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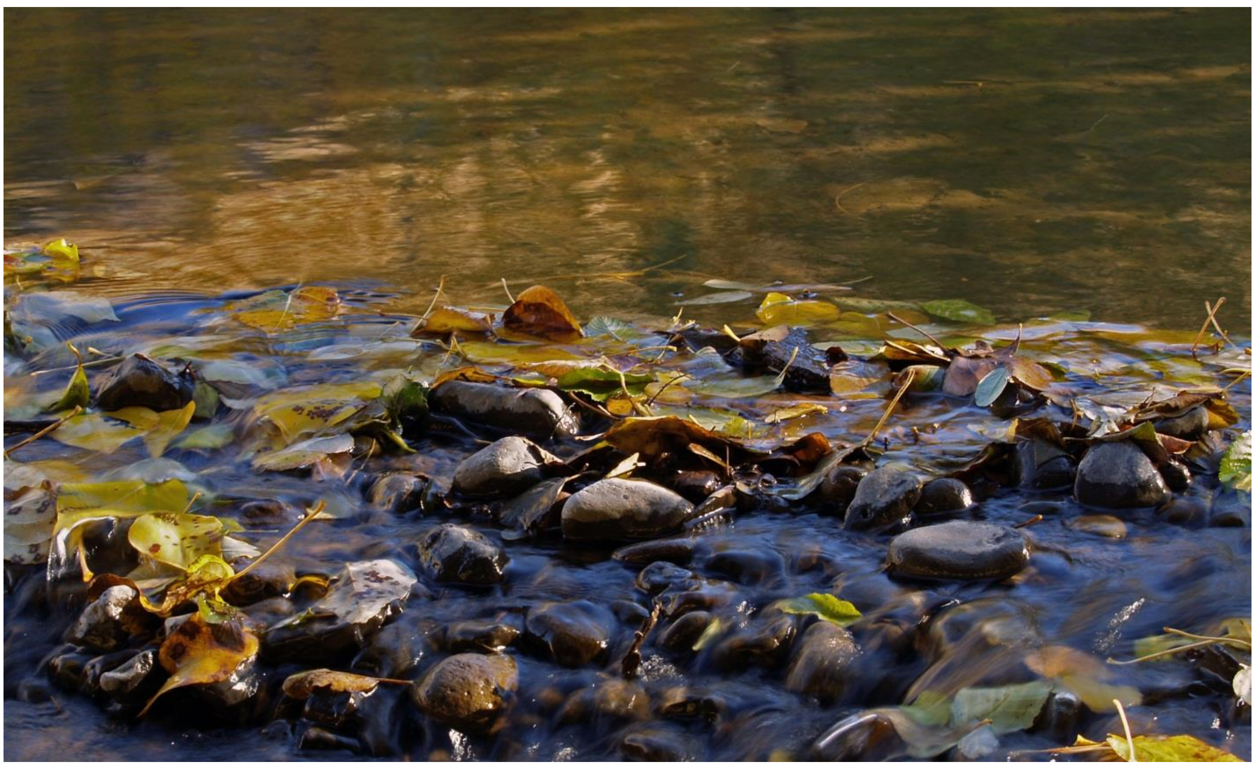
Walla Walla Basin Watershed Council
541-938-2170 or 7086 P.O.Box 68, Milton-Freewater, OR 97862

WWBWC Watershed Monitoring Program

Standard Operating Procedures



Standard Operating Procedures

Version 1.3

September 2018

CONTENTS

SOP Revision History

Revision Date	Revision Number	Summary of Changes	Sections Changed	Reviser(s)
11/2012	1.0	Creation of SOP document	All	Steven Patten
2/8/2013	1.1	Incorporated Review Comments	Study Design, Data Management, Surface Water monitoring and grammatical corrections	Steven Patten
4/1/2013	1.2	Photo Point Monitoring, Sampling Procedures and Grammatical changes	Photo Point Monitoring, Sampling Procedures and others	Steven Patten
9/2018	1.3	Update measurement procedures	Staff information, Surface water monitoring (changed to "flow monitoring"), Water temperature monitoring	Troy Baker Tara Patten

DISTRIBUTION LIST

This document will be made available to the public, agencies and grant funders through the Walla Walla Basin Watershed Council's website (www.wwbwc.org). Internal distribution of the document will occur through the WWBWC's internal server. All field and technical personnel will be given an electronic copy of this document. A printed version will be available in the WWBWC office. This document will be redistributed to personnel and uploaded to the WWBWC server and website upon revision.

BACKGROUND AND PROJECT DESCRIPTION

The Walla Walla Basin Watershed Council's Watershed Monitoring Program includes more than 60 flow monitoring sites, more than 100 groundwater sites, 10 water temperature sites, and more than a dozen water quality sites. The monitoring program covers almost the entire watershed starting in the upper reaches of the rivers and extending to the valley floor near where the Walla Walla River drains to the Columbia River. This document describes the WWBWC's Watershed Monitoring Program and includes the standard operating procedures used to collect environmental and hydrologic data.

PROGRAM AREA

The area of study for the Walla Walla Basin Watershed Council's Quality Assurance Program Plan includes the entire Walla Walla Watershed (Figure 1).

Monitoring locations for this program are spread throughout the valley (Figure 2), however the majority of the work conducted under this plan will take place on the valley floor Northwest of Milton-Freewater, OR, Southwest of Walla Walla, WA, and East of Touchet, WA. Aspects of the program (i.e. seepage runs) encompass other portions of the basin including almost the entire lengths of the Walla Walla River, the Touchet River and Mill Creek.

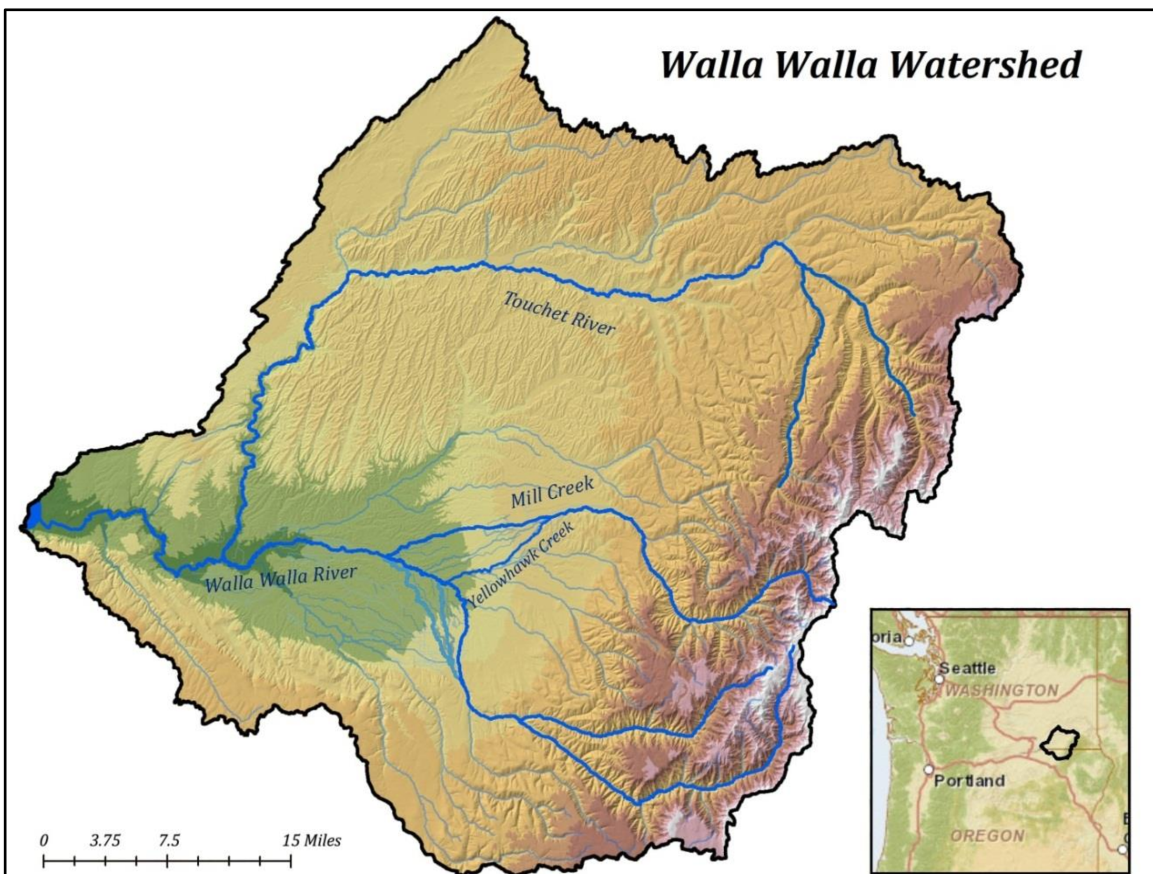


Figure 1. Map of the Walla Walla Watershed.

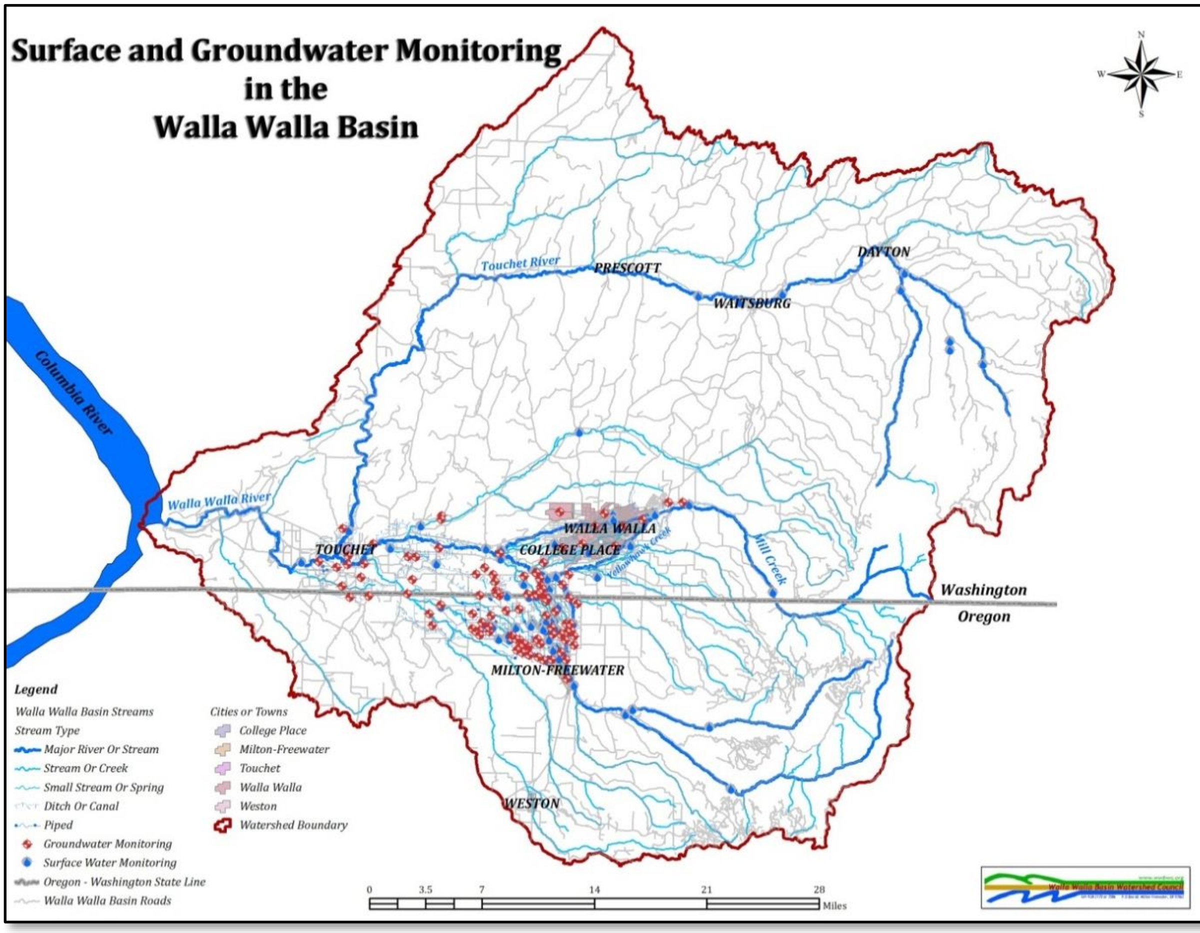


Figure 2. WWBWC Watershed Monitoring Program surface and groundwater monitoring locations.

PROJECT GOALS & OBJECTIVES

This monitoring program's goal is collect, organize, analyze and distribute hydrology related data for use by the WWBWC and other partners as projects are located, designed, installed and monitored so restoration in the Walla Walla Basin moves forward with knowledge of current and historic trends. The following objectives will achieve the program's goal.

- Collection of quality data utilizing well-established scientific protocols for monitoring activities.
- Organization of data into a functional system to allow use and analysis of data. Data must be organized and accessible for it to be useful.
- Analyzing data allows for trends and patterns to be determined. From these analyses we can determine how the basin is responding to changes (both environmental and project based).
- Distribution of data is critical. All of the above objectives can be completed, but without distribution of the data to other partners there cannot be a cohesive direction for restoration in the basin.

Organization and Schedule

Walla Walla Basin Watershed Council Personnel

Name	Position	Main Tasks	Email
Luke Adams	Watershed Technician	Data collection and processing	luke.adams@wwbwc.org
Troy Baker	Monitoring and GIS Program Manager	Monitoring program management & data collection and analysis	troy.baker@wwbwc.org
Graham Banks	Science Educator	Outreach and education	graham.banks@wwbwc.org
Marie Cobb	Senior Environmental Scientist	Project development and oversight	marie.cobb@wwbwc.org
Brian Wolcott	Executive Director	Program management	brian.wolcott@wwbwc.org
Wendy Harris	Operations Manager	Program/Operations management and oversight	wendy.harris@wwbwc.org
Tara Patten	Watershed Technician	Data collection and processing	tara.patten@wwbwc.org
Chris Sheets	Fiscal Technician	Fiscal oversight and management	chris.sheets@wwbwc.org

The Walla Walla Basin Watershed Council's phone number is: 541-938-2170

Program Partners

The Walla Walla Basin Watershed Council works with many partners throughout the basin to collect the monitoring data in the program. Program partners include: Hudson Bay District Improvement Company (HBDIC), Walla Walla River Irrigation District (WWRID), Gardena Farms Irrigation District #13 (GFID), Oregon Water Resources Department (OWRD), Washington Department of Ecology (WDOE), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), City of Walla Walla, City of Milton-Freewater, City of College Place, Walla Walla Watershed Management Partnership (WWWMP), Tri-State Steelheaders (TSS), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Washington Water Trust, The Freshwater Trust, Walla Walla University, Whitman College, Oregon Department of Environmental Quality (ODEQ), and many businesses and individual landowners in the basin.

Program Schedule

The WWBWC's monitoring program is an on-going process. A general schedule of activities is described in the table below:

Monitoring Activity	Year-round or Seasonal	General Schedule
Surface Flow (Real-time monitoring sites with continuous 15-min data collection)	Year-round and Seasonal	Sites are visited every other week to collect staff gauge measurements and perform general site maintenance. Manual discharge measurements and other data are collected during ~6 visits each year. A few river sites are only monitored seasonally during summer and fall base flows.
Surface Flow (Stand-alone monitoring sites with continuous 15-min data collection)	Year-round	Sites are visited 4-5 times a year to download data, conduct manual flow measurements, perform site maintenance and collect other data.
Groundwater Level Monitoring	Year-round	Sites are visited ~4 times a year to download data, conduct manual groundwater level measurements, perform site maintenance and collect other data.
Water Temperature (Continuous 15-min data collection)	Year-round and Seasonal	Data loggers are deployed in late spring or early summer and retrieved late fall or early winter dependent upon river flows. Telemetered sensors collecting continuous data year-round are installed at several real-time monitoring locations.
Evaporation-Transpiration (ET) Stations	Year-round	Sites are visited ~3-4 times a year to download data and perform site maintenance.
Scour Chains and Bed Stability	Seasonal	Sites are visited ~2-3 times a year to collect data, conduct channel survey and perform any maintenance.
Seepage Analysis	Seasonal	Seepage runs occur twice a year on each river system. Typically runs are conducted late spring or early summer and late summer or early fall.
Water Quality Sampling (SAR)	Seasonal	Water quality sampling is done during the shallow aquifer recharge season which typically starts in November and continues through May.
Water Quality Sampling (PSP)	Seasonal	Water quality sampling is done from March till June during the typical pesticide application time period.
Data Analysis and Distribution	Year-round	As data are collected, analyzed and incorporated into the WWBWC's database as provisional. Data are reviewed at the end of each water year.

Quality Objectives

Parameter	Check Standard	Duplicate Samples
Water Temperature	± 0.5 °C (NIST-certified Thermometer)	± 0.2 °C
pH	± 0.1 pH units	± 0.1 pH units
Specific Conductance	± 5% of standard	± 5% of reading
Dissolved Oxygen	± 0.2 mg/L	± 0.1 mg/L
Groundwater Level Measurement	N/A	± 0.01 feet
Manual Discharge Measurement	N/A	± 5%
Tape Down Measurement	N/A	± 0.02 feet
Vertical Staff Gauge Measurement	N/A	± 0.01 feet

Study Design

Monitoring locations were determined by availability to measure parameter of interest (e.g. groundwater can only be measured at wells or bore holes or high discharge measurements can only be taken at bridges). Professional judgment was also utilized in the placement of monitoring locations if multiple sites were available. Many monitoring locations were determined based upon anthropogenic changes to the system (e.g. irrigation diversions, flood control structures or restoration projects).

Sampling locations and frequency cover temporal and spatial variability within the valley. For example, measuring discharge at surface monitoring sites 4-6 times per year captures seasonal high and low flow periods. The schedule provided for each sampling parameter tries to accommodate temporal variability throughout the year.

The current study design is structured for two main functions. The first function is to provide baseline and/or trend monitoring for the hydrologic system within the Walla Walla Basin - are conditions improving, remaining the same or getting worse? The second function is to provide effectiveness monitoring for projects (habitat restoration, irrigation efficiency, aquifer recharge and others) occurring in the Walla Walla Basin.

The data collected under these standard operating procedures will help answer hydrologic and restoration questions such as (but not limited to):

- Are surface flows increasing in the Walla Walla River? If present, can the increases be attributed to conservation effects?
- Are groundwater levels declining in the alluvial aquifer? If so, is aquifer recharge helping to restore aquifer storage? Can declines be attributed to piping projects or other irrigation efficiency projects?
- Are water temperatures in the Walla Walla River improving over time? Where are the hottest locations? Are habitat projects improving water temperature?

Field Measurements

The majority of sampling for this program will occur in the field. Refer to the table below for which samples will be collected in the field and a sampling schedule for each.

Measurement Parameter	Monitoring Program	Schedule
River/Stream Discharge	Surface Flow Monitoring	4-6 times per year
Water Temperature	Surface Flow Monitoring	4-6 times per year
Specific Conductance	Surface Flow Monitoring	4-6 times per year
Staff Gage Reading	Surface Flow Monitoring	4-6 times per year (20+ for mainstem gage locations)
Elevation Reference Checks	Surface Flow Monitoring	4-6 times per year
Channel Survey	Surface Flow Monitoring	1 every 2-3 years
Groundwater Level Measurement	Groundwater Monitoring	4 times per year
Groundwater Temperature	Groundwater Monitoring	4 times per year
Specific Conductance	Groundwater Monitoring	4 times per year
Surface/Groundwater Temperature	Recharge Water Quality Monitoring	2-3 times per year
Surface/Groundwater Specific Conductance	Recharge Water Quality Monitoring	2-3 times per year
Surface/Groundwater Dissolved Oxygen	Recharge Water Quality Monitoring	2-3 times per year
Surface/Groundwater pH	Recharge Water Quality Monitoring	2-3 times per year
Channel Survey	Scour Chains & Bed Stability	2-3 times per year
Scour Chain Measurement	Scour Chains & Bed Stability	2-3 times per year
Pebble Counts	Scour Chains & Bed Stability	1-2 times per year
Longitudinal Survey	Scour Chains & Bed Stability	1 time per year
Water Temperature	River Temperature Monitoring	2-3 time per year
River/Stream Discharge	Seepage Runs	2 times per year per river
Water Temperature	Seepage Runs	2 times per year per river
Specific Conductance	Seepage Runs	2 times per year per river

Laboratory Measurements

Some of the water quality sampling that is conducted under this plan requires laboratory level analysis. Some of the sampling parameters and schedules are listed in the table below.

Sampling Parameter	Monitoring Program	Schedule
pH	Recharge Water Quality Monitoring	2-3 times per year
Electrical Conductivity	Recharge Water Quality Monitoring	2-3 times per year
Dissolved Oxygen	Recharge Water Quality Monitoring	2-3 times per year
Nitrate-N	Recharge Water Quality Monitoring	2-3 times per year
Total Organic Carbon	Recharge Water Quality Monitoring	2-3 times per year
Total Kjehldahl Nitrogen (TKN)	Recharge Water Quality Monitoring	2-3 times per year
Sulfate	Recharge Water Quality Monitoring	2-3 times per year
Chloride	Recharge Water Quality Monitoring	2-3 times per year

Sampling Parameter	Monitoring Program	Schedule
Calcium	Recharge Water Quality Monitoring	2-3 times per year
Alkalinity	Recharge Water Quality Monitoring	2-3 times per year
Ortho-Phosphate	Recharge Water Quality Monitoring	2-3 times per year
Sodium	Recharge Water Quality Monitoring	2-3 times per year
Potassium	Recharge Water Quality Monitoring	2-3 times per year
Magnesium	Recharge Water Quality Monitoring	2-3 times per year
Aluminum	Recharge Water Quality Monitoring	2-3 times per year
Iron (dissolved)	Recharge Water Quality Monitoring	2-3 times per year
Manganese (dissolved)	Recharge Water Quality Monitoring	2-3 times per year
PCBs	Recharge Water Quality Monitoring	2-3 times per year
Chlorinated Pesticides	Recharge Water Quality Monitoring	2-3 times per year
Herbicides	Recharge Water Quality Monitoring	2-3 times per year
Primary and Secondary contaminants listed in WAC 173-200, Table 1	Recharge Water Quality Monitoring	2-3 times per year

SAMPLING PROCEDURES

WATER QUALITY SAMPLING (GROUNDWATER)

Groundwater sampling is conducted utilizing the following procedures. The general overview of groundwater sampling includes gathering equipment, measuring the initial water level, installing a submersible pump in the well, purging the well at a low flow rate, collecting and labeling all required samples and delivering them to the lab or shipping company. Details on parameters sampled for each site can be found in its monitoring and reporting plan.

Note: this procedure is modified from:

Marti, 2011. Standard Operating Procedure for Purging and Sampling Monitoring Wells. Washington State Department of Ecology – Environmental Assessment Program. EAP078.

EQUIPMENT

- Sampling field data sheets (see below) or field notebook
- Chain of Custody form
- Water level measuring equipment (e-tape)
- Water quality meters and probes (Temperature, Specific Conductance, pH & Dissolved Oxygen)
- Submersible pump
- Pump controller
- Tubing and connectors
- Sample bottles/containers
- Cooler
- Ice
- Deionized water
- Diluted Bleach solution
- Non-phosphate soap
- Nitrile or latex gloves

- First aid kit
- Well keys
- Camera
- Paper towels or clean rags
- Plastic sheet for keeping equipment clean
- Buckets (5-gallon or similar for purge volumes)
- 1 liter container (for purge volumes)
- Socket set
- Screwdriver(s)

PURGING AND SAMPLING

1. Check well for any changes or potential hazards.
2. Make sure equipment has been cleaned and decontaminated (see below for details). Spread plastic or other material if needed to keep equipment clean.
3. Wear clean disposable gloves (latex or Nitrile) while performing purging and sampling. If gloves become contaminated or dirty replace with new gloves.
4. Make sure field water quality meters are calibrated according to the manufacturer's instructions.
5. If well is equipped with a pressure transducer, note how it is installed and its position to replace it after sampling. Remove the pressure transducer from the well. Note the time the pressure transducer was removed from the well on the data sheet or in the field notebook.
6. Measure the static water level in the well (see Groundwater Level and Temperature protocol below for details).
7. Measure the depth of the well or refer to the well log to determine the depth of the well.
8. Calculate the length of the water column. Calculate the volume of water in the well using the following values: 2" well = 0.1631 gallons per linear foot, 4" = 0.6524 gallons per linear foot (Equation used for water volume calculation – Volume (gal/ft) = πr^2(7.48 gal/ft^3) where r is the radius of the well and 7.48 is the conversion factor).
9. Install the submersible pump into the well. Be sure to slowly lower the pump into the well and through the water to avoid stirring up particulates. Place the pump in the middle of the screen section of the well (refer to well log to determine the open interval for pump placement).
10. Once the pump is installed correctly re-measure the static water level to monitor during purging.
11. Start purging. Set the pump controller to the desired pumping rate (~1 liter/minute). See notes from previous sampling for pumping rate.
12. Ideally, wells should be purged and sampled at flow rates at or less than the natural flow conditions of the aquifer in the screen interval to avoid drawing down the water level in the well. Use water level measurements to help adjust pumping rates to prevent well drawdown. Purging should not cause significant drawdown (considered to be 5% of the total height of the water column). If drawdown is significant, reduce pumping rate until water levels stabilize at an appropriate level.
13. Record pumping rate on the data sheet or field notebook.
14. Discharge evacuated water as far as possible from the wellhead and work area.
15. During purging and sampling water flow should be smooth and consistent without bubbles in the tubing.
16. Once pumping rate has been determined and flow has stabilized, start collecting field parameters (water temperature, specific conductance, pH and dissolved oxygen) at regular

intervals. The measurement interval will depend upon the pumping rate (typically 2-5 minutes between measurements).

17. Record field parameters, water level measurement, and estimated amount of water purged. Note any changes in purged water's appearance (clear, turbid, odor, etc.).
18. Continue purging well until field parameters stabilize. Parameters should be considered to be stabilized when 3 consecutive measurements fall within the following ranges:

Field Parameter	Stabilized Range
Temperature	± 0.1 ° Celsius
Specific Conductance <1000 μs/cm	± 10 μs/cm
Specific Conductance >1000 μs/cm	± 20 μs/cm
Dissolved Oxygen < 1 mg/L	± 0.05 mg/L
Dissolved Oxygen > 1 mg/L	± 0.2 mg/L
pH	± 0.1 pH units

19. Collect samples once field parameters have stabilized. Do not stop or change pumping rate during the final phase of purging and sampling.
20. Collect most sensitive analytes first (i.e. organics) followed by less sensitive analytes (i.e. nutrients). This order can be modified if using sulfuric or nitric acid preservatives to prevent contamination of sulfate and/or nitrogen samples.
    Collect any duplicate or quality control samples (see below for details).
21. Place samples in an ice-cooled cooler for delivery to the lab or shipping company. Make sure samples do not freeze during transport.
22. Complete chain of custody form. Record sample date and time, final water level and estimated total purge volume on the data sheet or in the field notebook. Also record any comments or observations regarding the purging and sampling process.
23. Replace pressure transducer if the well was equipped with one. Note re-install time on the data sheet or in the field notebook.
24. Clean and disinfect sampling equipment for next sampling event.

Decontamination

All non-disposable field equipment that may potentially come in contact with any soil or water sample shall be decontaminated in order to minimize the potential for cross-contamination between sampling locations. Thorough decontamination of all sampling equipment shall be conducted prior to each sampling event. In addition, the sampling technician shall decontaminate all equipment in the field as required to prevent cross-contamination of samples collected in the field. The procedures described in this section are specifically for field decontamination of sampling equipment.

At a minimum, field-sampling equipment should be decontaminated following these procedures:

- Wash the equipment in a solution of non-phosphate detergent (Liquinox® or equivalent) and distilled or deionized water. All surfaces that may come in direct contact with the samples shall be washed. Use a clean Nalgene and/or plastic tub to contain the wash solution and a scrub brush to mechanically remove loose particles. Wear clean latex, plastic, or equivalent gloves during all washing and rinsing operations.

- Rinse twice with distilled or deionized water.
- Dry the equipment before use, to the extent practicable.

Water Quality Sampling (Surface water)

Surface water sampling is conducted utilizing the following procedures.

Note: this procedure is a modified from:

Anderson, 2011. Standard Operating Procedure for Sampling of Pesticides in Surface Waters. Washington State Department of Ecology – Environmental Assessment Program. EAP003.

Equipment

- Sampling field data sheets (see below) or field notebook
- Chain of Custody form
- Water quality meters and probes (Temperature, Specific Conductance, pH & Dissolved Oxygen)
- Sample bottles/containers
- Cooler
- Ice
- Deionized water
- Diluted Bleach solution
- Non-phosphate soap (Liquinox or similar)
- Nitrile gloves
- First aid kit
- Camera
- Paper towels or clean rags
- Plastic sheet for keeping equipment clean
- Screwdriver(s)

Sampling

1. Check for any changes or potential hazards.
2. Make sure equipment has been cleaned and decontaminated (see below for details). Spread plastic or other material if needed to keep equipment clean.
3. Wear clean disposable gloves (Nitrile) while performing purging and sampling. If gloves become contaminated or dirty replace with new gloves.
4. Make sure field water quality meters are calibrated according to the manufacturer's instructions.
5. Collect required field water quality parameters and record on data sheet. Also note weather conditions
6. Fill out labels on each sample bottle with all necessary information.
7. Samples will be collected using the "Grab Sample" method described in EAP 003.
8. Take sample bottles and sampling equipment to the sample site and put on nitrile gloves.
9. Carefully collect samples by filling each container with water from the site. Note marked fill lines or preservatives to prevent over or under filling of the sample bottle.
10. Collect any duplicate or quality control samples (see below for details).

11. Place samples in an ice-cooled cooler for delivery to the lab or shipping company. Make sure samples do not freeze during transport.
12. Complete chain of custody form. Record sample date and time on the data sheet or in the field notebook. Also record any comments or observations regarding the sampling process.
13. Clean and disinfect sampling equipment for next sampling event.

DECONTAMINATION

All non-disposable field equipment that may potentially come in contact with any soil or water sample shall be decontaminated in order to minimize the potential for cross-contamination between sampling locations. Thorough decontamination of all sampling equipment shall be conducted prior to each sampling event. In addition, the sampling technician shall decontaminate all equipment in the field as required to prevent cross-contamination of samples collected in the field. The procedures described in this section are specifically for field decontamination of sampling equipment.

At a minimum, field-sampling equipment should be decontaminated following these procedures:

- Wash the equipment in a solution of non-phosphate detergent (Liquinox® or equivalent) and distilled or deionized water. All surfaces that may come in direct contact with the samples shall be washed. Use a clean Nalgene and/or plastic tub to contain the wash solution and a scrub brush to mechanically remove loose particles. Wear clean latex, plastic, or equivalent gloves during all washing and rinsing operations.
- Rinse twice with distilled or deionized water.
- Dry the equipment before use, to the extent practicable.

WATER QUALITY SAMPLING DATASHEET

Aquifer Recharge Water Quality Field Datasheet Page 1

Walla Walla Basin Watershed Council
www.wwbwc.org
541-938-2170 or 7086 P.O.Box 68, Milton-Freewater, OR 97862

Date:________ **Time:**________ **Sampler:**________ **Recharge Site Name:**________ **Sample: Beginning Middle End**

Up Gradient Well

Well #:______ Water Level (Feet bmp):______ ± _____ Time:______

Well Depth (From Well Log or Measure):__________

Water Column (Well Depth - Water Level) = ____________

Water Colum Volume (Water Column x volume per linear foot) = ________

(0.1631 per linear foot for 2" well or 0.6524 per linear foot for 4" well)

Water Level Measurement After Installing Pump

(Feet below measurement point):__________ Time:__________

Approximate Pump Flow Rate:______________ units:__________

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Comments/Notes:

Down Gradient Well (Close)

Well #:______ Water Level (Feet bmp):______ ± _____ Time:______

Well Depth (From Well Log or Measure):__________

Water Column (Well Depth - Water Level) = ____________

Water Colum Volume (Water Column x volume per linear foot) = ________

(0.1631 per linear foot for 2" well or 0.6524 per linear foot for 4" well)

Water Level Measurement After Installing Pump

(Feet below measurement point):__________ Time:__________

Approximate Pump Flow Rate:______________ units:__________

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Comments/Notes:

Aquifer Recharge Water Quality Field Datasheet Page 2

Down Gradient Well (Distal)

Well #:_______ Water Level (Feet bmp):_______ ± _____ Time:______

Well Depth (From Well Log or Measure):___________

Water Column (Well Depth - Water Level) = ______________

Water Colum Volume (Water Column x volume per linear foot) = _________

(0.1631 per linear foot for 2" well or 0.6524 per linear foot for 4" well)

Water Level Measurement After Installing Pump

(Feet below measurement point):___________ Time:___________

Approximate Pump Flow Rate:_________________ units:____________

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Comments/Notes:

Source Water

Source Water #:_______ Flow Rate (or Staff Gage):___________ Time:_________

Weather Conditions:____

Field Parameters

Time	Temp (°C)	Conductivity (µs/cm)	DO (mg/L)	pH

Duplicate Samples:____

Comments/Notes:

General Sampling Notes

MEASUREMENT PROCEDURES

PHOTO POINT MONITORING

Note: these procedures are based upon and modified from:
Hall, F.C., 2002. Photo Print Handgook: Part A – Field Procedures and Part B – Concepts and Analysis.

Photo point monitoring will be used to document changes at measurement points over time. For surface sites this will include change in channel shape, vegetation, and land use changes. For groundwater sites this can include casing changes, pump changes or land use changes.

EQUIPMENT

- Camera
- GPS (to find photo point)
- Clipboard
- Pencil or pen
- Datasheet (for appropriate monitoring site)
- Previous picture or description of photo point

ESTABLISHING A PHOTO POINT

1. Reconnoiter the area to determine the best location for the photo point. Take note of sun direction, potential vegetation growth and main objectives (i.e. channel shape, well casing, pump, etc.).
2. Record GPS coordinates for the photo point and record in the comments section of the data sheet. Also note the direction the photo should be taken and include a description of the main objectives of the photo (i.e. channel shape, vegetation, etc.)
3. Take photo point picture and review. Determine if all of the main objectives are visible in the picture.

VISITING A PHOTO POINT

Photo point monitoring should be conducted during every site visit.

1. Look at previous pictures taken at the photo point to orient. Look at site data sheets to determine GPS coordinates, photo direction and main objectives.
2. Take picture of site. Determine if all of the main objectives are visible in the picture.

FLOW MONITORING

The WWBWC flow monitoring program seeks to accurately measure stage height, conduct accurate instantaneous streamflow measurements and create reliable rating curves based on established methods to produce high quality discharge data for the rivers and streams we monitor. At near real-time telemetered sites, data are collected every 15 minutes and transmitted hourly to be automatically stored in our AQUARIUS database and reported online at www.wwbwc.org. At stand-alone sites, data are collected every 15 minutes, downloaded quarterly, added to our AQUARIUS database and reported online.

These procedures are based on and modified from the following reference documents:

Freeman, L.A. et al, 2004. Use of Submersible Pressure Transducers in Water-Resources Investigations: U.S. Geological Survey Techniques of Water-Resources Investigations 8-A3.

Kenney, T.A., 2010. Levels at gaging stations: U.S. Geological Survey Techniques and Methods 3-A19, 60 p.

Myers, J., 2009. Standard Operation Procedure for Conducting Stream Hydrology Site Visits. Version 1.0. Washington Department of Ecology – Environmental Assessment Program. EAP 057.

Myers, J. 2009 (updated 2015). Standard Operation Procedure for Conducting Stream Hydrology Site Visits. Version 1.1. Washington Department of Ecology – Environmental Assessment Program. EAP 057. (Also available at https://fortress.wa.gov/ecy/publications/documents/1803208.pdf)

ODEQ, 2009. Water Monitoring and Assessment Mode of Operations Manual. Watersheds Quality Monitoring Field Sampling Standard Operating Procedure – Laboratory and Environmental Assessment Division. Version 3.2

Rantz, S. E., and others., 1982. Measurement and Computation of Streamflow: Volume I. Measurement of Stage and Discharge. U.S. Geological Survey Water-Supply Paper 2175.

Rantz, S. E., and others., 1982. Measurement and Computation of Streamflow: Volume II. Computation of Discharge. U.S. Geological Survey Water-Supply Paper 2175.

Shedd, J. R., 2018. Standard Operating Procedure for Measuring and Calculating Stream Discharge. Version 1.3. Washington Department of Ecology – Environmental Assessment Program. EAP056.

Shedd, J.R., 2018. Standard Operating Procedure for Measuring Gage Height of Streams. Version 1.1. Washington Department of Ecology – Environmental Assessment Program. EAP042.

Sauer, V.B., 2002, Standards for the Analysis and Processing of Surface-Water Data and Information Using Electronic Methods: U.S. Geological Survey Water-Resources Investigations Report 01–4044, 91 p.

Sauer, V.B., and Turnipseed, D.P., 2010. Stage measurement at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A7, 45 p. (Also available at http://pubs.usgs.gov/tm/tm3-a7/.)

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/.)

TIME

Pacific Standard Time (PST) is used year round.

Equipment

- Flow Meter: FlowTracker ADV (wading) or Price AA current meter (bridge mmt)
- Four foot top set wading rod
- AquaCalc computer (bridge mmt)
- Bridge Board and Sounding Reel (bridge mmt)
- Columbus sounding weight (bridge mmt)
- Tape Down Measuring Tape with engineer's scale (with weight attached)
- Laser Level
- Stadia Rod
- NIST Thermometer
- YSI-30 Temperature and Conductivity Meter
- 100-200 Ft Measuring Tape with engineer's scale (feet, 10ths, 100ths)
- Chest or Hip Waders
- Laptop Computer
- Cables for connecting to data loggers
- Memory card to download data
- Pen or Pencil
- Data sheets
- Station Keys

Station Equipment

WWBWC flow gauges use a combination of submersible pressure transducers, data loggers and telemetry equipment to collect and transmit stage data.

Our real-time monitoring sites utilize some combination of the following types of equipment:

- CS451 - Campbell Scientific submersible, vented sensor to measure water level and water temperature. Collects and sends data to a data logger in an on-site weather-proof enclosure.
- Campbell Scientific data logger, one of several different models depending on site conditions and sensor used.
- CRS451 – Campbell Scientific submersible, vented, recordable sensor to measure water level and water temperature. Collects and logs data, can connect directly to radio.
- RF450 or RF451 – Campbell Scientific 900 MHz, 1 Watt Spread Spectrum radio
- CS470 – Ott Compact Bubble Water Level Sensor. Collects gauge height data
- WaterLog H-355 bubbler and gas purge system. Collects gauge height data
- WaterLog H-350 XL pressure transducer and data logger
- Campbell Scientific 107 temperature probe
- WaterLog H-377 temperature probe
- WaterLog H-222 GOES transmitter. Sends data through NOAA's Geostationary Operational Environmental Satellite (GOES) system.
- Solar panel, charge controller, and 12 volt battery to power sensors, data logger and radio

Our stand-alone monitoring sites utilize the following recordable pressure transducers that are downloaded quarterly using communication cables and a field laptop.

- Solinst Levelogger pressure transducer with water temperature sensor
- In-Situ LevelTroll 300 pressure transducer with water temperature sensor
- In-Situ LevelTroll 500, vented pressure transducer with water temperature sensor

MEASURING STAGE

Each flow monitoring site has an established primary gauge used as the reference gauge for continuous stage (water level) measurement. An arbitrary local gauge datum (zero point of the primary gauge) is established as a convenient working reference for each site. WWBWC uses bubblers and submerged pressure transducers to collect continuous stage data, which are then offset to align with reference gauge height measurements. Auxiliary gauge locations are established to serve as a check of the primary gauge (to make sure it has not moved) and to provide comparison for quality control. At many sites, the primary gauge is a staff gauge installed in the stream channel. Auxiliary gauges include tape down measurement locations and reference points (typically bolts in large boulders or other stable objects) on the streambank. At sites where conditions do not permit a permanent staff gauge, primary gauge height measurements are taken using differential level survey to determine vertical distance from the water surface to an established reference point with known elevation. The elevations (based on NAVD 88) of primary and auxiliary gauge locations are established by GPS survey. For ease of rating curve development, we establish an arbitrary local elevation (below the estimated elevation of zero flow) to serve as the zero point of our gauge height measurements at each site.

Procedure for Staff Gauge Measurements

1. Read the water level on the staff gauge to the nearest 0.01 ft. If the water level is fluctuating during the reading, take the average water level and note the range of fluctuation (1.25 ±0.04 where 1.25 is the average water level and 0.04 is the range above or below the average).
2. If water level fluctuations are excessive, you can get a more accurate reading by creating a temporary stilling well (using a 5-gallon bucket with the bottom cut out) around the staff gauge.
3. Take the necessary time to obtain an accurate staff gauge reading – both the water level and uncertainty.
4. Record the date, time and water level value on the data sheet.

Procedure for Tape-Down Stage Measurement

Measuring tape-down stage involves lowering a weighted measuring tape from a reference point to the water surface. Often the reference point is a metal washer attached to a bridge railing.

1. Locate the reference point.
2. Lower the weighted tape down to the water surface. The weight should only just touch the water surface creating a small “V” shape on the water surface.
3. Read the tape at the edge of the reference point and record to the nearest 0.01. Include uncertainty caused by wave action or wind.

4. Because the weight is attached to the end of the measuring tape, record the added length of the weight and any attachment hardware as a correction factor for the tape-down value.

Procedure for Laser Level Stage Measurement

Running levels at gauge stations is an important part of accurate stage measurement and the subsequent production of reliable streamflow values. Differential leveling is the process of measuring the vertical distance between a point of known elevation and point of unknown elevation. A differential level survey is used 1) to measure gauge height in the absence of a staff gauge and 2) to allow a check on the primary gauge (either staff gauge or primary reference point) and all auxiliary gauge locations (ie: tape down reference point). Levels are run at gauge stations whenever differences in gauge readings are unresolved, if stations are damaged or according to a pre-determined frequency. At new monitoring sites, levels to check the stability of staff gauge and and/or other reference points should be run at least once a year. Once stability is confirmed, levels will be run every 2-3 years. Our use of the laser level and stadia rod used will meet the precision standard of 0.001 feet and accuracy standard of <0.010 feet difference between measured and actual vertical distances.

1. Before using a laser level (LL) to measure stage height, you must confirm that the primary reference point has not moved. Record elevation differences between the primary reference point and 1-2 secondary reference points established nearby. Compare measured and previously established values to confirm that the primary reference point is stable.
2. Using the self-leveling laser and a stadia rod, measure the elevation difference between the primary reference point and the water surface. If a permanent staff gauge exists, place the stadia rod in the channel as close to it as possible. Record the LL and also the water level (including level of uncertainty) on the stadia rod.
3. Complete the calculations on the Stream Gage Logger Notes datasheet to compute the LL stage.

Continuous Stage Measurement

Water level sensors are installed at a fixed instream location and programmed to log stage measurements every 15 minutes. Two types of stage measuring devices are used. An electronic submersible pressure transducer measures water column pressure and converts it to a digital value with a measurement accuracy of ±0.03 ft[1]. The other type of device we currently use is an out-of-stream pressure transducer (bubbler) that measures the pressure needed to emit a bubble from the end of a pneumatic orifice line anchored at a fixed location instream. The pressure is directly proportional to the water column height above the bubble chamber. Pressure is converted to a digital value and stored in a data logger with an accuracy of 0.01 ft (WaterLog bubbler) or 0.02 ft (OTT bubbler).

[1] Measurement accuracy of the submersible pressure transducers currently in use does not meet the USGS accuracy standard of 0.01 ft. As funding allows, we will work to replace them with transducers meeting the accuracy standard.

Procedures for Station Visit (without Discharge Measurement)

Telemetered flow monitoring stations are visited every other week to take stage and water temperature measurements and perform any site needed maintenance. These visits do not include a discharge measurement.

1. Measure primary gauge height (see above for procedure)
2. Measure auxiliary gauge readings (see above for procedure)
3. Measure water temperature with NIST-certified thermometer
4. Measure air temperature with NIST-certified thermometer (if applicable)
5. Connect to or read display on the data logger and record the following:
    a. Data Logger clock time – double check with GPS time
    b. Water temperature
    c. Air temperature (if applicable)
    d. Battery volts
6. Once every 6 weeks, download data from the data logger and note the time on the data sheet
7. For bubbler systems:
    a. Purge the pressure sensor
    b. Record battery minimum and maximum.
    c. Reset Stats screen.
    d. Delete the .New file after download
8. Note any problems, maintenance issues or other information at the bottom of the data sheet.
9. Replace desiccant as needed
10. Close and secure the gauge station

MEASURING DISCHARGE

Discharge measurements are conducted to capture the widest possible range of flows at each monitoring site in order to develop a reliable rating curve. Once the curve has been established, discharge measurements are made to verify the rating curve approximately every 6 weeks at telemetered monitoring sites and quarterly at stand-alone flow sites (or more frequently as site conditions require). As high flow events modify channel geometry by depositing or eroding bed material, measurements are used to verify and update rating curves with the objective of accurately predicting discharge across the full range of flow for each site.

WWBWC currently uses two methods for measuring stream discharge: 1) wading cross-sectional measurement using a rod-mounted ADV and 2) cross-sectional measurement from a bridge using a Price AA current meter. In each case, we divide the cross section into segments, determine the depth and water velocity of each and use the USGS mid-section method to calculate flow.

Duplicate Discharge Measurements

For quality control, a duplicate discharge measurement will be taken each month at a randomly selected flow monitoring site. Duplicate measurements are intended to assess the precision of discharge measurements and document variability inherent in the measurement procedure. The cross section and meter used for the first measurement will also be used for the duplicate, but depth and velocity measurements should be taken at different vertical locations. Verticals for the duplicate should be offset by some distance ie: 0.5 or 1 ft from the vertical locations of the first measurement. The relative percent difference (RPD) for the two measurements will be calculated using the equation below. To meet our quality objectives the RPD of duplicate measurements should be within 5%.

$$RPD = \left[\frac{|R1 - R2|}{R1 + R2} \right] x200$$

Where R1=Result for the first measurement
R2=Result for the second measurement.

Procedure for Wading Measurements

1. Select an appropriate location to perform a discharge measurement (refer to Rantz, 1982 for full details). Often some or many of the below criteria cannot be met. The best available cross section location should be chosen. A good cross section will typically have the following characteristics:
    a. relatively straight channel with defined, parallel edges, and uniform shape
    b. free of vegetative growth and large cobbles or boulders
    c. free of eddies, slack water and turbulence
    d. depths greater than 0.5 feet
    e. evenly distributed velocities greater than 0.5 feet per second
    f. close to the gauging station

2. Stretch a measuring tape across the channel where the measurement will be taken. The tape should be perpendicular to as much of the flow as possible to reduce oblique flow angles.
3. Determine the width of the wetted channel and divide the width into 25-30 segments (verticals). The width should be divided such that each cell has approximately 5% of the total flow and no more than 10%. Segments should be shorter where flow is more concentrated or the bottom is irregular. The width of any segment should not be less than three tenths of a foot (0.3 feet).
4. Perform the FlowTracker QC test (BeamCheck) to verify system performance. If any warnings result, try moving the sensor to a different location and perform the test again. If warnings persist, the instrument cannot be used for discharge measurement until it is further evaluated.
5. Start at either the right or left edge of water (REW or LEW). Record tape distance for edge of water.
6. Set wading rod at location for the first measurement. The rod is graduated in tenths of a foot. Depth should be estimated and recorded to the nearest 0.01 feet.
7. If depth is less than 1.5 feet use the one point method of measuring velocity at 0.6 of the depth.
8. If depth is equal to or greater than 1.5 feet use the two point method of measuring at both 0.2 and 0.8 of the depth and average the velocities.
9. In cases where there is no logarithmic relationship to the velocities in the water column (this is when the 0.2 velocity is less than the 0.8 velocity or the 0.2 velocity is more than twice the 0.8 velocity) the three point method should be used. The three point method measures at 0.2, 0.6 and 0.8. The 0.2 and 0.8 velocities should be averaged and then that result should be averaged with the 0.6 velocity. This weights the 0.6 velocity at 50% and the 0.2 and 0.8 each at 25%. (Based on 0.8 and 0.2 velocities, the FlowTracker ADV will prompt the user to measure 0.6 velocity as necessary and will also perform the calculation described above.)
10. The meter should be set to average velocity data over 40 seconds in order to capture variations in water velocity over time at each vertical measurement point.
11. Repeat steps 5-10 for each of the subsequent verticals until you reach the opposite edge of water.
12. Sometimes, water flow direction is oblique to the FlowTracker sensor. As it conducts its automatic QA test prior to each velocity measurement, it will produce a warning for high flow angle. Keep the sensor oriented perpendicular to the flow and continue with the velocity measurement. The FlowTracker will conduct an internal calculation to correct the resulting velocity value according to the flow angle at which it was measured.
13. The FlowTracker calculates discharge using the mid-section method in which each section extends halfway between measurement locations. The flow through each section is calculated by multiplying the average velocity by the cross-sectional area of the section. See references for a complete description of discharge calculations.
14. The FlowTracker evaluates several quality control parameters for each velocity measurement and produces warnings when thresholds are exceeded. (Quality Control

thresholds are established according to USGS standards.) Whenever warnings are produced, move the probe location slightly and redo the velocity measurement. Under certain measurement conditions, QC warnings cannot be remedied. The FlowTracker tracks QC parameters for each velocity measurement and calculates an overall uncertainty value for the cross section.

15. Grade the measurement on a scale from excellent to poor based the FlowTracker's uncertainty calculation as well as measurement conditions (streambed smoothness, velocity conditions, equipment performance). Grades will be used to determine the tolerance for adjustment of the rating curve for that site. Observations that can influence the rating of a measurement include (but are not limited to): channel characteristics, proximity to bridges or other structures, number and degree of oblique flow angles, condition of equipment, weather, water level bounce and velocity pile up on wading rod. Use the FlowTracker uncertainty values as follows to inform a professional judgment of grade:
    a. ≤2.5% uncertainty = Excellent
    b. 2.5-5% uncertainty = Very Good
    c. 5-10% uncertainty = Good
    d. 10-20% uncertainty = Fair
    e. >20% uncertainty = Poor

Procedure for Discharge Measurement from a Bridge

This section describes procedural changes specific to bridge discharge measurements. Follow the procedure for wading discharge measurements above with the following changes:

1. Perform a spin test on the Price AA current meter each day before leaving the office. Spin time must exceed 2:00 minutes to indicate acceptable performance of the meter. If not, the meter cannot be used for measurement.
2. The choice of cross section locations is obviously limited when measuring from a bridge.
3. Use a bridge board, sounding reel and sounding weight instead of a wading rod. Depths should be measured to the nearest 0.1 feet.
4. For accurate depth measurement under swift and deep conditions, perform dry and wetline angle corrections according to USGS guidelines.
5. Increase measurements near bridge piers.
6. Use the one point method on depths less than 2.5 feet and the two point method on depths equal to or greater than 2.5 feet.
7. Sometimes, water flow direction is all oblique to the bridge. In these cases multiply the raw average velocity of the measurement by the cosine of the angle between current direction and the cross section. Use the data sheet to measure the angle coefficient and then apply a correction to the velocity (see figure below). Align the point of origin on the measuring tape. Rotate the data sheet until the opposite long edge is parallel to the direction of flow (the same direction the meter is pointed). The angle coefficient is read where the measuring tape intersects the data sheet. Multiply the velocity measurement by the angle coefficient to calculate the perpendicular velocity. The AquaCalc flow computer will perform the calculation to correct for flow angle when an angle's cosine (angle coefficient) is entered.

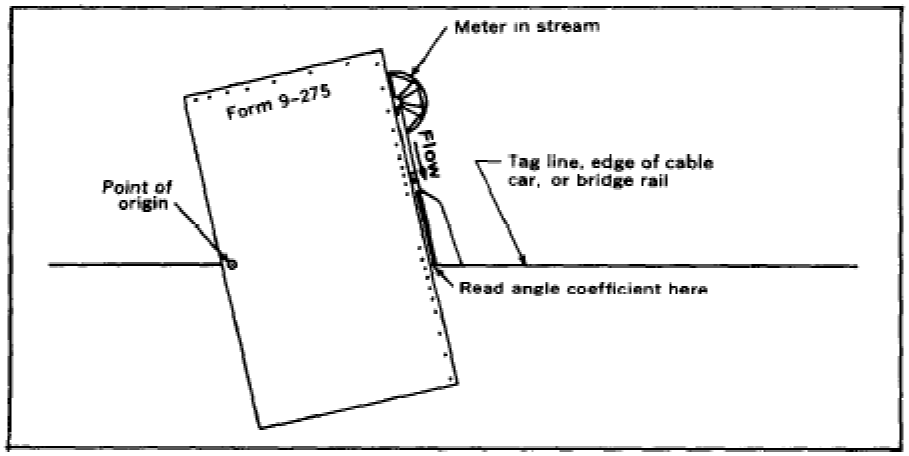


Figure taken from Rantz, 1982.

8. The AquaCalc calculates discharge using the mid-section method in which each section extends halfway between measurement locations. The flow through each section is calculated by multiplying the average velocity by the cross-sectional area of the section. See references for a complete description of discharge calculations.
9. Discharge measurements from a bridge using the Price AA and Aquacalc should be graded based on site conditions and professional judgement of velocity data quality. Grades will be used to determine the tolerance for adjustment of the rating curve for that site.
10. After returning to the office, conduct the daily maintenance of Price AA current meter.

Calculating Streamflow Using Gauge Height and Rating Curve

To obtain a continuous streamflow record, 15-minutes gauge height data are applied to a stage-discharge equation (rating curve). For each site, we use the AQUARIUS rating tool to develop a mathematical relationship between gauge height and instantaneous flow. Measured stage and discharge values are plotted to logarithmic scales and a scale offset (the effective gauge height of zero flow) is defined, producing a linear relationship between stage (the independent variable) and discharge (the dependent variable). In most cases, the rating curve will have multiple segments, each with their own scale offset, to describe the stage-discharge relationship during various flow conditions (low flow, within bank, overbank flow).

We work to conduct discharge measurements and record corresponding gauge height values across the full range of flow for each site. If the rating curve does not cover the full range of flows, the curve can be extended to twice the highest and ½ of the lowest discharge measurement. Any extension beyond those limits will serve only to estimate flow, and the data will be graded as estimated values.

Shifting

Stream channels change due to natural or man-made influences. Shifts are gauge-height adjustments that account for temporary changes to rating curves. When site conditions change temporarily due to scouring or material deposition or to seasonal vegetative growth, the rating curve can be shifted for a specified time period. All shift records are maintained in the AQUARUIS database.

Annual Data Review and Station Summary

At the close of each water year, we will conduct a thorough review of data, assign grades and approve the record. A narrative description of conditions and results will be produced for each site summarizing measurement activities and quality controls.

DISCHARGE NOTES DATA SHEET

.0 .10 .20 .30 .40 .50 .60 .70 .75

River at—

Dist. from initial point	Depth	VELOCI- .6	.6	.8	.8	.2	.2
1	REW / LEW						
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

.0 .10 .20 .30 .40 .50 .60 .70

Walla Walla Basin Watershed Council

DISCHARGE MEASUREMENT NOTES

Meas No. ....

Comp. by ....

Checked by ....

Station No. ....

Name .... Meter No ....

Date ...., 20.......... Party..........

Width .... Area.......... Vel.......... G.H.......... Disch..........

Method .... No. secs.......... G.H. change.......... in ....mins

Max Depth .... Hor. angle coef.......... Wetted Perim ....

Time	TD/WT	Logger	Staff	+/-
REW				
LEW				
WW				
Cell Width				

Type of Meter ....

Calibration Pre.......... Post..........

QA Form attached Y / N

Vel Unc ....

Depth Unc ....

Overall Unc ....

Measurement Type:

Wading / Bridge / Boat

Check-bar, found ....

changed to.......... at ....

Measurement rated excellend (2%), good (5%), fair (8%), poor (over 8%), based on following conditions:

Cross Section ....

Flow ....

Control ....

.... Photo taken Y / N

Gage ....

Weather..........

Other ....

Remarks ....

Zero Flow = GH .... - depth at control .... = ... ft.

GAGING STATION LOG DATA SHEET

Walla Walla Basin Watershed Council

Gaging Station Log

Station Name: ______________________ Station Number ____________ Water Year ________

Party												
Date												
Time												
PGI												
SGI												
AUX												
LOGGER												
H20 TEMP.												
THERMISTOR												
AIR TEMP.												
THERMISTOR												
BATT. V												
REPLACED (Y / N)												
DOWNLOADED (Y / N)												
PURGE (Y / N)												
SYNCED (Y / N)												
SYSTEM RESETS												
BATT. V (MIN/MAX)												
RESET STAT SCREENS (Y / N)												
MEASUREMENT (Y / N)												
MGH												
MEASURED Q												
PROFESSIONAL RATING												
METHOD												
LOCATION												
MAX DEPTH												
MAX VELOCITY												
PZF												
CONTROL (LOCATION, CONDITION, ETC.)												

STREAM GAGE NOTES DATA SHEET

Batt V .... Min .... Max ....

Reset Stats Y / N Batt Replaced Y / N

GOES Time OK Y / N

Data Downloaded Y / N .NEW File Erased Y / N

Desiccant Condition .... Changed Y / N

CSG checked Y / N

HWM .... ft on stick + Ref Elev .... ft

= HWM Elev .... ft. Cleaned Y / N

Added Cork Y / N

Remarks:............

Walla Walla Basin Watershed Council

WWBWC Stream Gage Logger Notes

Station name ....

Station # .... Party ....

DATE					
TIME (PST)					
LOGGER					
STAFF GAGE					
WIRE WEIGHT					
CHECK BAR					
TAPE DOWN					
CORR. FACTOR					
CORRECTED TD					
TD RP ELEVATION					
CORRECTED TD					
= WS ELEV @ TD					
LASER: LASER ROD READING					
- WATER SURFACE, ROD READING					
= DIFFERENTIAL, LASER TO WATER SURFACE					
LASER BEAM ELEVATION					
DIFFERENTIAL					
= STAGE					
WATER TEMP				ELEVATION	READING
THERMISTER			LL RP1		
AIR TEMP			LL RP2		
THERMISTER			LL RP3		

Groundwater Monitoring

These procedures are for monitoring groundwater levels and groundwater temperature and specific conductivity. The procedure covers equipment needed, establishing a measuring point, manual water level measurements, pressure transducer deployment, download and maintenance, groundwater grab samples for temperature and specific conductivity and site maintenance.

Note: These procedures are modified from Drost, B.W., 2005, Quality-assurance plan for ground-water activities, U.S. Geological Survey, Washington Water Science Center: U.S. Geological Survey Open-File Report 2005-1126, 27 p.

Equipment

- E-tape (Solinst model 102 Water Level Meter)
- Laptop
- Extra pressure transducers (if available)
- Cables for downloading pressure transducers
  - LT-300
  - MicroDiver/Solinst
  - MicroDiver (direct connect cable)
  - Solinst (direct connect cable)
  - MiniTroll
- Bailer
- Graduated Cylinder
- Temperature and Conductivity meter (YSI 30)
- Sounding Tape
- Measurement tape (measured in tenths of a foot)
- Data sheet (waterproof paper)
- Pen (waterproof) or pencil
- Well keys
- Battery removal tool for MiniTroll pressure transducers
- GPS
- Extra Batteries (AA lithium for pressure transducers & 9v for E-tape)
- Flashlight
- Screwdrivers
- Hammer
- Pipe wrench
- Socket set
- Crescent wrench
- Cable snips
- Pliers (preferably needle-nose)
- Camera
- Well Field Instructions and Procedures binder
- WellNet binder for site references and maps
- Business cards
- U-bolts and cable crimps
- Inverter (for charging laptop from vehicle)
- Cable (speaker wire or 1/16" aviation cable)
- Extra sacrificial weights for E-tape
- Work gloves

- Disposable gloves (nitrile)
- Disinfectant (Lysol or diluted bleach)
- Sharpie or other marking device (for measuring point)
- WD-40

Establishing a Measuring Point

This procedure is for establishing a measuring point on wells from which all water levels are measured.

1. Measuring point (MP) must be permanent as possible, clearly defined and easily located. Typical locations include the top of the well casing or access ports.
2. MP should be located so that the measuring tape can hang freely during water level measurements.
3. Mark MP with Sharpie or other marker (paintstick, etc).
4. Measure distance from the MP to the land surface and record on the data sheet. This measurement is called the top of grade (TOG) for the well. MP's located below the land surface are positive and MP's located above the land surface are negative. If the well has been GPS surveyed, measure TOG from the MP to the surveyed elevation.
5. Take a photograph of the MP to document location Well Network Database or in case the marker wears off.

Manual Groundwater Level Measurement (E-tape)

1. Before measuring the water level in a well utilized for drinking-water supply, disinfect the first 5-10 feet of the E-tape with diluted bleach water and dry with single-use towels (e.g. Kimwipes). Use latex or nitrile gloves for drinking-water supply wells and disinfection.
2. Review well info page in the Well Network binder for the MP.
3. Record if the Pump is On (1) or Off (0) in the "Pump" field.
4. Test the E-tape by turning it to "test" or by pressing the "test" button. If the E-tape does not buzz, check the battery. Start with sensitivity set to the mid-range and adjust as necessary.
5. Carefully lower the tape (and weight) into the well. The tape should be lowered slowly to prevent splashing or excess wear on the E-tape.
6. When the E-tape buzzes, pull the tape up and down a few inches to determine the exact level. Hold the tape at the MP and record the value to the nearest 0.01 feet in the "Static" field.
7. Repeat water level measurement. If measurements differ by more than 0.02 feet determine why (well pumping, well recovering, etc) and document reason on data sheet.
8. Periodically check the E-tape to make sure it is in good working condition.

Pressure Transducer Deployment

1. Sound well and record measurement or, if available, consult the well log to determine well depth and pump location.
2. Take a manual water level measurement (see above) and record measurement on data sheet.
3. Program and start the pressure transducer. Pressure transducers should collect data every 15 minutes. Pressure transducer should be started so that data will be recorded on the hour (i.e. 12:00, 12:15, 12:30, 12:45, 13:00…). Program transducer with the well's GW

number. Follow the manufacturer's instructions on how to program and start the transducer.

4. Attached pressure transducer to one end of the cable using two wire crimps and a stainless steel U-bolt. Do not use crimps and do not over tighten the U-bolt if using a communication cable.
5. Measure and cut aviation cable or speaker wire to suspend the pressure transducer approximately 5-10 feet above the bottom of the well. This value can change depending upon the depth of the well and the pressure range of the pressure transducer. Make sure to not deploy the pressure transducer below its rated pressure range (typically marked on the side of the device). If the well is deeper than the pressure range, place the pressure transducer at a depth so there is 10-15 feet of pressure range still available (to account for potential water level increases). Pressure transducers should not rest on the bottom of the well or be surrounded by silts/fines that have accumulated in the well. Remember to account for the length of the logger when measuring the length of the cable.
6. If using a communication cable for the manufacturer, following the steps above to determine cable length.
7. Record length of cable, pressure transducer serial number and communication cable serial number if used.
8. Slowly lower pressure transducer and cable into the well making sure the transducer is not free falling. Take extra care as the transducer passes through the water-air interface to prevent damage to the transducer or entrainment of air bubbles.
9. Attach cable to the well at the surface using wire crimps and a stainless steel U-bolt.
10. Mark the cable so that cable slippage, if it occurs, can be accounted for during future site visits.
11. Make sure that all of the cable is deployed and the transducer is hanging on the cable rather than caught on a pump or some other obstruction.
12. Photograph the well to document the pressure transducer deployment and well. Try to capture the area around the well, any well apparatus and the measuring point. Multiple photos may be required.

PRESSURE TRANSDUCER DOWNLOAD AND MAINTENANCE

1. Record manual water level measurement, date, time and whether the well is being pumped.
2. Retrieve pressure transducer to the surface (if not attached to a communication cable).
3. Connect the pressure transducer, using the appropriate cable, to the field laptop.
4. Record the following information on the data sheet: Download start time (DL), Logger Time (LT – difference between pressure transducer time and computer time), Restart Time (RT – if the pressure transducer was stopped and restarted), Serial number (S#), Battery level (Batt - % of battery left or if batteries were replaced) and U-bolt and crimp conditions (Ubolts).
5. Follow manufacturer's protocol for downloading, saving and exporting data from the pressure transducer. Data should be saved in the proprietary format and in comma separated value format (.csv). File names should be in the following format: GW_xx_Data start date_Data end date_data collector's initials (For example: GW_129_3-3-11_7-6-11_sp – This file is for well GW_129 and the data in the file is from March 3rd through July 6th and was collected by Steven Patten).
6. Visually check the graphed data to ensure there are not any major issues that should be addressed. Raw data visual checks may be able to determine if the transducer came out of the water, the cable slipped/shifted or other issues that can be resolved through site

maintenance. Potential fixes could include readjusting/lengthening cable length or tighten U-bolts.

7. Note when the pressure transducer will run out of memory so a future visit will occur before that time.
8. Examine the pressure transducer for indications of damage or wear. Make sure access ports for the pressure diaphragm are clear of obstructions so the pressure transducer performs correctly.
9. Slowly lower transducer back into the well taking extra care as it transitions between air and water.

Grab Samples for Groundwater Temperature and Specific Conductivity

1. Check the bailer to determine if the string/cable is attached properly and that it is not frayed or damaged and that the bailer is in proper working order.
2. Slowly lower the bailer into well until is below the water level and fills with water. NOTE: Do not put the bailer down access or vent holes. If unsure do not put the bailer down the well. The data sheet indicates which wells should have water grab samples taken – if the temperature and conductivity fields are grayed out do not take a sample. The Well Network database also indicates whether a water grab sample should be collected.
3. Slowly reel the bailer back to the surface taking care to limit it banging/hitting the well casing.
4. Empty the water in the bailer into the graduated cylinder.
5. Put the temperature/EC probe into the water in the graduated cylinder.
6. Turn on the YSI-30 (temperature/EC meter). Ensure that the meter is correctly set to measure temperature in degrees Celsius and specific conductivity in µs/cm.
7. Wait for the reading to stabilize and then record temperature and conductivity values in their appropriate fields on the data sheet. In the summer or winter water temperature may increase or decrease depending upon the ambient air temperature. If the reading does not stabilize in 15-20 seconds, record the mean value over the 15-20 second period.
8. Turn off the YSI-30.
9. Discard water from the graduated cylinder.

Site Maintenance

1. Check the well casing and surrounding area for any changes that have occurred since the last field visit. If needed document the changes on the data sheet and with photographs.
2. Check TOG measurement approximately once a year to determine if there are any changes.
3. If well has not been surveyed in, survey well using Magellan ProMark 3 GPS system at earliest opportunity.
4. Check cable integrity and other well monitoring components for wear or damage. Replace as needed.
5. Photograph the site during every field visit to visually track changes to the site.

GROUNDWATER MONITORING DATA SHEETS

Shallow Aquifer Monitoring Network
OR Well Monitoring Field Notes

Well_ID	Name	Date	Time	Static	Pump	TOG	Temp (C)	Cond
GW_48								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_58								
GW_60								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_61								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_62								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_63								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_64								
GW_65								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_67								
GW_68								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_69								
GW_73								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_74								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_75								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_98								
GW_115								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_116								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_119								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_120								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_135								
DL=	LT=	RT=		S#		Batt	Ubolts	
Notes								

Shallow Aquifer Monitoring Network
OR Well Monitoring Field Notes

Well_ID	Name	Date	Time	Static	Pump	TOG	Temp (C)	Cond
GW_04								
GW_05								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_06								
GW_07								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_08								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_09								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_10								
GW_11								
GW_13								
GW_14								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_28								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_31								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_33								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_34								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_35								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_36								
GW_37								
GW_38								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_39								
GW_40								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_41								
GW_45								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_46								
DL=	LT=	RT=		S#		Batt	Ubolts	
GW_47								
DL=	LT=	RT=		S#		Batt	Ubolts	

Water Temperature Monitoring

This procedure is for continuous water temperature monitoring in rivers and streams using data loggers. The procedure describes the equipment needed, calibration checks, deployment, field accuracy checks (site visits) and recovery.

This procedure is modified from the following references:

Water Quality Monitoring – Technical Guide Book, 2001. Oregon Watershed Enhancement Board.

ODEQ, 2009. Water Monitoring and Assessment Mode of Operations Manual. Watersheds Quality Monitoring Field Sampling Standard Operating Procedure – Laboratory and Environmental Assessment Division. Version 3.2

U.S. Geological Survey, 2006. National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chapter 6, available online at https://water.usgs.gov/owq/FieldManual/Chapter6/6.1_ver2.pdf.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; available online at http://pubs.water.usgs.gov/tm1d3.

Ward, W., 2018. Standard Operating Procedures for Continuous Temperature Monitoring of Freshwater Rivers and Streams, Version 2.1. WA Dept of Ecology. SOP Number EAP080. https://fortress.wa.gov/ecy/publications/documents/1803205.pdf

Equipment

- Data Logger (Onset U-22, Solinst Levelogger, In Situ Leveltroll 300 or other)
- Laptop/Computer set to Pacific Standard Time
- Computer interface cable for data logger
- NIST-certified field thermometer
- 1 medium sized cooler
- Ice
- Temperature Accuracy file (MS Excel workbook)
- 1 ½” PVC Pipe, grey (to reduce temperature variations due to solar radiation)
- 1/16” aviation cable or 16 gauge speaker wire
- Wire cutters
- Stainless steel u-bolts
- Needle nose pliers or other tool to tighten u-bolts
- Forestry Flagging/Surveyors Tape
- GPS unit
- Camera
- Waders
- Field Notebook
- First Aid Kit

Note: All field measurements and datalogger clocks should use Pacific Standard Time (PST) year-round.

CALIBRATION CHECKS

1. For 20°C calibration test, pour room temperature water into the cooler. Adjust temperature in the cooler with ice, cold water or hot water to the desired 20°C. If ice is used make sure it is completely melted. Close lid.
2. Insert the NIST-certified field thermometer sensor into the cooler. Pull it through enough so that when the lid is closed, the sensor will be suspended midway (or slightly lower) in the water bath.
3. Use the computer and manufacturer's software to start the temperature data loggers and set them to record data (°C) every 1-minute.
4. Place temperature data loggers directly into the water bath.
5. Allow water bath to stabilize (for 15-30 minutes) before recording NIST thermometer temperatures (°C). After stabilization, record temperatures from the NIST thermometer every minute for ten minutes. More readings may be necessary if there is suspicion the water bath temperature changed or was not stabilized.
6. Download data from the temperature data loggers and audit thermometer results with time of record on an audit form. Water temperatures should not vary more than ± 0.5°C between the NIST thermometer and the data logger's temperature. Units not passing this accuracy test should be re-tested and will not be used if the ± 0.5°C accuracy standard is not met.
7. Repeat accuracy test for cold water bath at 5°C.
8. For telemetered sensors that are deployed year-round, a single point ambient temperature water bath calibration test is conducted annually, typically during the summer months.

DEPLOYMENT

1. Start temperature data logger either prior to going to the field or in the field with a laptop. Data loggers should be set to record data in Celsius (°C) every 15 minutes. Data loggers should be set to start collecting data at the quarter hour.
2. Secure data logger inside of the 1 ½" PVC pipe using the aviation cable, ensuring that the entire length of the logger is covered by the PVC.
3. Secure data logger at the site using the aviation cable. Often the cable can be secured to trees, logs, large rocks or other stable structures. Make sure that the logger is in a well-mixed portion of the river to ensure accurate readings. Ideal deployment locations are typically at the upstream outside edge or downstream inside edge of the river bends or in the middle of riffles of low flow and wadeable streams. Also, place the data logger to ensure that it will stay submerged in the water as river flows drop.
4. Place NIST-certified thermometer in the water directly next to the temperature data logger.
5. Allow field thermometer to stabilize for at least one minute and then record the temperature reading.
6. The representativeness of the temperature logger deployment location should be verified by measuring several points in and near the vicinity of the logger and the temperature of the well-mixed part of the stream. If the stream can be easily waded, then a simple cross sectional temperature survey could also be done. Review the survey results, calculating the average temperature, and consider another deployment location, if necessary, to help ensure that the logger will record representative results.
7. Record in the field notebook the following:
    a. Time of deployment
    b. Date the data logger will run out of memory for logging data
    c. Record site name and data logger serial number
    d. Stream temperature using the NIST-certified field thermometer
    e. Cross sectional temperature survey results and calculation of average value

f. GPS coordinates
g. Write a short description and create a sketch of the site including approximate distances from structures (bridges, log jams, etc.)

8. Take pictures of site for future reference and recovery.

Field Accuracy Checks (Site visits)

During a typical season of water temperature monitoring (June-November), two field accuracy checks will be conducted using the following procedure. At telemetered monitoring sites, field checks are conducted every other week.

1. Determine if the data logger is still adequately placed in the river (see deployment procedure for details) to record water temperatures.
2. Place NIST-certified thermometer in the water directly next to the temperature data logger.
3. Allow field thermometer to stabilize for at least one minute and then record the temperature reading.
4. If the stream may be easily waded, consider doing a cross-sectional survey of the stream temperature. The survey results may help determine if the stream-temperature logger measured representative temperatures and show any cross-sectional temperature differences.

Recovery

1. Locate temperature data logger
2. Place NIST-certified thermometer in the water directly next to the temperature data logger.
3. Allow field thermometer to stabilize for at least one minute and then record the temperature reading.
4. If the stream may be easily waded, consider doing a cross-sectional survey of the stream temperature. The survey results may help determine if the stream-temperature logger measured representative temperatures and show any cross-sectional temperature differences.
5. Record time of data logger recovery and note any site conditions that may have affected data accuracy or reliability.
6. Return to the office and download the data. Data loggers should be stopped after data download to prevent unnecessary battery use.
7. Compare the logged water temperature values to the field thermometer measurements. Data accuracy should be ± 0.5°C.
8. Conduct the post-deployment accuracy check in the room temperature and cold water baths.

Data Management

1. Enter field measurements into the AQUARIUS database, recording to the tenths place
2. Load continuous temperature data into the database and visually verify values by plotting with field measurements.
3. Apply data corrections as needed:
    a. Delete any air temperature values logged when the sensor was not submerged.
    b. If logged data differ from field measurements by more than 0.2°C, correct for fouling, calibration drift and cross-section variability.

c. Correct for logger bias according to results of calibration checks: If the mean absolute value of the temperature difference for a logger in each water bath, compared against the NIST-certified thermometer, is equal to or less than the manufacturer stated accuracy (i.e. usually ±0.2°C for a water-temperature logger or ±0.4°C for an air temperature logger), then a second check should be performed. If a second calibration check result confirms a consistent bias above the stated accuracy, then the raw data should be adjusted by the mean difference of the pre- and post-calibration check results to correct for the logger bias.
d. The AQUARIUS software documents all corrections and the user who applied them. If the recorded values differ from the corrected values by more than 2.0°C, the data cannot be used or reported.

4. Grade the data from excellent to unusable based on the completeness of the dataset, comparison of logger data and field checks, equipment maintenance and performance, the corrections applied, instrument calibration information and other pertinent factors. Use the table below as a starting point for the accuracy rating.

	Magnitude of corrections applied for fouling and/or calibration drift
Excellent	≤ ±0.2 °C
Good	±0.2-0.5 °C
Fair	±0.5-0.8 °C
Poor	≥ ±0.8 °C
Unusable	> ±2.0 °C

5. Use AQUARIUS report tools to calculate desired statistics and publish “provisional” data online.
6. Conduct annual data review and publish “approved” data online.

Scour Chains and Bed Stability

This procedure is for monitoring bed scour and fill to look at river bed stability and river bed conditions. The procedure covers the construction, installation and monitoring of scour chains (including cross-sectional surveys) and pebble counts.

Note: Scour chain procedures were based upon the following sources:

Lisle and Eads. 1991 Methods to measure sedimentation of spawning gravels. Res. Note PSW-411. Berkley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 7 p.

Nawa and Frissell. 1993. Measuring Scour and Fill of Gravel Streambeds with Scour Chains and Sliding-Bead Monitors. North American Journal of Fisheries Management. 13: 634-639.;

Leopold, Wolman and Miller. 1964. Fluvial Process in Geomorphology. Freeman, San Francisco.

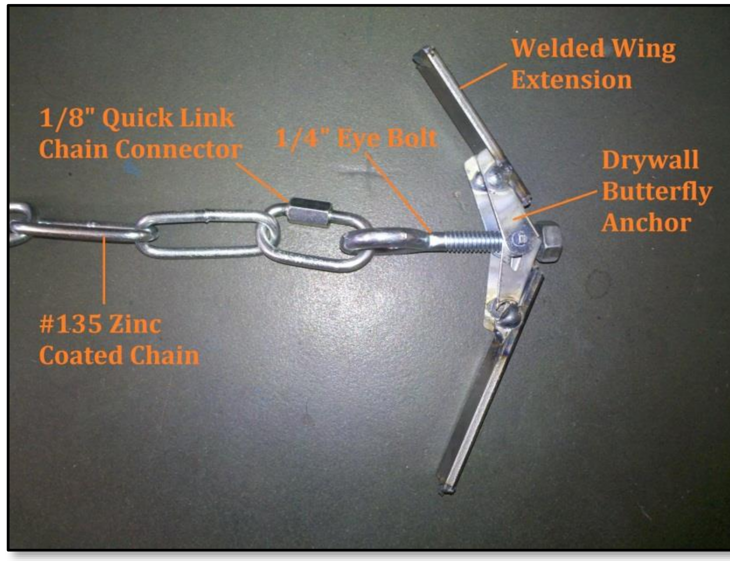
Pebble count procedures where based upon Wolman, M.G. 1954. A Method of Sampling Coarse River-Bed Material. Transactions of the American Geophysical Union. 35(6):951-956.

Equipment

- Scour Chains
  - 2.5-3.0 feet of #135 Zinc Coated Chain (links are ~1.5")
  - Chain Quick-Link Connector (1/8")
  - Anchor (Modified Drywall Butterfly Anchor)
  - Eye bolts
- 100' or 200' tape
- Waders (hip or chest)
- Laser Level with Stadia rod
- Flow meter
- Shovel
- Hand Trowel
- Fence Post Driver
- 1 ½" galvanized steel pipe
- 1" metal rod
- Rubber bands
- Fishing line
- Forestry Flagging Tape
- Pipe Wrenches
- Data Sheets or Field Notebooks
- Pen or Pencil
- First Aid Kit

Scour Chain Construction

Scour chains are constructed by WWBWC staff to help reduce costs. Scour chain anchors are created by modifying drywall butterfly anchors (1/4" bolt/screw). Extensions (1/2" flat metal) are welded to each wing of the anchor creating ~2-3 inch wing on each side. Eye bolts are then welded on to the anchor to prevent them from detaching. A ~2.5-3.0 foot section of #135 chain is attached to the eye bolt with a quick link chain connector. See figures below.

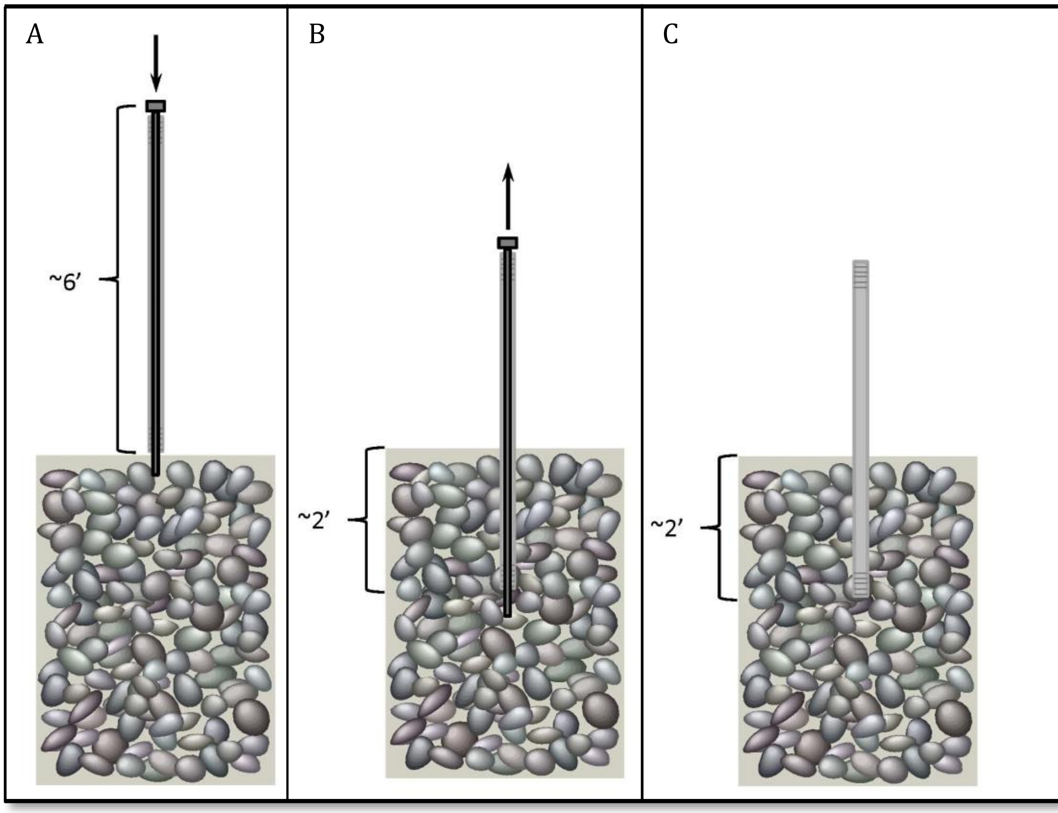


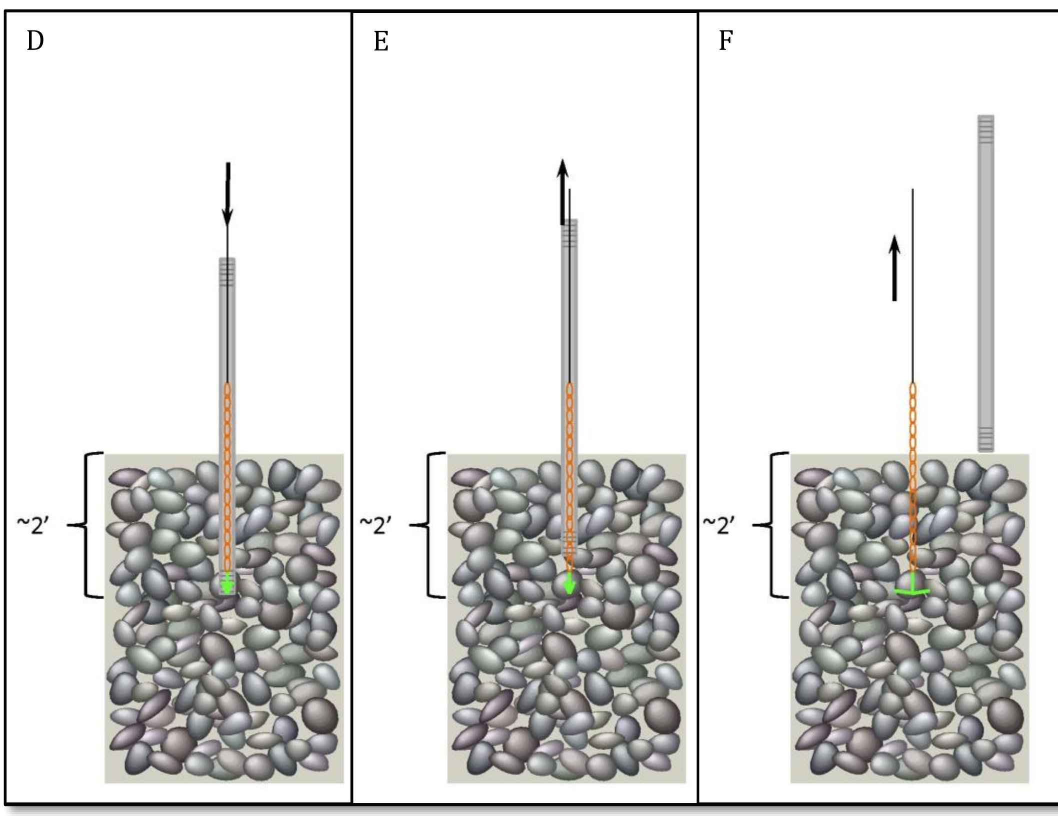
SCOUR CHAIN INSTALLATION

Scour chains are installed perpendicular to the direction of flow in the river (similar to a discharge measurement). 4-5 chains are typically installed across the width of the river, but this will increase or decrease depending upon the width of the river. Chains are installed approximately 10-12 feet apart across the channel.

1. Determine location for scour chain installation.
2. Establish a control point on both banks. Make sure the location of each control point is as stable as possible and will not be damaged by higher flows. Preferably the control points should be located above the bank full width to avoid frequent flood damage. Drive a piece of ½" rebar into the ground as far as possible. Place a blue WWBWC control point marker on the end of the rebar and flag it with forestry flagging.
3. Run a tape across the width of the channel between the control points on either bank. You can tie off the tape to the control points or to rocks/trees on the shore. If not tying off to the control points make sure the tape goes directly over each of the control points.
4. Determine the width of the river – typically this will be the bank full width as to capture river scour/fill influences during frequent high flow events.
5. Decide how many scour chains to install based upon width. Chains are installed ~10 feet apart. So if the river is 40 feet across plan on installing 4 chains.
6. Divide the river into approximately even sections and make note where each scour chain should be installed. The exact location of each chain will vary side to side by a small amount based upon sediments present at each location (see 7 below).
7. Drive pipe and metal rod into the river bed substrate using the fence post driver to a depth of ~2 feet. Because river bed sediments in the Walla Walla Basin are often gravels and cobbles (and sometime boulders) you may have to try multiple locations to find a successful spot where the pipe can be driven in ~2 feet (Figure A).
8. Remove metal rod from inside the pipe. Be sure to not remove the pipe. You may have to turn the metal rod using pipe wrenches to loosen it before it can be removed. (Figure B & C)

9. Prepare a scour chain anchor with ~2.5-3.0 feet of chain attached to it with the 1/8" quick link connector. Attach fishing line to the end of the chain to allow it to be lowered into the pipe. Count the number of links and record on the datasheet or in the field notebook.
10. Use a small rubber band to hold the two wings of the anchor device together so it will slide down into the pipe. When the anchor wings are held together the anchor is considered "closed" and when the rubber band is removed to allow the wings to spring apart the anchor is considered "open." Tie fishing line on to the rubber band so it can be pulled off and allow the wings to spread and anchor the device.
11. Slowly slide the "closed" anchor down the inside of the pipe (Figure D).
12. Once the anchor is at the bottom of the pipe (make sure by slowly pulling up and dropping the anchor) gently lift the pipe 6-8" upwards. This should allow the "closed" anchor to be exposed to the sediments (Figure E).
13. Pull on the fishing line attached to the rubber band to release the wings and "open" the anchor.
14. Remove the pipe completely making sure to keep holding the fishing line attached to the chain to prevent the chain from falling into the hole.
15. Gently pull up on the chain/fishing line to set the anchor in the sediments. Once the anchor is set you can pull harder to verify it is solidly anchored (Figure F).
16. Count the number of links that are exposed above the river bed and lay chain downstream. Record number of links on the data sheet or in the field notebook (Figure G).
17. Take note of the distance from both the left and right bank control points to the scour chain.
18. Repeat process for the other scour chains to be installed in the set.
19. After all scour chains have been installed conduct a perpendicular channel survey (see below for procedure). Scour chain location accuracy is extremely important for finding each scour chain in the future especially since some chains will be covered by sediments.
20. Also conduct a river discharge measurement at or near the site (see above for procedure).

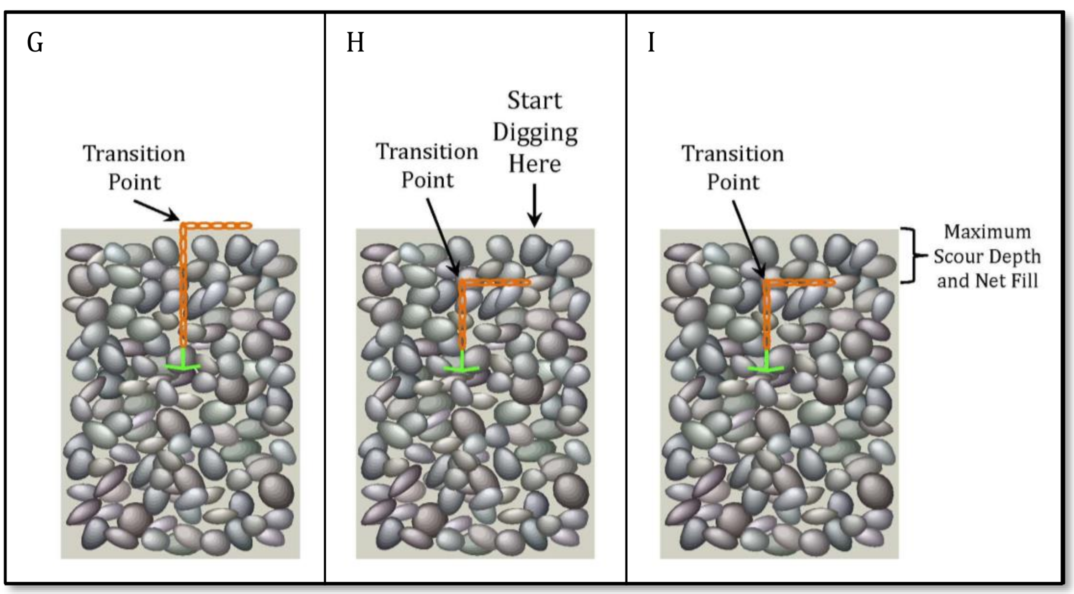

A
~6′
B
~2′
C
~2′


D
~2′
E
~2′
F
~2′

Scour Chains Scour/Fill Monitoring

This procedure will provide information on how to locate and measure scour chain data. Data collected at each chain will provide information on maximum scour since the last monitoring and net fill since last monitoring.

1. Locate both left and right bank control points.
2. Using a 100' or 200' tape, measure from the control points to the find the scour chain closest to the right bank (you can also start near the left bank if that is more convenient). Note – refer back to installation notes on datasheet or the field notebook to determine the location for each scour chain.
3. Once you have determined the location for the first scour chain, look to see if the chain is exposed. If the chain is not exposed on the river bed it may be buried under the sediments. Carefully and slowly dig just downstream of where the chain was installed. Dig until you find the chain and then slowly work upstream until the chain changes from lying horizontally to vertical. This transition point is the maximum scour depth. (Figure G & H)
4. Measure the vertical distance between the transition point and the river bed surface (see figures below). (Figure I)
5. Count the number of links from the transition point to the end of the chain. This can be used to verify the vertical measurement taken in step 4.
6. Hold scour chain vertically while excavated sediments are replaced.
7. Count the number of links that are exposed above the transition point (on the river bed surface).
8. Place the exposed chain on the river bed surface facing downstream.
9. Repeat process for other scour chains in the set.



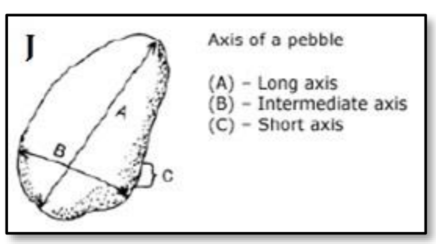
CHANNEL SURVEY

This procedure provides information for preforming a channel survey for scour/fill within a scour chain set. All changes are relative to the control point(s) established for the scour chain set (see above).

1. Place the laser level in a location where it will be visible when measuring at each scour chain in the set and visible at each control point.
2. Adjust laser as close to level as possible.
3. Turn on laser and allow it to auto level. Once the laser has leveled it should start spinning. If it does not the laser may be tilted too much and cannot level itself – turn the laser off, readjust it and turn it back on to auto level.
4. Stretch a 100’ or 200’ tape across the channel. Make sure the tape goes directly over each of the control points.
5. Take the stadia rod with the laser sensor attached to the control point on the right bank (you can start on the left bank if that is more convenient). Place the stadia rod on the control point and read the height with the laser sensor. Record laser height value, depth of water and the tape distance on the datasheet or field notebook.
6. Continue measuring height and tape distance values as you move across the channel until you reach the opposite control point. Make sure to capture changes in the river bed as well as important locations such as edge of water, gravel bars, thalweg and each scour chain.
7. Return to the first control point and measure the height and tape distance a second time to verify that the tape or the laser has not moved.

PEBBLE COUNTS

1. Select reach of the river for sediment particle size distribution (typically between two closely spaced scour chains sets).
2. Start transect randomly between the scour chain sets by throwing a rock along the stream edge. Take a step into the river, perpendicular to the flow, from that point and pick up the first pebble you touch with your index finger next to your big toe. Avert your eyes to prevent as much bias as possible when pick up pebbles.
3. Measure the intermediate axis (see Figure J below) by determining the smallest hole the pebble will fit through using the gravelometer. For embedded pebbles or those too large to pick up, use the side of the gravelometer to measure the shortest visible axis
4. Record info on the datasheet.
5. Take another step across the river and repeat the steps of picking and measuring pebbles until you reach the opposite bank. Once you reach the opposite bank, throw another rock and start back towards the first bank repeating the steps above.
6. Continue collecting pebble data until you have recorded 100 measurements.



PEBBLE COUNT DATA SHEETS

Walla Walla Basin Watershed Council

Pebble Count Datasheet

www.wwbwc.org — Walla Walla Basin Watershed Council — 541-938-2170 or 7086 — P.O.Box 68, Milton-Freewater, OR 97862

Date & Time ____________ Site Name: ____________

Data Collected by: ____________ GPS Coord: ____________ River/Stream: ____________

Data #	Largest Size b-axis will fit through	Data #	Largest Size b-axis will fit through	Data #	Largest Size b-axis will fit through	Data #	Largest Size b-axis will fit through
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

NOTES:

Data Computation

Inches	PARTICLE	Millimeters		Particle Count	Total #	Item %	% Cum
< 0.08	Sand	< 2	Silt/Clay/Sand				
0.08—0.16	Very Fine	2—4	Gravels				
0.16—0.22	Fine	4—5.7					
0.22—0.31	Fine	5.7—8					
0.31—0.44	Medium	8—11.3					
0.44—0.63	Medium	11.3—16					
0.63—0.89	Coarse	16—22.6					
0.89—1.26	Coarse	22.6—32					
1.26—1.77	Very Coarse	32—45					
1.77—2.5	Very Coarse	45—64					
2.5—3.5	Small	64—90	Cobbles				
3.5—5.0	Small	90—128					
5.0—7.1	Large	128—180					
7.1—10.1	Large	180—256					
10.1—14.3	Small	256—362	Boulders				
14.3—20	Small	362—512					
20—40	Medium	512—1024					
40—80	Large	1024—2048					
80—160	Very Large	2048—4096					
	Bedrock		Bedrock				
			TOTALS				

Seepage Analysis

Seepage analysis protocols are discussed in the Seepage Report (found on the WWBWC website – www.wwbwc.org). The WWBWC performs seepage analyzes on multiple stream systems within the Walla Walla Basin to determine the water budget for each system and to determine gain/loss reaches. The primary measurement procedure used during a seepage analysis is a stream discharge measurement. The procedure described above for a wading stream discharge measurements is used during seepage measurements.

Water Quality Monitoring (Field Measurements)

ODEQ, 2009. Water Monitoring and Assessment Mode of Operations Manual. Watersheds Quality Monitoring Field Sampling Standard Operating Procedure – Laboratory and Environmental Assessment Division. Version 3.2

Water Temperature and Conductivity (YSI-30)

1. Check sensor calibration to NIST-certified thermometer and standard conductivity solution (typically done in the office before field visit). Recalibrate if necessary.
2. Turn the YSI-30 unit on.
3. Make sure units are set to °C for temperature and to µs for conductivity. The °C should blink indicating the YSI-30 is in temperature compensating mode.
4. Gently place the sensor in the water. Make sure that the sensors are completely covered by water. Gently agitate the probe to ensure air bubbles are dislodged.
5. Allow the values to stabilize for at least 1 minute and then record on the data sheet or field notebook.
6. Replace the sensor in the holder and turn the unit off.

Dissolved Oxygen

1. Connect the dissolved oxygen sensor to the meter.
2. Turn on the Thermo Scientific Orion 5-Star meter.
3. Check sensor calibration (typically done in the office before field visit). Recalibrate if necessary.
4. Make sure units are set correctly for dissolved oxygen (mg/L).
5. Gently place the sensor in the water. Make sure that the sensor is completely covered by the water.
6. Allow the value to stabilize and then record on the data sheet or field notebook.
7. Replace the sensor in the holder and turn the unit off.

pH

1. Connect the pH sensor to the meter.
2. Turn on the Thermo Scientific Orion 5-Star meter.
3. Check sensor calibration using a standard pH solution (typically done in the office before field visit). Recalibrate if necessary.
4. Gently place the sensor in the water. Make sure that the sensor is completely covered by the water.
5. Allow the value to stabilize and then record on the data sheet or field notebook.
6. Replace the sensor in the holder and turn the unit off.

Conductivity

1. Connect the conductivity sensor to the meter.
2. Turn on the Thermo Scientific Orion 5-Star meter.
3. Check sensor calibration using a standard conductivity solution (typically done in the office before field visit). Recalibrate if necessary.
4. Gently place the sensor in the water. Make sure that the sensor is completely covered by the water.
5. Allow the value to stabilize and then record on the data sheet or field notebook.
6. Replace the sensor in the holder and turn the unit off.

Turbidity

1. Turn on the Hach 2100P Turbidimeter.
2. Check sensor calibration using a standard turbidity solution (typically done in the office before field visit). Recalibrate if necessary.
3. Collect water sample in glass vial and wipe clean. Insert the vial into the turbidimeter, cover and read the sample.
4. Record the value on the data sheet or field notebook.
5. Empty the vial and turn on the meter.

Quality Control

Quality Control for Laboratory Measurements

Field duplicates and blanks will be used to ensure quality control for lab samples.

- Field blanks: Once per sampling even a blank sample with known concentrations of the monitored constituent will be included in the samples sent to the analytical laboratory. The field blank will be purchased from a scientific supply vender.
- Field duplicates: Once per sampling event one additional sample will be collected from one of the sites.
- Analytical laboratory will also have internal QA/QC procedures to ensure data validation.

Quality Control for Field Measurements

Field Records

Field notes and other pertinent data associated with the monitoring program will be maintained at the WWBWC office and archived for reference. Completeness of data sheets and chain of custody forms and verifying holding times for samples will also be used for data validation.

Flow Monitoring

Flow monitoring will use the following quality control measures:

- Conduct a monthly duplicate discharge measurement to confirm method and instrument precision within 5%.
- Field equipment will be maintained and calibrated to ensure proper operation and reduce bias.
- Comparison of equipment to other equipment or rated structures (such as flumes, etc).
- Primary and secondary stage height values are referenced to benchmarks to ensure no elevation changes.
- Comparison of primary, secondary and laser level stage height values.

Groundwater Monitoring

Groundwater monitoring will use the following quality control measures:

- Yearly comparison of E-tape measurements against other tapes.
- Duplicate groundwater level measurements during every field visit.
- If available, comparison of manual measurements to other agencies' data.
- Duplicate water sample for groundwater temperature and conductivity at approximately 5% of the sites.

Water Temperature Monitoring

Water temperature monitoring will use the following quality control measures:

- Pre and Post data logger accuracy testing.
- Manual field checks during deployment.

Water Quality Monitoring

Water quality monitoring will use the following quality control measures:

- Field equipment will be maintained and calibrated to ensure proper operation and accuracy.
- Duplicate samples will be taken at approximately 5% of the sites.
- Comparison of field and laboratory values.

Data Management Procedures

Field Notes

In The Field

Data should be recorded on WWBWC datasheets (if available) printed on waterproof paper (Rite-in-the-Rain). Notes should be clearly and legibly written so data and remarks are easily read and interpreted. If a mistake is made, draw a single line through the bad data and record the data next to it. Do not erase or completely mark out mistakes. All datasheets should be completed as fully as possible during data collection.

At The Office

Upon returning to the office scan all datasheets and place a scanned copy on the WWBWC server in the appropriate location and incorporated into the AQUARIUS database. After scanning the datasheets, use them to input the data into the appropriate software (AQUARIUS, Excel, etc.). After all data from the datasheet has been incorporated into the software, place the datasheet in the project's 3-ring binder.

Data Loggers

In The Field

Data loggers should be downloaded during every site visit if practical. Data from the data logger should be downloaded and saved to the field laptop before the data logger file(s) is deleted or restarted to ensure data are not lost. After restarting a data logger take note of when the logger's memory will be full so a site visit can be scheduled before that date. Files should be saved in the following format: type of file (gh = gauge height, mmt = measurement and temp = temperature)_site number_data start date_data end date_downloader's initials. For a surface flow example the file format for site S105 with stage data from March 1st, 2012 through July 15th, 2012 and downloaded by Steven Patten would look like: gh_S105_3-1-12_7-15-12_sp. For a groundwater example the file format for site GW_115 with water level (stage) data from May 1st, 2012 through September 29th, 2012 and downloaded by Steven Patten would look like: gh_GW115_5-1-12_9-29-12_sp.

At The Office

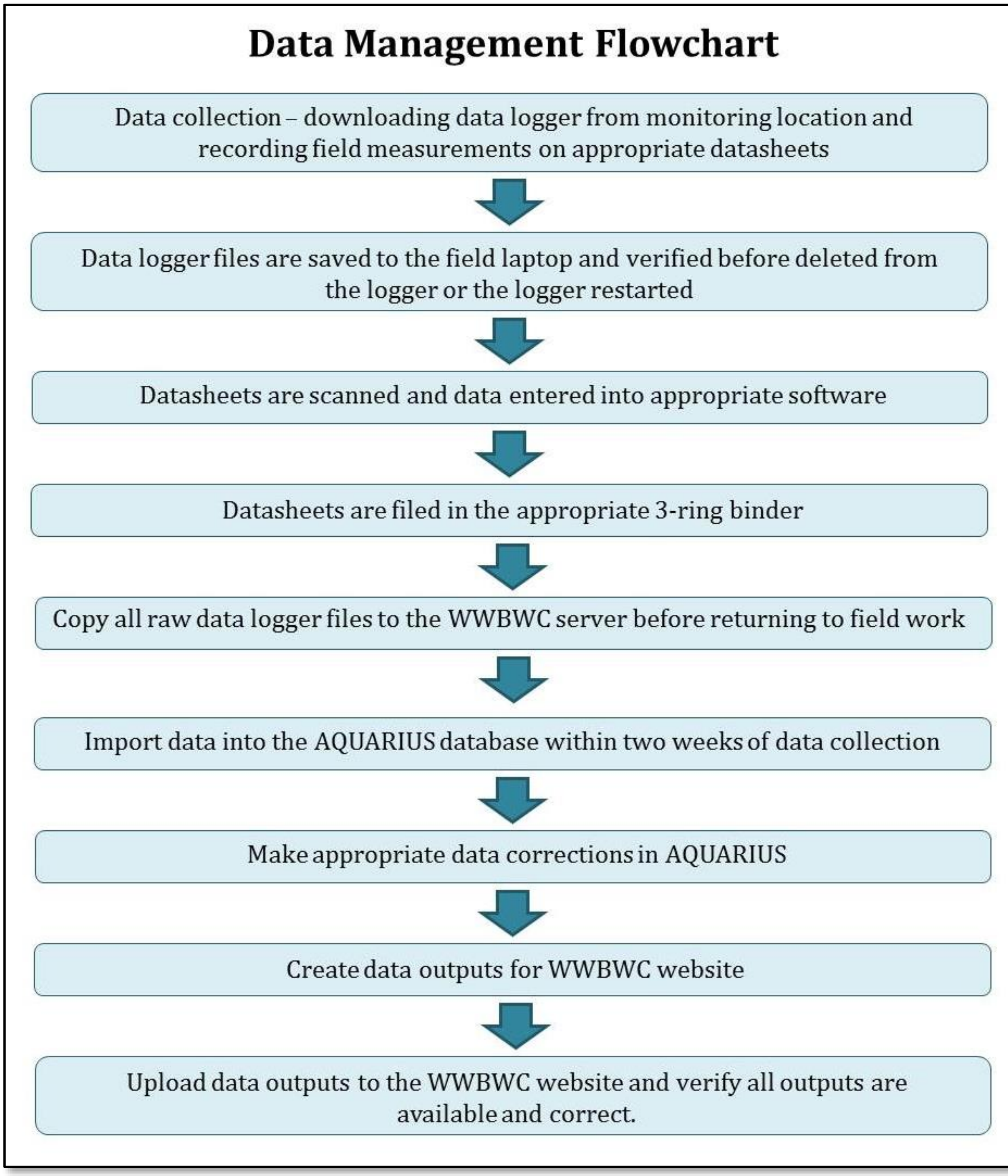
All raw data logger files collected during a day of field work should be transferred to the WWBWC server before going back out in the field to ensure data are not lost due to laptop failure or damage.

Data Input (AQUARIUS)

Data should be incorporated into the AQUARIUS database within two weeks of data collection. Both manually collected data and data logger files should be imported into the AQUARIUS database. After data have been imported, data should be adjusted to account for stage shifts or cable length corrections. For surface monitoring locations, the rating curve should be checked to ensure the new discharge measurement does not indicate a change in the stream channel. If needed, adjust the rating curve with the new discharge measurement. After data are imported and corrected, outputs should be created including a hydrograph (or similar data graph), hourly data set for the entire range of data, and daily average data set for the entire range of data. All data in AQUARIUS should be rated as "unverified" until the end of the water year (Sept 30th) and a review of the entire water year's data can be completed.

DATA ACCESS (WWBWC WEBSITE)

AQUARIUS data outputs should be uploaded to the WWBWC's website (typically accomplished through Fling software). Verify that all data outputs have been successfully uploaded to the website for public and agency access. Data and information for each surface monitoring location includes: current hydrograph, hourly data set, daily average data set, rating curve, metadata and site photograph. Data and information for each groundwater monitoring location includes: current hydrograph, hourly data set, daily average data set, metadata and manual water level measurements.



DATA SECURITY AND BACKUPS

All data incorporated into the AQUARIUS database or located on the WWBWC server has redundancy backup (i.e. stored on multiple hard drives through the use of RAID). The WWBWC server and AQUARIUS database are backed-up monthly and stored at the WWBWC office and off-site for additional security.

Data Quality Assessment

Initial Posting of Data/Near-Real Time Data

All data posted to the WWBWC website should be considered provisional unless otherwise stated. Near-real time data from surface gauges and other sites goes through an automated process without constant human oversight. Data discrepancies will be fixed as soon as possible. Until data are reviewed and published (see below) data quality will remain "unverified" or "provisional" and are subject to change. Data may be given an initial estimated data quality (estimated excellent, good, fair or poor) however this quality rating should be considered provisional and subject to change during review.

Data Quality Review

After each water year (typically in October), "unverified" or "provisional" data will be reviewed by WWBWC staff and any necessary changes will be made. After any revisions, data quality will be changed to "published" and a quality grade will be assigned. The published data will be available at the WWBWC's website

Data Quality Rating

Flow Monitoring

Flow data will be given a quality rating based upon the following factors:

- Rating curve distribution and number of discharge measurements for rating curve development.
- Accuracy of discharge measurements to calculated discharge flow from stage data.
- Site maintenance issues including sediment build-up, vegetation growth, channel migration and other localized influences.
- Accuracy of individual discharge measurements including variation in duplicate discharge measurements.
- Gauge location (e.g. concrete structure, silty channel, or stable stream bed).
- Site manipulation (especially in irrigation canals or ditches).
- Data set completeness.

All stage height measurements will include a margin of error.

Groundwater

Groundwater data will be given a quality rating based upon the following factors:

- Number of manual water level measurements.
- Accuracy of manual water level measurements to cable-length adjusted transducer data.
- Accuracy of manual water level measurements (e.g. cascading well, pumping well, etc.).
- Data set completeness

All manual water level measurements will include a margin of error.

Temperature

Temperature data will be given a quality rating based upon the following factors:

- Accuracy of data logger’s Pre and Post deployment accuracy checks.
- Accuracy of field accuracy checks with thermometer (NIST or YSI-30).
- Data set completeness.