Snohomish County Surface Water Management
Resource Monitoring Group

Standard Operating Procedures for the Collection, Processing, and Analysis of Stream Discharge Using OTT MF Pro ® Handheld Electromagnetic Flow Meter

Samples Version 1.1

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Please note that Snohomish County Surface Water Management's (SWM) Standard Operating Procedures (SOPs) are adapted from Washington State Department of Ecology Standard Operating Procedure EAP 109 version 1.6, other published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Snohomish County 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 Snohomish County.

Although SWM follows the SOP in most cases, there may be instances in which the County uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
July 28. 2022	1.1	Updated 0.8 to 0.9 = smooth edge with no vegetation), rather than rough edge.	9.4	Britsch/Hume
July 28. 2022	1.1	Clarified with OTT that if no stage reference exists, skip step by selecting O.K., which assigns a zero value to stage reference.	9.6	Britsch/Hume
July 28, 2022	1.1	Emphasized not using sensor to set wading rod depth – added examples	9.9	Britsch/Hume

Resource Monitoring Group

Standard Operating Procedure for measuring stream discharge with the OTT MF Pro® Electromagnetic Handheld Flow Meter and 4ft wading rod.

Introduction

The OTT MF Pro® Electromagnetic Handheld Flow Meter and top setting wading rod is used by Snohomish County, Surface Water Management's (SWM) Resource Monitoring (RM) group to collect discharge measurements (Figure 1). These data are used by the RM group to assess the effects of flow on water quality, habitat and aquatic life, and to describe watershed health and inform on salmon recovery efforts.

Figure 1. OTT MF Pro® Electromagnetic Handheld Flow Meter.

1.0 Purpose and Scope

1.0 This Standard Operating Procedure (SOP) details methods used by the WQMP to collect stream discharge from streams and rivers using an OTT MF Pro® Electromagnetic Handheld Flow Meter and 4ft wading rod. It may also contain methods that other users would find helpful for their monitoring work.

1.2 The scope of the SOP applies to instrument preparation, maintenance, and field discharge measurements conducted on wadable streams in depths ranging from 1.25 inches to 4ft and velocities from 1 to 20ft/second. Each new instrument user must be trained by a custodian or a designated proficient user. Operating instructions should be consulted for detailed information: https://www.ott.com/products/water-flow-3/ott-mf-pro-water-flow-meter-968/. Failure to do so, could result in injury to the operator or equipment. If the operating instruction does not provide adequate information, consult a custodian or contact technical support.

2.0 Applicability

This SOP is intended for any SWM program involving the collection and analysis of water discharge from streams.

3.0 Definitions

3.1 Discharge – the volumetric flow rate of water transported through a cross-sectional area of a river or stream.

3.2 Mid-section Method – A widely used technique for calculating stream discharge, the midsection method involves the calculation of discharge in individual measurement cells of a river or stream cross section.

3.3 QAMP – Quality Assurance Monitoring Plan

3.4 RM Group – Resource Monitoring Group

3.5 SWM – Snohomish County Surface Water Management

3.6 Top Setting Wading Rod – A metric rod used for discharge measurements to which the meter, sensor and cable are attached to. The English style rod is generally 4-ft tall and marked in tenths of feet.

4.0 Personnel Qualifications/Responsibilities

4.1 Field operations require training specified by job title in SWM's Safety Training database.

4.2 This SOP pertains to all Natural Resource Scientists, Environmental Specialists, Interns and Environmental Technicians in the RM group or other staff using this SOP.

4.3 All field staff must have read the Quality Assurance Monitoring Plan, this SOP, completed field training, and be familiar with procedures for data collection.

4.4 All field staff must be familiar with the electronic data recording tablet (iPad® and required fields for data entry).

4.5 The field lead directing sample collection must be knowledgeable of all elements of the project's Quality Assurance Monitoring Plan (QAMP) discharge measurement requirements to ensure that credible and useable data are collected. All field staff should be briefed by the field lead or project manager about the sampling goals and objectives prior to arriving at the site.

5.0 Equipment, Reagents, and Supplies

5.1 OTT MF Pro Flow meter (set to collect measurements in English units [ft/s])
5.2 OTT MF Pro manual
5.3 4-ft top setting wading rod (with depth increments in tenths of feet)
5.4 Distance measuring tape or stadia rod (in feet)
5.5 iPad w/ car charger
5.6 Phone/camera
5.7 Vehicle Gas Card and Personal PIN number
5.8 Quality Assurance Management Plan
5.9 Any rights of entry
5.10 First aid kit
5.11 Personal gear (boots, gloves, hat, water, clothing, food, waders, survey vest)
5.12 Traffic control equipment

5.13 OTT MF Pro and Wading Rod Overview

1.	Portable meter
2.	Sensor height lock/release
3.	Top setting wading rod
4.	Sensor cable
5.	Adjustable mount for portable meter
6.	Sensor assembly

Figure 2. Components of the OTT MF Pro Flow meter

6.0 General Instrument Set Up

6.1 Before use, fully charge the instrument battery with the supplied charger. A full battery will power the system for approximately 10-11 hours.

6.2 Assemble system (note you only need to affix sensor to meter for set up)

6.3 Power on meter and select OK

6.4 Scroll down to Setup and select OK

6.5 Scroll down to Filter Parameters and select OK

6.6 Select Main Filter and OK

6.7 Select Fixed Period Avg., enter **30** and select OK

6.8 Select Filter Parameters again and select OK

6.9 Select Main Filter again and OK

6.10 Select RC, enter **6** and select OK

6.11 Scroll down to Wet/dry Threshold, select **default** and OK

6.12 Scroll down to Auto Zero Depth, select **On** and OK

6.13 Scroll down to EMI, select **60Hz** and OK

6.14 Scroll down to Clock and **set correct time/date**

6.15 Scroll down to **More** and select OK

6.16 Scroll down to Units and select **English** (**select ft/s for velocity, ft^3/s for flow, ft for depth, and ft^2 for area)**

6.17 Scroll down to **More** and select OK

6.18 Scroll down to **Flow Calculation** and select OK

6.19 Select **Mid-section** method and OK

6.20 Scroll down to **More** and select OK

6.21 Scroll down to **Station Entry** and select OK

6.22 Select **Non-Fixed** and OK

6.23 Select **Top** for Measurement Reference

6.24 Scroll down to **More** and select OK

6.25 Scroll down to **Measurement Resolution**, select OK and **0.001** – This completes instrument set up and configuration.

7.0 Measurement Pre-Planning

7.1 Work with project managers/leads to determine the location of proposed and/or confirmed discharge measurement. In some cases permission to access private property is needed and requires attention to landowners requests prior to sampling. Scouting of measurement locations prior to conducting work may be necessary to identify logistical, access or safety related issues.

7.2 It may be helpful to use ArcGIS or other mapping software to ensure you understand the best place to park at each sample location. Your parking location will dictate the level of traffic control needed to conduct work safely.

7.3 Staff should always prepare for the field day using the equipment checklist to ensure that all equipment and personal protective equipment are available and loaded to the vehicle.

7.4 Obtain any right of entry paperwork necessary.

7.5 Notify a supervisor, management team member or project manager of pending field work. Check out on the white board and hardcopy check in/out sheet to ensure a supervisor, management team member or project manager knows where you are going and when you expect to return.

7.6 Never compromise your personal safety or that of field partners to complete any data collection during this monitoring program. Be aware of outside surroundings. Reschedule if conditions are not favorable to survey conditions.

8.0 **Discharge Measurement Procedures**

8.1 Ensure battery is charged and affixed in the meter, with the sensor and cable attached to the wading rod.

8.2 Choose an appropriate stream cross section for a discharge measurement. Characteristics of an appropriate cross section include running water only, absence of counter currents or eddies, stream has well-defined edges, minimal obstructions (large rocks, logs, vegetation), and no backwatering.

8.3 Using either a stadia rod (small streams) or tape measure (larger streams), lay it from bank to bank and perpendicular to stream flow ensuring it is taught and has no contact with the water. This creates your tagline along which discharge measurements are taken.

8.4 Determine wetted stream width and use the table below to identify the total number of stations at which to collect discharge measurements. The goal is to make the distance between stations such that no measurement cell contains more than 10% of the discharge. Stations may be evenly spaced where discharge is uniform. Distances between stations are generally smaller where water depth and flow velocities change significantly.

Feet	Number of Stations
< 1.6	5 to 6
>1.6 and < 3.3	6 to 7
>3.3 and < 9.8	7 to 12
>9.8 and < 16.4	13 to 16
>16.4	≥ 22

Identification of Site Name, Collector, and Stage

8.5 Push the power button until an audible beep is heard – a self-test will run

8.6 Select OK after self-test is complete (battery voltage must be greater than 3.4v)

8.7 Scroll to Profiler and select OK

8.8 Select Stream and OK

8.9 Enter Operator Name or Initials (23 char. Max.)

8.10 Enter name (site name or acronym) for new stream profile select OK (23 char. Max)

Determining Cross-Section Morphology

9.0 Select Edge/Obstruction and select left or right – depending upon whether the measurements start on the left or right bank (looking downstream)

9.1 At distance to Vertical prompt enter the value corresponding with where you are at across the tape or stadia rod. (e.g. location of measurement across the tagline – this is not necessarily 0 at the edge).

9.2 Select Set Depth and enter depth of water.

9.3 If edge has depth > 0 (such as vertical bank/wall) then after setting depth – edge factor menu appears.

9.4 Select edge factor from list (0.5 to 0.6 = rough walls, 0.7 = brick sides w/vegetation, 0.8 to 0.9 = smooth edge with no vegetation)

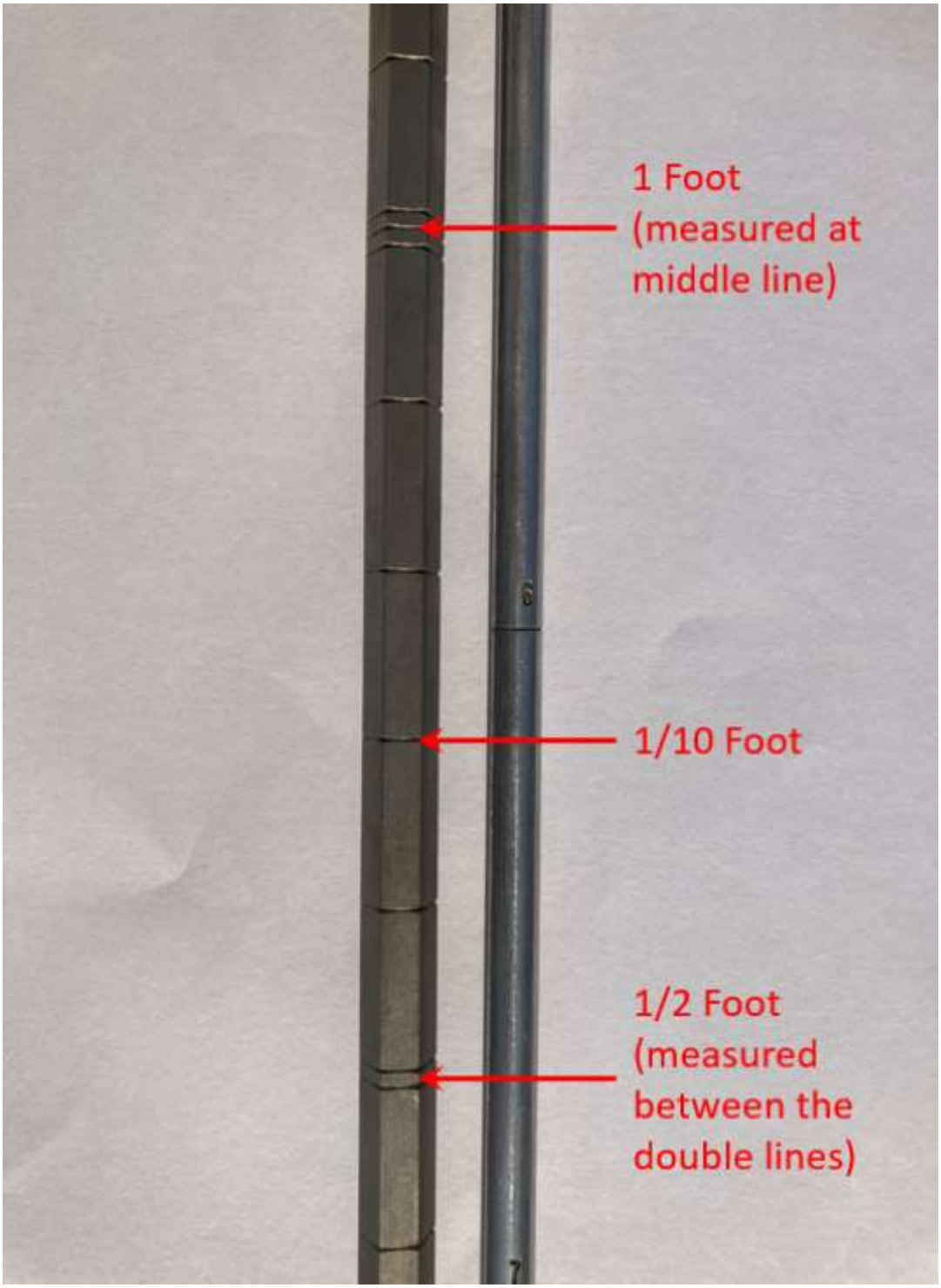
9.5 If edge has no depth the edge factor menu will not appear

9.6 Enter stage reference and select OK. The stage reference is usually an elevation value from an object that cannot be moved such as a survey marker, staff gauge, or bridge (if staff plate is present at site enter elevation of water). If stage reference is not available, skip step by pressing O.K, which assigns a zero value to stage reference.

9.7 Select next and move to next station along the tag line. (Note station 2 will generally be the first with a depth and velocity).

9.8 Select Distance to Vertical and input your next station's distance across the tagline.

9.9 Select Set Depth and enter the max depth of the location. Obtain the depth measurement from the top set wading rod (see illustration on the next page). Press 'OK'



Estimate water depth to nearest 1/10 foot. Water depth is measured on the hexagonal rod. The rod is marked at 1/10-foot interval with single line, 1/2-foot interval with double line, and 1-foot interval with triple line

9.10 Select Measure Velocity next. Set the wading rod to 60% of the total depth (Figure 1).

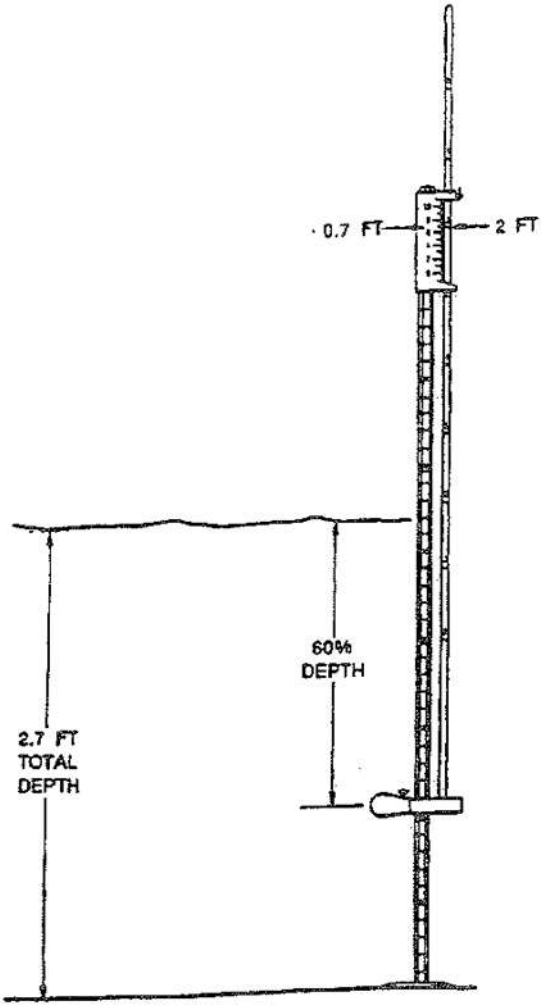


Figure 3. Setting the wading rod at 60% depth when at a station that is 2.7 feet deep. Modified from Marsh-McBirney (1990).

9.11 Select One Point and 0.6 (default). You will be prompted to adjust sensor to a certain height, **ignore this value because the top set wading rod already accounts for the required 60% depth.** Select 'Capture.'

Note: The top-setting wading rod can also be used for 2- and 3-point measurements, where the measurements are taken at 20% & 80% or 20%, 60%, & 80% depth, respectively. The 20% measurement is made by setting the positioning rod at double the measured water depth (e.g. if the water depth was measured at 2' then setting the position rod at 4' would set the sensor to read at 20% below the water surface (1.6')). Conversely, to measure the 80% depth, half the measured water depth should be applied (e.g. for the same 2' measured water depth set the positioning rod at 1').

10.0 Making Point Discharge Measurements

10.1 The sensor will measure velocity for 30 seconds before calculating a final reading. Once complete select OK.

10.2 The next screen will display 0.6 at the stop and main and verify at the bottom. Select main to return to the main screen. Select Next to proceed to station 3

10.3 Continue steps 9.1 – 10.2 until all measurements across the tagline have been taken – including the right or left edge.

10.4 Once all measurements have been recorded, select Save Data and Exit.

11.0 Records Management

11.1 Total discharge for each stream cross section is input into the field computer.

11.2 Digital discharge files stored on the portable meter are downloaded onto the County server and stored as .csv files for processing.

11.3 Discharge and associated metrics are eventually uploaded to the WISKI database for storage, processing and viewing.

11.4 Records must be kept for a minimum of 5 years (State Archival Requirement). Records archival is coordinated through SWM administration. For more information on archival of records see: https://team/depts/spw/AO/Records/default.aspx

12.0 Quality Control and Quality Assurance

12.1 Quality control and quality assurance procedures are described in detail in the QAMP (Section B.5.11; Hydrology Monitoring QC).

12.2 Where duplicate discharge measurements are obtained, it's important to ensure the original discharge transect (tag line) is physically marked/known to the QC team.

12.3 Data are reviewed and verified following quality control and quality assurance procedures identified in the QAMP for accuracy and precision.

13.0 Safety

13.1 Persons involved with discharge measurements could be subjected to hazardous conditions. Hazards include, but are not limited to roadside traffic, slips, trips, falls, drowning, heat and cold stress, exposure to chemicals and biological pathogens (discharge measurements are collected while wading in the river or stream).

13.2 Staff are provided appropriate PPE (Personal Protective Equipment) to minimize hazards. Teams of two should be considered especially for sites where discharges are gathered on larger streams/rivers during moderate to high flow events.

13.3 Washington State Department of Labor and Industries requires the employers provide a safe work environment through communicating hazards and providing adequate training

13.4 Required safety training, inclusive of General Field Safety and Swiftwater Rescue and awareness have been identified by position. Additional requirements include: Defensive Driving, First Aid, and CPR/AED training.

14.0 Invasive Species and Decontamination Procedures

Special care must be taken to prevent the spread of aquatic invasive species (AIS). Two problem species have been tentatively or definitively identified in western Washington watersheds. These include *Didymosphenia geminata* (Didymo) and New Zealand Mud Snail (*Potamopyrgus anitpodarum*).Washington Department of Ecology identifies problem invasive species by two categories: Areas of Extreme Concern and Areas of Moderate Concern. Watersheds with New Zealand Mud Snails are Areas of Extreme Concern. Staff must follow standard operating procedures as adapted from (Parsons et al., 2012) to ensure sampling in areas where the New Zealand Mudsnail exists do not unintentionally promote distribution into *other waterbodies.*

Any sampling planned in watersheds of Lake Washington should be followed by decontamination procedures for Areas of Extreme Concern.

- Benthic sampling involves contacting stream water or wet streamside soils during sample collection so should be subjected to decontamination procedures using chemicals or heat, especially when cold treatment (4 hrs at -40^{o}C) or drying (48 hours to fully dry) cannot be completed in time.
- Wearing short rubber boots will simplify decontamination, while wearing felt-soled boots will make decontamination more difficult. Check regulations from Washington Department of Fish and Wildlife to ensure felt-bottomed soles are legal for use in specific waterbodies.

New Zealand Mud Snails

New Zealand Mud Snails have been found in numerous areas of Washington State, where they can potentially cause tremendous environmental and economic impacts. These areas are now considered to be of Extreme Concern. In western Washington they include Marathon Park, Capital Lake (Olympia), and Kelsey and Thornton Creeks in the Seattle area, and Union Slough in the lower Snohomish River.

Review Appendix B in the Quality Assurance Monitoring Plan for State of Our Waters Monitoring for detailed decontamination instructions for equipment that may contact waters known to contain aquatic invasive species (Snohomish County 2019).

15.0 References

OTT Hydromet. MF pro Operating Instructions. DOC026.53.80211, Edition 7, 09/2018. Access 7/19/2022 at: https://www.ott.com/download/ott-mf-pro-operating-instructions-1/

Snohomish County. 2019. Snohomish County State of Our Waters Quality Assurance Monitoring Plan, Version 1.0. Snohomish County Surface Water Management: Resource Monitoring, Everett, WA. 156 p.

Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A8, 87 p. (Also available at http://pubs.usgs.gov/tm/tm3-a8/.)