided by the time to fill it. Average either the time or volume depending on the technique used when performing repeat measurements.

6.10.2 Discharge of a Jet of Water

6.10.2.1 This technique can be used on any discharge regardless of size. The limitations are that the pipe must be horizontal and it must be running completely full.

6.10.2.2 Measure or estimate the diameter of the pipe.

6.10.2.3 Measure the distance from the end of the pipe to the spot where the stream of water hits the ground (“x”).

6.10.2.4 Measure the vertical distance from (“x”) to the midpoint of the pipe orifice (“y”).

6.10.2.5 Calculate the velocity as: \( V = \frac{4.01(x)}{\sqrt{y}} \)

6.10.2.6 Calculate the area (“A”) of the pipe as: \( A = \pi r^2 \)

6.10.2.7 Calculate the volume by multiplying the area by velocity. Units of measurement must be the same.

6.10.3 Measuring Discharge from a Culvert

6.10.3.1 Culvert discharge can be calculated by measuring the culverts circular diameter, the average velocity, and the depth of water at the end of the culvert. These measurements can then be entered into a spreadsheet used to calculate discharge.
6.10.3.2 The three necessary measurements needed to calculate culvert discharge include (1) culvert diameter, (2) water depth, and (3) average velocity. The average velocity should be measured using a velocity meter. Three or more average velocity measurements may be necessary to find the central tendency.

6.10.3.3 The spreadsheet used to calculate culvert discharge uses the Manning equation for circular culvert geometry and can be obtained from Directed Studies Unit personnel.

6.11 Use of Staff Gage for Estimating Flow

6.11.1 A staff gaging station may be set up at a sample site (preferably at the mouth of the watershed). The purpose of a staff gaging station is to develop a relationship between stream height (stage) and flow. Once this relationship is established, stream discharge may be estimated based on gage heights.

6.11.2 Site Selection

6.11.2.1 The stream course should be relatively straight and free flowing for 200-300 feet upstream and downstream of the measurement site. The site, however, should be free from excessive turbulence.

6.11.2.2 The stream channel should be free from vegetative growth and be relatively stable (free from major seasonal scouring or deposition of bed material).

6.11.2.3 The stream bed should be relatively uniform with only minor irregularities (no large cobbles or boulders).

6.11.2.4 During low flow conditions, the stream channel should be confined to a single course.

6.11.2.5 The stream bank should be stable and able to contain the maximum stream discharge (floods).

6.11.2.6 Gaging stations should be located a sufficient distance upstream of tributaries and tidal action to prevent the distortion of stage/discharge measurements.

6.11.2.7 Discharge should be measured within the reach. It is not necessary to measure low and high flows in exactly the same place.

6.11.3 Staff Gage Installation

6.11.3.1 Attach staff gage vertically on a permanent structure (concrete piling, revetment, etc.) or install in the stream by driving an appropriate post into the substrate and then attaching the staff gage to the post.

6.11.3.2 At locations where the stage range is high, it may be necessary to set staff gages in series to accommodate a variety of stream levels. Sometimes two or more staff gages are necessary for low and high flows.

6.11.3.3 Set the zero point of the staff gage below the lowest level of possible streamflow to prevent negative values of the gage height. Staff gages with higher ranges reduce the possibility of negative values such as 6-9 ft or 9-12 ft ranges rather than a 0-3 ft range. Place in a location where de-watering is not likely.
6.11.3.4 Establish a datum point on the gage, and make two or three reference points (RP’s) at the same level on nearby permanent features. (Use a point on the gage that is above the highest expected gage height to prevent flow-related erosion of the marks.) It is recommended to install and survey in at least 3 reference points at locations that will not be disturbed during the study period. With three RP’s one can determine with good certainty any staff gage movement or replace staff gage (reestablish or reconfirm datum) if necessary during study period. Three RP’s also gives ability to check if any of the RP’s themselves have moved. The datum may also be referenced to an official surveyor’s benchmark. Establishing reference elevations allows data to be recovered if the staff gage is destroyed.

6.11.4 Reference Point Measurement

6.11.4.1 The distance from a reference point (RP) to the water surface is measured with a weighted fiberglass measuring tape (tape-down). The weighted tape is lowered to the water surface just to the point were the wake from the water passing by the weight forms a slight distinctive "V" shape. The distance from the RP to the water surface is recorded to the nearest 100th of a foot. If possible use tape-downs as a secondary/back up gage to a staff gage rather than the primary or sole gage at a site. Keep in mind tape-downs are subject to inaccuracies from windy conditions (under-measures stage) and fiberglass tapes tend to stretch over time (also resulting in under-measurement of stage).

6.11.4.2 Establish a RP on the bridge by locating or creating a permanent mark over an area of the stream not likely to dewater during low flow.

6.11.4.3 Find the RP mark on the bridge.

6.11.4.4 Lower the weighted tape until it just touches the water (a distinctive "V" should appear downstream of the weight). Raise the weight to make sure you are just touching the water.

6.11.4.5 Read the tape at the edge of the RP to the hundredth of a foot.

6.11.4.6 Record the time, RP measurement, and the correction factor for the tape (written on the side of the tape) in the field notes.

6.11.5 Establish a Rating Curve

6.11.5.1 The development of rating curves is complex. The USGS has detailed information about rating curve development (Sauer, 2002). Rating curve regressions work well over a relatively narrow range of discharge. Most stage/discharge relationships are logarithmic and usually regression correlations breakdown as range of measured flows increases.

6.11.5.2 Take streamflow measurements over a wide range of gage heights and/or RP measurements. It is very important that measurements are not just made in average flow conditions, but also at high and low flows to develop a rating curve for a wide range of flow conditions. Make sure to note the gage height/RP measurement before and after the flow measurement.

6.11.5.3 Develop a rating curve using regression analysis of instantaneous flow measurement and stage height. Rating curves should be based on sufficient number of measurements to allow a smooth curve to be drawn through the points (usually 8 to 10 measurements).
6.11.5.4 Periodically check the discharge curve, especially after high flows, to ensure the stream bed has been unaltered by sediment deposition or erosion, and that a reasonably accurate rating curve still exists. Smaller streams are subject to regular channel/control changes that may result in frequent rating adjustments. This can occur several times a year in some cases.

6.12 Other Flow Measurement Methods

6.12.1 A good reference for a variety of ways to measure flows in different situations is the Water Measurement Manual published by the U.S. Bureau of Reclamation (http://www.usbr.gov/pmts/hydraulics_lab/pubs/wmm/).

7.0 Records Management

(Not Applicable)

8.0 Quality Control and Quality Assurance Section

8.1 QA/QC procedures will be addressed thoroughly on a project-by-project basis in the Quality Assurance Project Plan (QAPP) for the project.

9.0 Safety

9.1 Wading streams is one of the most dangerous activities undertaken by field staff especially during higher flows. Two people are required at all times when streams are to be waded. Life jackets are to be worn if there is any chance of being pushed downstream or being submerged after falling into the water. Life jackets should also be worn when new sites are being established and when-stream conditions to be encountered are unknown.

9.2 If there is any chance of the streamflow being strong enough to potentially cause injury (by being swept downstream into rocks or other dangerous settings, drowning, hypothermia, etc.), do not consider taking a flow cross section. If a safety harness or safety rope is warranted, do not take velocity measurements. Consider requesting Ecology’s Freshwater Monitoring Unit assistance for measuring streamflow where conditions are beyond the techniques presented in this SOP. When in doubt, err on the side of safety.

9.3 For further field health and safety measures refer to the: http://aww.ecology/programs/eap/Safety/safety.html

10.0 References


Appendix A: Current Meter Instructions

1.0 Current Meter Instructions

1.1 Marsh-McBirney® Model 2000

The Marsh-McBirney® 2000 consists of a transducer probe cable, and a signal processor. The probe emits an electromagnetic frequency used measure velocity. The Marsh-McBirney® wading rod has an adapter capable of holding the transducer probe.

Marsh-McBirney® model 2000 current meters should be zeroed periodically to ensure accurate measurements. The meters should be zeroed at least once a week during use; however, it is preferable that they are zeroed at the beginning and end of each day of use. They should also be sent to the factory for calibration at least once a year. First clean the sensor because a thin film of oil on the electrodes can cause noisy readings. Then place the sensor in a five gallon plastic bucket of water. Keep it at least three inches away from the sides and bottom of the bucket. To make sure the water is not moving, wait 10 or 15 minutes after you have positioned the sensor before taking any zero readings. Use a filter value of 5 seconds. Zero stability is ± 0.05 ft/sec.

Marsh-McBirney® Model 2000 Zero Adjust

- Position the sensor as described in the zero check procedure.
- To initiate the zero start sequence, press the STO and RCL keys at the same time. You will see the number 3 on the display.
- Decrement to zero with the 6 key.
- The number 32 will be displayed.
- The unit will decrement itself to zero and turn off. The unit is now zeroed.

Measuring Velocity

- Attach transducer to the probe to wading rod.
- Turn the meter on.
- Set selector to desired measuring unit (e.g., FT/S). You can toggle between M/S and FT/S by pressing the On and Off keys simultaneously. Set the meter to Fixed Point averaging (FPA) and set the interval between 20 and 40 seconds. Press the ↑ and ↓ keys simultaneously to alternate between the FPA and rC displays. The display will show the letters FPA when you first switch to the FPA display. Except for the first period, the display is updated at the end of each averaging period. For example, if the FPA is set to 10 seconds, the display is updated once every ten seconds. The FPA display will have a horizontal time bar under the velocity output. The time bar provides an indication as to the amount of time left until the display is updated. The FPA time is specified in seconds. The ↑ key increments time and the ↓ key decrements time. The display will show the FPA length in seconds. After you have reached the desired setting, wait and the display will automatically switch to velocity.
• Place the probe in the stream with the round end of the sensor facing into the stream.
• The wading rod should be set to the appropriate depth (see Measuring Stream Velocity-Section 6.4).
• Wait for the appropriate time delay and then record the stream velocity.

1.2 Marsh-McBirney® Model 201

The Marsh-McBirney® 201 consists of a transducer probe cable, and a signal processor. The probe emits an electromagnetic frequency used measure velocity. The Marsh-McBirney® wading rod has an adapter capable of holding the transducer probe.

Measuring Velocity

• Attach transducer to the probe to wading rod.
• Set selector switch to Cal and the time constant switch to 2. After approximately 10 seconds, the readout should be on or between 9.8 and 10.2. If not, change the batteries and recheck.
• Set selector to desired measuring unit (e.g., FT/SEC).
• Set time constant switch. The purpose of the time constant is to help stabilize flow readings. This produces a delay between when the unit is first turned on and the time the first full scale reading is reached. This delay can be calculated as seconds by multiplying the switch setting by five. Start with the smallest time constant 2 (10 second delay). If after the calculated time delay the output has not stabilized, move to the next highest number.
• Place the probe in the stream with the round end of the sensor facing into the stream.
• The wading rod should be set to the appropriate depth (see Measuring Stream Velocity-Section 6.5).
• Wait for the appropriate time delay and then record the stream velocity.

1.3 Swoffer®, Inc. Model 2100®

The Swoffer® is composed of a rotor assembly, sensor body, and cable which are attached to a wading rod (assembly is called the Sensor Wand), an indicator panel then attaches to the Sensor Wand to form the whole unit.
Measuring Velocity

- Turn knob on Swoffer® meter to Calibration. It should read 185-186. If it is does not, change the nine-volt battery. Record the Calibration # in the proper space in the field notes. Install the propeller on the wading rod and tighten the Allen screw.
- Turn the knob on the Swoffer® meter to Ave. Velocity.
- Press the start button on the Swoffer meter.
- Place the propeller in the stream with the propeller facing into the streamflow.
- Record the velocity in the proper column in the field notes.

Upon completion of the flow measurement, turn the knob on the Swoffer® meter to Calibration and record the number in the proper space in the field notes.