General Quality Assurance Project Plan (QAPP)

for

Volunteer Monitoring Programs in Montana

Developed by MSU Water Quality Program, Montana Watercourse, and Montana Department of Environmental Quality

August, 2009

1. Approvals

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Table of Contents

1. Approvals ... 1
Part A. Project Management ... 4
1. Distribution List ... 4
2. Project/Task Organization ... 4
3. Problem Definition and Background ... 6
4. Project Description/Task Description ... 7
4.1. Project Lifecycle ... 7
5. Quality Objectives and Criteria (DQO's and DQI's) ... 8
5.1. Data Quality Objectives (DQO's) ... 8
5.2. Data Quality Indicators (DQI's) ... 10
5.3. Precision versus Accuracy ... 10
6. Special Training/Certifications ... 11
7. Documentation and Records ... 11
7.1. Document Retention ... 12
Part B. Data Gathering ... 12
8. Sampling Process Design ... 12
8.1. Identifying your watershed: Spatial divisions and hierarchy ... 12
8.2. Spatial and temporal considerations in Sample Design: ... 14
9. Sampling Methods ... 14
9.1. Summary of Water Quality Assessment Monitoring Event (including methods) ... 15
9.2. "Ground Truth" stream reaches identified during pre-season planning. ... 15
10. Sample Handling and Custody ... 16
10.1. Shipment or Delivery ... 18
11. Quality Control ... 18
11.1. Inspection/Acceptance of Supplies and Consumables ... 18
11.2. Field sampling quality control ... 18
11.3. Laboratory Quality Control ... 19
11.4. Field Instruments ... 21
12. Instrument/Equipment Testing, Inspection, and Maintenance ... 21
12.1. Field Equipment - Pre season Maintenance and Initial Calibration ... 21
12.2. Analytical Laboratories and Biological Contractors ... 21
13. Instrument/Equipment Calibration and Frequency ... 21
13.1. Calibration - Laboratory ... 21
13.2. Calibration – Field Instruments ... 21
14. Non-direct measurements ... 22
15. Data Management ... 22
15.1. Field Forms ... 22
15.2. Laboratory Reports and Electronic Deliverables ... 22
Part C. Assessment and Oversight ... 22
16. Assessments and Response Actions ... 22
16.1. Laboratories and Biological Contractors ... 22
16.2. Assessment of Field Activities and Corrective Actions ... 22
17. Reports to Management ... 23
17.1. Laboratory and Field Crew Assessments ... 23
17.2. Results of Analytical Report and QC Summary Reviews ... 23
Part D. Data Validation and Usability ... 23
18. Data Review, Verification, and Validation ... 23
18.1. Data Review by Laboratories and Biological Contractors ... 23

18.2. Review by the VM Project Leader..... 23
18.3. Data Validation 24

List of Figures

Figure 1. Flow Path…….…6
Figure 2. Shewhart Cycle...……..…8
Figure 3. Precision versus Accuracy...……...…….….…11
Figure 4. USGS Water Resource Regions...……...…….….…13

List of Tables

Table 1. Distribution List……4
Table 2. Careless Cr. Analytical Method Performance Criteria…….……..……..9
Table 3. Websites for Available Water Quality Data…….……..……14
Table 4. Sampling Methods and Handling Requirements…….……...……17
Table 5. Field QC description…….……..……...….…19
Table 6. Example laboratory batch QC description……..……...….…19

Appendices

Appendix A. Volunteer Monitoring Guidebook Addendum……25
Appendix B. Example Sampling Analysis Plan/maps - Careless Cr...…….……..…….….29
Appendix C. Certification Field Data Sheets/Forms……...…….45
Appendix D. Example SOP – Greater Gallatin Watershed Counsel……..……..52

Part A. Project Management

1. Distribution List

This General QA Project Plan will be made available through the following websites:

- Montana Watercourse http://www.mtwatercourse.org/
- MSU Water Quality Program http://waterquality.montana.edu
- Montana DEQ (QA Program) http://www.deq.state.mt.us/wqinfo/QAProgram/index.asp

Table 1.0 Distribution list.

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2. Project/Task Organization

The Montana Watercourse in cooperation with MSU Water Quality Program and the Department of Environmental Quality are committed to supporting Volunteer Monitoring (VM) efforts in Montana. This support comes in many forms including technical and administrative assistance, some limited financial support funding, and monitoring training at a level that is appropriate for the needs of individual monitoring groups.

This QA Project Plan serves as the generic quality system documentation for Montana VM groups; providing general data quality guidelines and a basic framework for training members of a VM Group.

The responsibilities and roles of each coordinating entity in the VM infrastructure are listed below. An organization chart illustrating these relationships can be seen in Figure 1.0

VM Certification Program Coordination - MT Watercourse

- MTWC will serve as the contact point for VM inquiries and respond to emails, phone calls and conduct site visits to assist new and existing VM groups.
- Provide VM Certification training
- Manage certification proficiency testing and recertification
- Manage VM data base and entry training
- Oversee and maintain basic VM equipment for training.
- Write an annual report on Montana's statewide VM program which identifies successes, challenges and recommendations for future direction
- MTWC will promote VM program MTWC will promote and coordinate World Wide Monitoring Day activities.

VM Certification Program Technical Assistance – MSUWQ & MT DEQ

- Provide field training
- Provide in-field QA checks
- Provide technical assistance for equipment trouble shooting - MSUWQ
- Provide assistance in data organization and interpretation – MSUWQ
- Training for data entry into STORET – MT DEQ

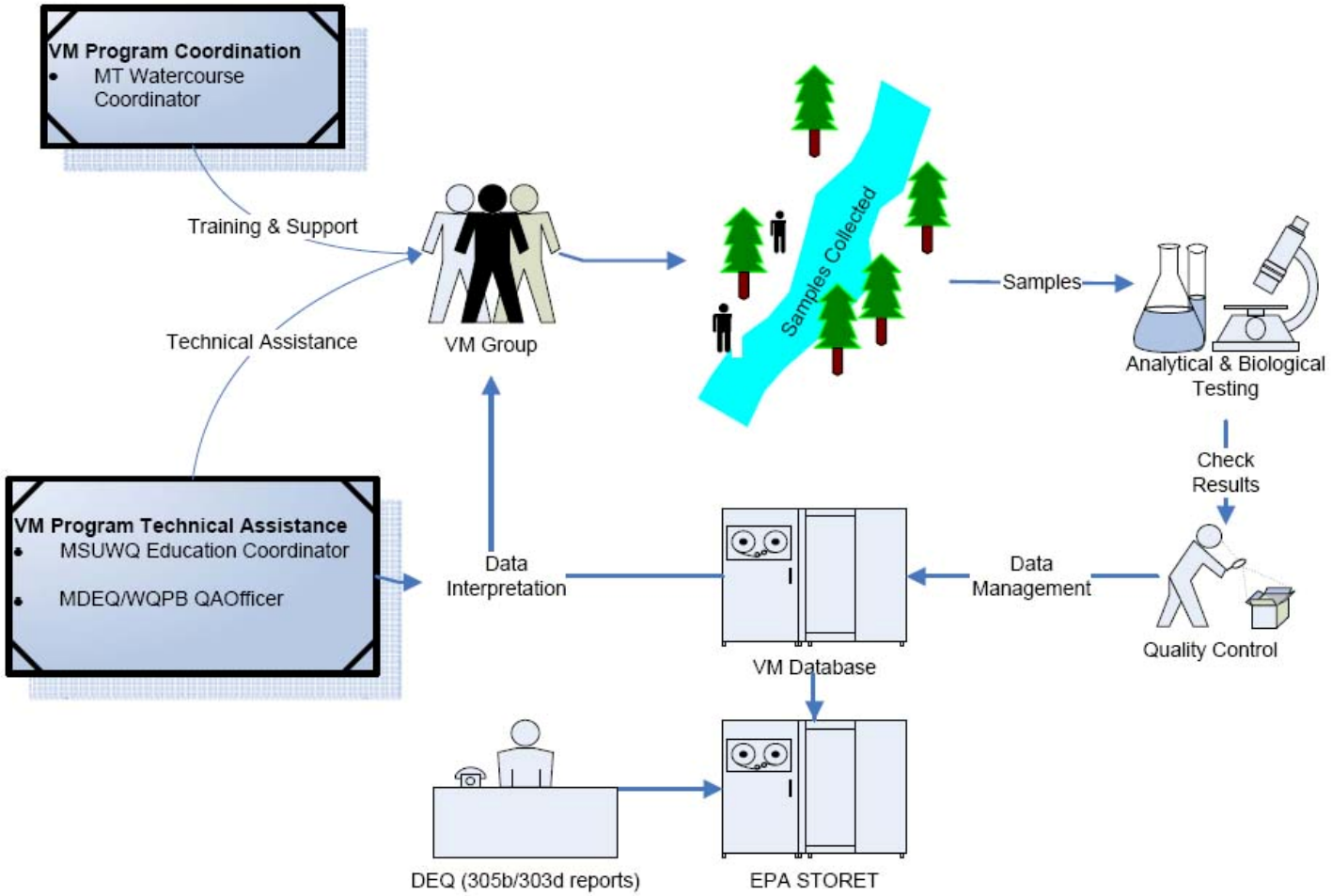
VM Chemical Water Analysis - analytical laboratory

- Contracted to provide chemical analyses

VM Biological Water Analysis – biological/taxonomy lab

- Contracted to provide biological and taxonomic analyses.

Figure 1.0 – Relationship of MTWC, MSUWQ, and MT DEQ to VM Monitoring Groups and their data flow path.



3. Problem Definition and Background

Volunteer water quality monitoring is an opportunity to connect with your community, contribute to the understanding and management of your local water resources, and experience hands on learning opportunities with water monitoring. In addition, monitoring groups can play a role in assisting state and local decision makers by filling in water quality data gaps which exist throughout the state. However, the volunteer monitoring process must be rigorous enough to ensure the data collected is of sufficient quality to be used for water resource management decisions.

The Montana Volunteer Monitoring Program is designed around three levels of monitoring. These levels are described below and in more detail within the Volunteer Water Monitoring Guidebook & Addendum (Appendix A).

Level 1 Basic: Education and Awareness
This level provides an introduction to water quality monitoring and is aimed at groups or individuals who have no previous experience or who have had previous trainings but would like a refresher. Community groups, educators, school groups, or individuals will benefit from a level one training.

Level 2 Advanced: Continuous Record
This level provides a more advanced training than level one, but is appropriate for first time volunteers who are interested in water monitoring such as community and school groups with some experience in water quality monitoring. Individuals interested in level two have a strong desire to become more involved in the management and protection of their watershed. Level two groups collect data that will be used for identifying long term trends or continuous record, educating local decision makers, or for a long term classroom project.

Level 3 Certified: Volunteer Certification / Problem Investigation
This training provides advanced level problem investigation and requires completion of proficiency tests to become "certified". Individuals or groups participating in level three are committed to assisting local and state officials in collecting sound scientific data that help fill in existing gaps and assist in characterizing issues and concern surrounding a watershed. The goals of this level include collecting data that can be submitted to federal or state agencies, determining current baseline conditions, monitoring trends, or assisting the evaluation of best management practices. The participants or their group leader will coordinate closely with the Department of Environmental Quality (DEQ) to ensure that appropriate methods and parameters will be measured.

4. Project Description/Task Description

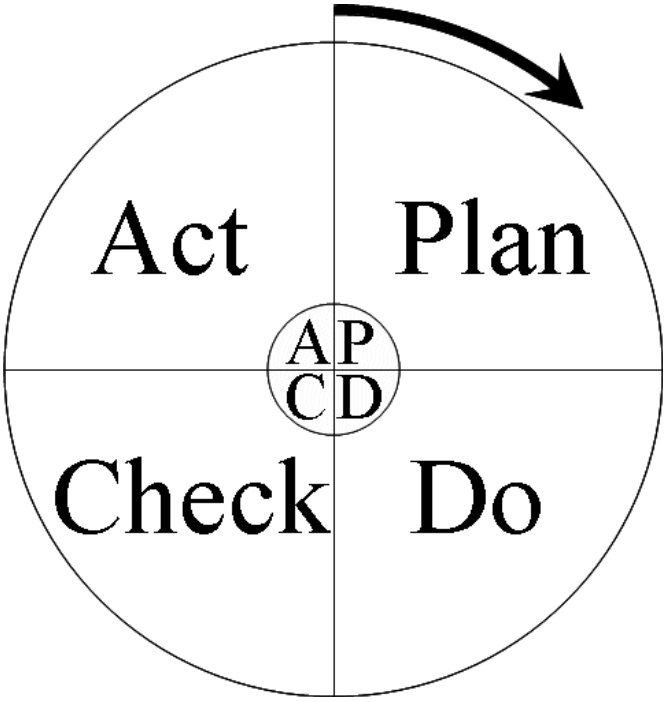
A specific description of the projects and tasks planned for a particular VM initiative are not known until the group forms and develops a charter or work statement. In a generic QA Project Plan only the *considerations* of project planning are described. The results of these planning efforts are documented in a Sampling and Analysis Plan (SAP) for the VM group's data collection project. A checklist of considerations for developing a SAP is available at the DEQ QA Program website (http://www.deq.state.mt.us/wqinfo/QAProgram/index.asp) and an example SAP is provided in Appendix B.

4.1. Project Lifecycle

Projects typically have a definite beginning and end (lifecycle). This QAPP describes the project lifecycle and considerations of project planning that should occur in any given VM initiative.

In its most simple form the project lifecycle can be described by the Shewhart (Deming) or Plan, Do, Check, Act (PDCA) cycle, illustrated in Figure 2.0.

Figure 2.0. Shewhart Cycle



All projects begin with planning. It is the essential project function that assures success. Initial planning points include development of project goals and objectives, scope, budget, and duration.

With these considerations, planning progresses to development of a Sampling and Analysis Plan (SAP), describing the sampling design.

- What is the study about?
- Decision(s) sought
- Data and information inputs
- Study boundaries
- Decision rules (standards)
- Error control and checks

5. Quality Objectives and Criteria (DQO's and DQI's)

The project planning steps described in section 5.1 are based on an EPA project planning process called the Data Quality Objectives (DQO) Process. Outputs of the DQO process are Data Quality Objectives (DQOs), which are fundamental elements of the sampling design, and Data Quality Indicators (DQIs), which are specific data quality controls that will be assessed to validate that everything went according to plan.

5.1. Data Quality Objectives (DQO's)

Data quality objectives are elements of the sampling design that must be satisfied for the design to accomplish its objectives. They are Completeness, Representativeness, Comparability, and Sensitivity.

5.1.1. Completeness

The element of completeness measures the quantity of data and information that was planned against what is actually collected and deemed useable after all quality control considerations have been evaluated. Any data lost from the original design, due to site access issues, or loss of samples due to spillage, instrument failures, or laboratory mistakes, may make decision-making either impossible or require the intended decision-making certainty to be lowered in the end. For instance, if you planned to take 10 samples and spill one, you have 90% completeness for the sampling event. If the completeness goal is 90%, the loss of a single sample would not require the decision-making certainty to be adjusted. However, spilling two or more is not acceptable and would necessitate resampling to achieve the project completeness goal.

The completeness goal for volunteer monitoring is 90% of planned samples collected and passing quality control evaluation as described on page 23, section 18.2.

5.1.2. Representativeness

Representativeness is the degree to which data accurately and precisely portray an environmental condition in time and space. In scientific terms, time and space are described as *temporal* and *spatial*, respectively. Temporal and Spatial rigor are considerations of the sampling design which are fulfilled with adequate data (6.4.1 Completeness), relevant data (6.4.3 comparability), and data that is sufficiently sensitive (6.4.4 Sensitivity – Detection Limits) when compared to decision-making thresholds.

In Volunteer Monitoring, representativeness is often achieved using a judgmental sampling design (due to the higher costs associated with random sampling designs). When developing a sampling design based on one's judgment, it is imperative that the rationale underlying the judgment is documented and objectively reviewed by external parties to assure that a favored outcome (bias) will not taint decision-making. These designs and rationale are required to be documented in a Sampling and Analysis Plan for the Volunteer Monitoring group's projects.

5.1.3. Comparability

Comparability expresses the similarity of design and methodology by which two or more data have been produced. In water quality monitoring this typically means comparability of data to the water quality standards that have been set to protect water quality. For results to be deemed comparable, the field collection method and the analytical method must be equivalent to the expression of the water quality criteria. This is achieved through the use of consistent Standard Operating Procedures (SOPs – DEQ or USGS) for field collection <u>and</u> the *use* of equivalent analytical methods as published in 40 CFR Part 136, Tables 1A through 1H.

Comparability also refers to the spatial and temporal elements of the sampling design when compared to the decision rule. Water Quality Standards have criteria expressed with a magnitude, duration, and frequency. The spatial and temporal components of the sampling design should match the expression of magnitude, duration, and frequency of any criteria used for decision-making. Assumptions of representativeness must be documented.

Finally, comparability refers to reporting data in common units (or to the same taxonomic resolution for biology) so data analysis is simplified. A concise description of comparability must be provided in a Sampling and Analysis Plan for the Volunteer Monitoring group's projects. This is often provided as a table of Methods, Detection Limits and Units (Table 2.0).

5.1.4. Sensitivity - Detection Limits

Sensitivity refers to the ability of a measurement to detect a changed value of a measured property. In analytical chemistry, the Method Detection Limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with a 99% confidence that the concentration of the parameter measured (known as an analyte) is greater than zero.

In biological testing, sensitivity refers to the lowest practical taxonomic level that can be identified.

<u>Detection Limit Low Enough to Assess Uses</u>
Many of the State numeric standards are low to sub-part per billion (ppb) values that if exceeded by a magnitude of 25% to 50%, in (potentially) a single sample, could result in a determination of "impaired".

It is imperative that detection limits (or taxonomic levels) are:

- Low enough to assess against the decision rules (e.g., WQ Standards),
- encompass the entire analytical method, and
- Are updated at least annually, and routinely demonstrated to be achievable.

A concise description of sensitivity must be provided in a Sampling and Analysis Plan for the Volunteer Monitoring group's projects. This is often provided as a table of method performance criteria. An example is provided in Table 2.0.

Table 2.0 Example of analytical method performance criteria from Carless Creek SAP.

Parameter	Method	Method Blanks	Lab Duplicates (RPD)	Field Duplicates (RPD)	Lab Control (LCS/LFB)	MS/MSD
Solids, Total Dissolved	A2540 C	<10 mg/L	20%	25%	90% - 110%	80% - 120%
Solids, Total Suspended	A2540 D	<1 mg/L	10%	25%	75% - 120%	NA
Alkalinity	A2320 B	<4 mg/L	20%	25%	90% - 110%	80% - 120%
Nitrogen, Total Persulfate	A4500 N-C	<0.1 mg/L	10%	25%	90% - 110%	90% - 110%
Nitrogen, Ammonia	E350.1	<0.05 mg/L	10%	25%	90% - 110%	90% - 110%
Nitrogen, Nitrate + Nitrite	E353.2	<0.01 mg/L	10%	25%	90% - 110%	90% - 110%
Phosphorus, Total	E365.1	<0.005 mg/L	10%	25%	90% - 110%	90% - 110%

5.2. Data Quality Indicators (DQI's)

Chemical results are compared to numeric standards and require greater confidence in the results because one or more errant values that exceed the numeric standards will likely lead to an impairment determination (due to limited availability of "a large data sets" comprised of three years quarterly monitoring data, or 96-hour average). DEQ requires QC summaries to be provided along with analytical results so that Data Quality Indicators can be used to assess the quality of the data.

5.3. Precision versus Accuracy

5.3.1. Precision

Precision is the degree of mutual agreement between or among independent measurements of a similar property. Simply stated, it is a measure of consistency and repeatability. For instance, if four arrows hit the target in a cluster, you have a high degree of precision. Precision is calculated (for two duplicate samples) by dividing the difference of two values by the average of those two values and multiplying that value by 100. The result is expressed as Relative Percent Difference (RPD%) which should be equivalent to +/-20%.

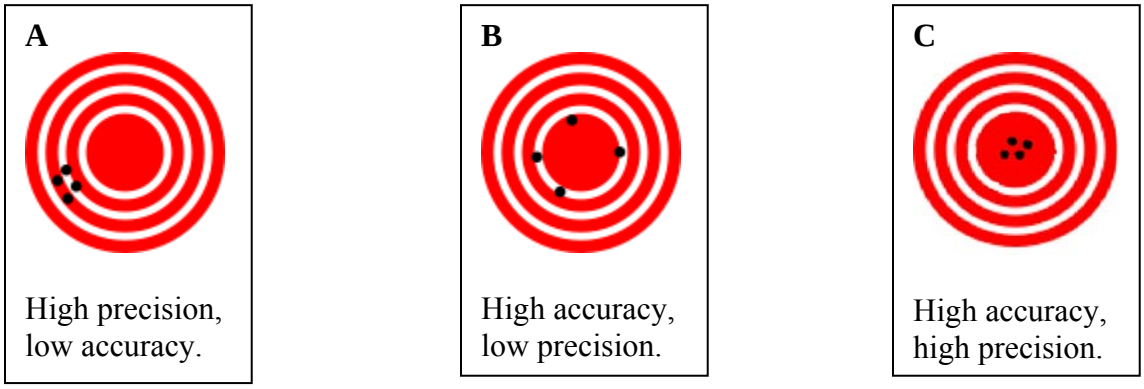
5.3.2. Accuracy (Bias)

Accuracy is a combination of high precision and low bias. Bias is defined as systematic error that favors one outcome (or direction) over another. This is typically expressed as agreement of a measurement with a known or true value (% Recovered). For instance, if your goal is to hit the inner red circle in the diagram below, you have high accuracy. The guidelines for acceptable accuracy of a measurement are parameter dependent and should be defined within a Sampling and Analysis Plan for the Volunteer Monitoring group's projects.

5.3.3. Precision versus accuracy

There is a difference in the diagrams below that explain the concepts of precision versus accuracy. Imagine the diagrams below represent your performance in a dart game. Your goal was to hit the inner red circle of the target. In attempt A you had high precision because you hit the same relative spot each time. However, you were not very accurate in hitting your intended target. In attempt B you effectively bracketed the target, but were not very precise because you hit in different locations each time. In attempt C both precision and accuracy were high and achieved the goal of hitting the inner red circle.

Figure 3.0 Precision versus Accuracy



In measurements, high precision but poor accuracy (A) often leads to a decision-making error due to bias. High accuracy and poor precision (B) would likewise result in decision-making error if decisions were based on individual data points. However, when one recognizes that (B) is the case, a correct decision is still possible by aggregating results and using the average to overcome poor precision.

6. Special Training/Certifications

6.1.1. Training – VM groups

Level 1 Basic: Education and Awareness
The training will consist of 2-4 hours of classroom time and 4-6 hours of field training depending on the needs of your group. Monitors are encouraged to enter their data into Public Folders on the Volunteer Monitoring database repository two times per year.

Level 2 Advanced: Continuous Record
The training will consist of 4-6 hours of classroom time and 4-8 hours of field training depending on the needs of your group. Monitors are encouraged to enter their data into Public Folders on the Volunteer Monitoring database repository two times per year.

Level 3 Certified: Volunteer Certification / Problem Investigation
Training will consist of 6-8 hours of classroom and 6-8 hours of field time. Monitors must enter their data in the Volunteer Monitoring Data Repository. Monitors are required to enter their data into the Volunteer Monitoring database repository four times per year.

6.1.2. Training - laboratories and biological contractors

External contractors are responsible for providing personnel qualified for the methods requested. A copy of the Laboratories Quality Assurance Plans (LQAP) describing the training programs for Rhithron, Energy Laboratories, PACE Analytical, MSE - TA, and the Department of Public Health and Human Services laboratory are on file with the QA officer.

7. Documentation and Records

Good documentation of the measurements, and observations collected at each site is critically important for the data to be viewed as scientifically sound. A standard packet of field forms are often developed for a project to assure consistent data collections for the duration of the project.

Certified volunteers will use the basic package of field forms that are provided as Appendix C. Of these, the specific field forms used by a Volunteer Monitoring group for a project must be included as an attachment to their a Sampling and Analysis Plan.

7.1. Document Retention

Once data is collected, proper storage maintains the integrity of the data for future use. Level 2 volunteers will place all data into the Volunteer Monitoring Data Repository, managed by the MTWC. Volunteer monitors will be trained to input data during the standard Level 2 training and required to import data twice per year. Certified volunteer monitors will be required to place data (both filed data and QC data) into both the Volunteer Monitoring Data Repository and STORET, managed by EPA. Certified monitors will be trained in both processes and must import data two-four times a year, or dependent on the needs of the individual watershed.

Prior to each sampling season, monitors will need to update their SAP to reflect any changes in field or analytical processes. SAP will be stored in electronic format within the monitoring group's electronic filing system. Hard copies must be included as appendices in all yearly reports.

Part B. Data Gathering

8. Sampling Process Design

The "meat and potatoes" of data collection is the sampling design. The most important aspects that volunteer monitoring groups should describe in their sampling design include:

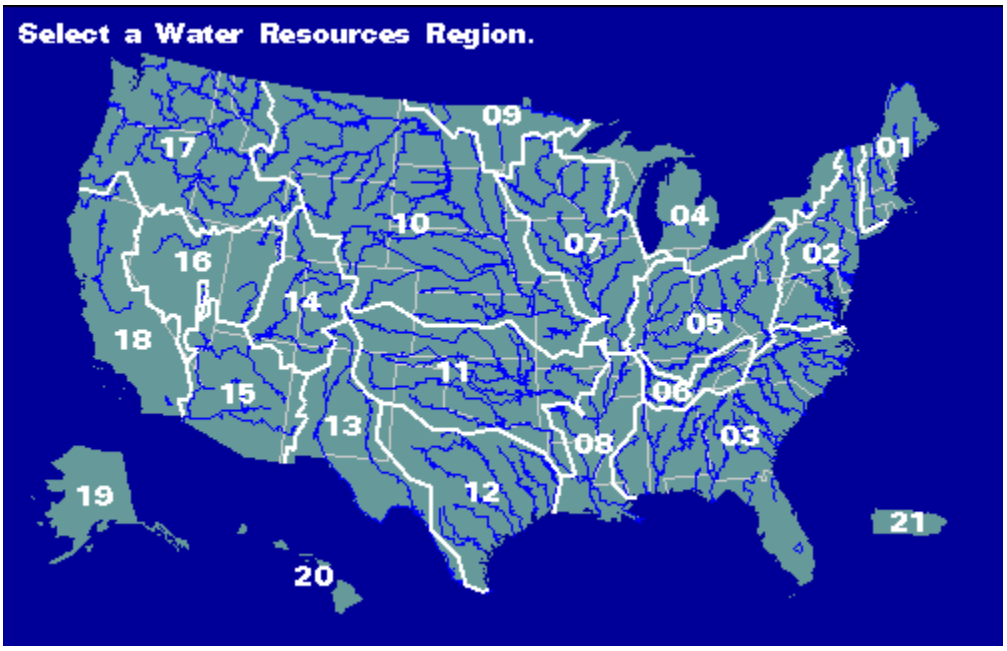
- water body names and HUC Code
- site locations, where you will monitor
- parameters, what you will monitor
- Timing, when will monitoring take place
- Other?

In this general QAPP, key aspects of the identifying site locations for a sampling design are discussed and should be considered when groups prepare their sampling and analysis plan. An example Sample Analysis Plan is provided in Appendix B and should be used as a guide but should be modified to fit the group's needs.

8.1. Identifying your watershed: Spatial divisions and hierarchy

The USGS developed a system that assigns numbers to watersheds. This consistent method makes it easier to search for data for your particular watershed. This system divides watersheds or hydrologic units into four levels (from largest to smallest): regions, sub-regions, accounting units, and cataloging units. Each one has a unique Hydrologic Unit Code (HUC). Each level is described in more detail below.

Figure 4.0 USGS Water Resource Regions



Regions: Regions are the largest Hydrologic Unit and are assigned a two digit number. As seen in the USGS Water Resources map, all streams and rivers in Montana fall into either the Pacific Northwest (17) or Missouri (10) region.

Sub regions: Regions divided into sub regions are assigned four numbers, the first two identify the region. For example – the Kootenai-Pend Oreille Spokane River basins are a sub region and is HUC 1701.
Accounting Units: Subregions are then divided into accounting units. Accounting units are assigned six digits, first two identify the region, the second two identify the sub region and finally, the last two digits identify the accounting unit. For example The Kootenai River Basin within Idaho, Montana is HUC 170101.

Cataloging Units: Accounting Units are then divided into cataloging units and are assigned eight numbers. The last two numbers identify the cataloging unit. For example the Upper Kootenai in Idaho and Montana is HUC 17010101. Accounting units are often referred to as 4th code or 4th field HUCs and are the most commonly used description of a watershed by water resource professionals. **Therefore, the default unit for describing a watershed in a Volunteer monitoring program should be the 4th code HUC.** Smaller divisions of the USGS HUC system exist (5th & 6th code), however, 4th code HUCs are used by state agencies in their water body databases and are a good starting point from the view of where activities are taking place. For more information please visit the USGS Water Resources page at http://water.usgs.gov/GIS/regions.html

8.1.1. Streams, Reaches, and Sampling Sites

Selecting Sampling Sites: the selected sampling locations must be representative sites. The term "representative point" is defined as a location in surface waters or ground waters at which specific conditions or parameters may be measured in such a manner as to characterize or approximate the quality or condition of the water body" When selecting a site consider the following:

1. General characteristics of a waterbody: Choose sampling sites that are representative of the stream.
2. Pronounced water quality degradation: Critical locations that have the potential for displaying the most pronounced water quality or biological problems should be considered.
3. Flow measurement: Locations shall be considered where the corresponding discharges are known or can be estimated.
4. Convenience, accessibility, and practicability. However, these shall be secondary to the representativeness of the sampling.

Sampling Site Selection: Level 2 Advanced: Continuous Record

Sampling designs for continuous record projects are relatively straightforward to set-up. Consistent, repeated measurements at a fixed station over time are the most important aspect of a sampling design that documents status and trends (continuous record). These designs typically have only a few key sampling locations monitored in a watershed (HUC 4th code) that are usually located at the point where the largest river or stream exits the watershed and at major confluences. How often you will sample is the most important decision to make. Additionally, you will want to collect data from other sources to ensure that efforts are not duplicated. A list of data sources is included in Table 3.0.

Table 3.0 Websites for available water quality data.

Agency	Website
USGS Water Data Discovery	http://water.usgs.gov/data/
Natural Resource Information System (NRIS)	http://nris.mt.gov/
EPA - STORET	http://www.epa.gov/storet/dbtop.html

Sampling Site Selection Level 3 Certified: Volunteer Certification / Problem Investigation

When a group chooses to investigate a problem, they must define what length of stream(s) they will examine. MDEQ has already developed a system for defining streams or Water Body Identification Units called "segments." You can find a list of these segments at the Clean Water Act Information Center http://cwaic.mt.gov/. Certified volunteers will choose from this list when identifying the stream and stream reach to ensure that their data can be quickly and efficiently applied to the appropriate water body segment.

The boundaries of extents (or areas for lakes) are based on factors such as; water quality standards use classification, confluence with another water body, significant tributaries, political boundaries, and other factors. In sampling design, extents are often too long to adequately characterize with a single data collection point. An example is when there is significant changes in geology, land use or land cover. Where significant changes occur, a division defining a "reach" of the extents can be made. Each of these reaches are usually sampled (depending upon access) to characterize that portion of the segment. Data from all reaches are considered when making decisions about the segment.

8.2. Spatial and temporal considerations in Sample Design:

An understanding of the spatial and temporal limits of different types of data is necessary to develop a sound sampling design.

Spatial considerations: Sampling sites are chosen to represent the potential of landscape characteristics and land use/land cover influences existing in the watershed to influence water quality. Limitations do exist as a result of site access and landowner permission. Sampling sites should be identified based on site access and opportunities to capture the variability in land use and watershed characteristics.

Temporal considerations: When choosing when to monitor, time periods are chosen to spatially represent the variation in stream flows. For example, sampling during spring runoff can represent the increase concentrations of some parameter concentrations in waterbodies during high flow.

9. *Sampling Methods*

Volunteers will conduct sampling activities following the Volunteer Monitoring Standard Operating Procedures (SOP) for stream monitoring which will be developed by each group. An example is provided in Appendix D. These SOPs are based upon MDEQ Field Procedures Manual (WQPBWQM-020), the Montana Watercourse Volunteer Monitoring Handbook and U.S. EPA EMAP. An example of this information is summarized in Table 5.

9.1. Summary of Water Quality Assessment Monitoring Event (including methods)

9.2. "Ground Truth" stream reaches identified during pre-season planning.

9.2.1. Determine representative sampling site(s) within each reach.

Sampling sites should be selected after a scoping trip with DEQ and personnel from the watershed group, should include locations which are helpful to defining water quality conditions within the stream, and should help identify to the stakeholder community why water quality data collected does or does not meet the targets and goals.

9.2.2. Sample sites from downstream to upstream.

9.2.3. Complete all required Field Forms for each sampling event. (Appendix C.)

9.2.3.1. Identify sampling site with GPS and record Lat./Long on Site Visit Form (Datum NAD83).

9.2.4. Label all sample bottles with sample name, date, time of sampling, and field crew initials.

9.2.5. Field Measurements and Chemical Sampling:

9.2.5.1. Calibrate Field Meter and measure pH, conductivity, temperature, and dissolved oxygen (DO). Record values on site visit form. Turbidity can be measured on a Horiba U-10 but is most often an observed result based on the clarity of the water.

9.2.5.2. Collect grab samples for water chemistry (Commons, Nutrients, TR Metals, TSS) and indicate sample identifiers and method of collection on site visit form

9.2.5.3. Collect sediment, TSS, and TDS samples and indicate sample identifiers and method of collection on site visit form (if mining sources are in the area).

9.2.6. Biological Sampling:

9.2.6.1. Select representative riffle or pool following EMAP sample site selection criteria. Collect macroinvertebrate sample using method approved by MT Department of Environmental Quality.

9.2.6.2. Conduct Macroinvertebrate habitat assessment using method approved by MT Department of Environmental Quality.

9.2.6.3. Collect a periphyton sample from an undisturbed area of sampling site using method approved by MT Department of Environmental Quality.

9.2.6.4. Determine Chlorophyll-a collection procedure(s), i.e. rock, hoop, phytoplankton and/or core method(s), and take samples. Use method approved by MT Department of Environmental Quality.

9.2.6.5. Indicate sample identifiers and method of collection on site visit form.

9.2.7. Physical/Habitat Measurements:

9.2.7.1. Conduct Site Scale Habitat Assessment

9.2.7.2. Complete Supplemental Site Information

9.2.7.3. Characterize streambed material

9.2.7.3.1. Wolman pebble count

9.2.7.4. Measure channel cross-section and record.

9.2.7.5. Determine stream classification (Rosgen, Process-based or other - Optional)

9.2.7.6. Measure discharge (Marsh-McBirney meter) or estimate flow and record results and method on Site Visit Form.

9.2.7.7. Download data from TruTrak data logger (if applicable).

9.2.8. Verify that all pertinent field forms are completed:

9.2.8.1. Site Visit Form

9.2.8.2. Macroinvertebrate habitat assessment form

9.2.8.3. Site Habitat Assessment

9.2.8.4. Supplemental Site Form

9.2.8.5. Laser Level or Non-Laser Channel Cross-Section

9.2.8.6. Stream Classification (Optional)

9.2.8.7. Total Discharge

9.2.8.8. Chain-of-Custody (fill out upon return to vehicle)

10. *Sample Handling and Custody*

Certified volunteer monitors are responsible for the integrity of the sample from the time of collection until shipment to the Analytical Laboratory. Training will be provided to ensure proper storage, preservation and establishing the sample custody documentation is performed accurately. See Table 4.0 for sample handling specifications.

Table 4.0 Sampling Methods & Handling Requirements.

Parameter	Preferred Method	Alternate Method	Req. Report Limit ug/L	Lab MDL Study Result	Lab Routine Reporting Limit or PQL	Reporting Approach[2]	Holding Time Days	Bottle	Preservative
Water Sample - Common Ions and Physical Parameters									
Total Suspended Solids (TSS)	EPA 160.2	A2540 D	4000				7		
Total Dissolved Solids (TDS)	EPA 160.1	A2540 C	4000				7		
Alkalinity (Bicarb., Carb.)	EPA 310.2/A2320 B	A2320 B	1000				14	000 ml HDPE	≤6°C
Sulfate	EPA 300.0	A4110 B	50				28		
Chloride	EPA 300.0		50				28		
Dissolved Organic Carbon (DOC)	A 5310 B						28	125 ml Glass	Filt. 0.45 um, H_2SO_4, ≤6°C
Sulfide	A 4500-S2 D						7	250 ml HDPE	Zinc Acetate + NaOH to pH
Water Sample - Nutrients									
Total Persulfate Nitrogen (TPN)	A 4500-N C	A4500-N B	50				30	250ml HDPE	≤6°C
Dissolved Orthophosphate as P	EPA 365.1	A4500-P F	1				2	125ml HDPE	≤6°C
Total Phosphorus as P	EPA 365.1	A4500-P F	5						
Nitrate-Nitrite as N	EPA 353.2	A4500-NO3 F	10				28	500ml HDPE	H2SO4, ≤6°C
Total Ammonia as N	EPA 350.1	A4500-NH3 B,C,D,E,or G	50						
Water Sample - Dissolved Metals (0.45 um filtered)									
Aluminum	EPA 200.7	EPA 200.8	30						
Cadmium	EPA 200.8		0.08						
Chromium	EPA 200.8	EPA 200.7	1						
Copper	EPA 200.8	EPA 200.7	1						
Iron	EPA 200.7		50						
Lead	EPA 200.8		0.5						
Silver	EPA 200.8	EPA 200.7	0.5						
Zinc	EPA 200.7		10				180	250 ml HDPE	HNO_3
Antimony	EPA 200.8		3						
Barium	EPA 200.7	EPA 200.8	5						
Beryllium	EPA 200.7	EPA 200.8	1						
Boron	EPA 200.7	EPA 200.8	10						
Manganese	EPA 200.7	EPA 200.8	5						
Nickel	EPA 200.7	EPA 200.8	10						
Thallium	EPA 200.8		0.2						
Uranium, Natural	EPA 200.8		30						
Chromium VI	EPA 218.6	A 3500-Cr E	10				28	125ml HDPE	Filt. 0.45 um, ≤6°C, pH 9.3-9.7 with Ammonium
Water Sample - Total Recoverable Metals									
Total Recoverable Metals Digestion	EPA 200.2		N/A						
Arsenic	EPA 200.8		3						
Cadmium	EPA 200.8		0.08						
Calcium	EPA 200.7		1000						
Chromium	EPA 200.8	EPA 200.7	1						
Copper	EPA 200.8	EPA 200.7	1						
Iron	EPA 200.7		50						
Lead	EPA 200.8		0.5						
Magnesium	EPA 200.7		1000						
Potassium	EPA 200.7		1000						
Selenium	EPA 200.8		1						
Silver	EPA 200.8	EPA 200.7/200.9	0.5				180	500 ml HDPE	HNO_3
Sodium	EPA 200.7		1000						
Zinc	EPA 200.7		10						
Antimony	EPA 200.8		3						
Barium	EPA 200.7	EPA 200.8	5						
Beryllium	EPA 200.7	EPA 200.8	1						
Boron	EPA 200.7	EPA 200.8	10						
Manganese	EPA 200.7	EPA 200.8	5						
Nickel	EPA 200.7	EPA 200.8	10						
Thallium	EPA 200.8		0.2						
Uranium, Natural	EPA 200.8		30						
Water Sample - Total									
Mercury	EPA 245.1		0.05				28	HDPE, Glass	HNO3
Mercury, Ultra low level[1]	EPA 245.7		0.005				28	100mL Glass	0.5 ml 12N
Mercury, Ultra low level	EPA 1631		0.005				90	100mL Glass	0.5 ml 12N
Water Sample - Organics									
Total Extractable Petroleum Hydrocarbons (TEH	EPA 8015 m		1000				14	2 x 1L Amber	HCl, ≤6°C
Total Volatile Hydrocarbons (TVH)	EPA 8021 m		10				7	3 x 40ml VOA	HCl, ≤6°C
Water Sample - Calculated Results									
Total Hardness as $CaCO_3$	A2340 B (Calc)	EPA 130.1	1000						
Sodium Absorbtion Ratio (SAR)	Calc								

Parameter	Preferred Method	Alternate Method	Req. Report Limit mg/kg (dry weight)				Holding Time Days	Bottle	Preservative
Sediment Sample - Total Recoverable Metals									
Total Recoverable Metals Digestion	EPA 200.2		N/A						
Arsenic	EPA 200.8	EPA 200.9	1						
Cadmium	EPA 200.8	EPA 200.9	0.2						
Chromium	EPA 200.8	EPA 200.7	9				180	500ml HDPE Widemouth	
Copper	EPA 200.8	EPA 200.7	15						
Iron	EPA 200.7	EPA 200.7	10,000						
Lead	EPA 200.8	EPA 200.9	5						
Zinc	EPA 200.7	EPA 200.7	20						
Mercury	EPA 7471B		0.05				28		

Parameter	Preferred Method	Alternate Method	Req. Report Limit mg/m²				Time Days	Bottle	Preservative
Substrate Sample - Chlorophyll-a									
Chlorophyll-a (benthic)[4]	A 10200 H						21(pH≥ 7) or ASAP(p	Filter	Freeze[3]
Ash Free Dry Weight (AFDW)	A 10300 C (5)								
Water Sample - Chlorophyll-a									
Chlorophyll-a (phytoplankton)[4]	A 10200 H						21(pH≥ 7) or ASAP(p	Filter	Freeze[3]

[1]For Ultra low-level mercury by methods 245.7 & 1631, both a trip blank and field blank are required for each set of samples. Both the trip blank and field blank will be analyzed and charged at $_____ each.
[2]Reporting approcah can be: Standard (if Reporting Limit or PQL meet or exceed Required Report Limit), MDL Report (reporting results to MDL, unqualified), or "J" value Report (reporting results between Reporting Limit or PQL and MDL with "J" qualifiers)
[3]Freeze samples only if filtered or hoop samples. Samples requiring filtration shall not be frozen until filtered.
[4]The analysis of chlorophyll-a may require the compositing of several filters or hoop collections. Refer to SOP WQPBWQM-011v4 for details of preparation and analysis. (URL below)
http://deq.mt.gov/wqinfo/QAProgram/SOP%20WQPBWQM-011v4_final.pdf

10.1. Shipment or Delivery

Shipment and delivery of sample will occur at the end of each sampling day to meet the EPA required holding times (See table 4). All samples will be placed on dry ice or sufficient regular ice to drop the temperature of the samples to 6°C within 6 hours of sampling. 6°C will be maintained throughout shipping until received by the laboratory. The laboratory will keep samples in a refrigerator maintained at a constant 6°C until the time of analysis.

10.1.1. Chain of Custody (COC)

Chain-of-custody will be maintained for all volunteer monitoring samples from field sampling until the results are returned to the monitoring group. An example chain-of-custody is provided in Appendix D, Field Forms. The sampling personnel must initiate the chain-of-custody before samples are placed in cold storage (this is typically when monitors return to their vehicle). Upon receipt by the analytical laboratory coordinator, the COC will be signed (by the lab coordinator) and checked for missing information. If any information is missing, the monitoring group will be contacted as soon as possible for resolution of the missing information. The analytical laboratory coordinator will take the samples to the laboratory and have the laboratory sample custodian sign the COC. Once in the possession of the laboratory, the COC is considered complete

10.1.2. Samples for Chemistry

Table 2.0 details the standardized analytical chemistry measurements that will be used for water quality assessments and includes both standard and optional parameters, analytical methods, and reporting limits. EPA holding times and the required preservatives are included in Table 4.0. Samples requiring preservative will be preserved in the field using a measured amount of acid preservative provided by the laboratory. Acid is added to the sample, *not* visa verse.

10.1.3. Optional sample for sediment

A sediment sample may be taken if sedimentation is an issue for the segment. Sediment samples will be taken in a 1 Liter HDPE wide mouth bottle, unpreserved.

11. *Quality Control*

11.1. Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used for monitoring must be free of contaminants that could result in false positive result and an errant decision.

The laboratory will provide sample bottles used for chemistry samples. These are to be new bottles (not recycled/cleaned bottles from previous submittals). The manufacturer of the bottles or reagents verifies their product to be free of contaminants by providing the results of assays. The laboratories providing sample bottles and preservatives retain the results of these assays.

11.2. Field sampling quality control

Field QC descriptions are listed in Table 5.0.

11.2.1. Field Blanks

Certified monitors will verify that site conditions and reagents are not sources of contamination by performing field blanks at the beginning, middle, and end of the season. Field blanks will originate at the analytical laboratory by supplying monitors with reagent water and sample bottles. A sample bottle will be selected from the same lot used as used by monitors for field samples and filled with the laboratories reagent water. It will be preserved in the field along with samples taken from the site. The field blank will be

identified as such, recorded on the Chain-of-custody and returned to the laboratory with the shipment of samples.

Field blanks will be submitted for all chemical parameters. Whether or not results of field blanks qualifies data near the reporting limit for accuracy is parameter dependent and should be defined within a Sampling and Analysis Plan for the Volunteer Monitoring group's projects.

11.2.2. Field Duplicates

Field duplicates are used to assess both the reproducibility of the sampling technique and the precision of the analytical method. Other factors such as homogeneity of the sampled media can influence field duplicates. Because these QC samples indicate the entire sample process they become very important for understanding the variability of the final results. Where the variance is high, a larger number of samples would have to be taken to arrive at higher certainty that the decisions made with the data are not in error. Field duplicates should be collected at the beginning, middle, and end of their sampling season. When collecting duplicate surface water samples, all steps performed in collecting one sample are repeated for another. Duplicate samples should be collected immediately after filling initial sample bottle. Field duplicates should agree within a DQO of +/-25%.

Table 5.0 Field QC description.

FIELD QC		
Term	**Description**	**Purpose/Usage**
Trip Blanks	Used only for VOC (Volatile Organic Chemicals). Alias VOA (volatile organic analysis)	To determine if cross contamination occurs between samples.
Field Blank	Reagent water exposed to field sampling conditions	Monitors contamination resulting from field activities and or ambient levels of analytes present at time of sampling.
Field Duplicate	Two independent samples taken under the same conditions. For solids; two samples which are co-located (taken side by side.) Water samples would be two independent samples taken at the same location at the same time.	To determine the homogeneity of the samples collected.
Field Replicate	A single sample is obtained, homogenized, then slit into multiple samples	Monitors laboratory precision independent of laboratory operations.

11.3. Laboratory Quality Control

Laboratory Quality Control requirements are specified in each analytical method. General abbreviations and required Quality Control elements are listed in Table 7.0

Table 6.0 Example laboratory batch QC description.

LABORATORY BATCH QC		
Acronym	**Description**	**Definition**

LRB/Method Blank	Laboratory Reagent Blank	An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The LRB is used to determine if method analytes or other interferences are present.
LFB/LCS	Laboratory Fortified Blank; Laboratory Control Sample	Reagent water spiked with a known amount of analyte. Ideally treated exactly like a MS/LFM. Control used to determine bias in sample spikes.
MS/LFM	Matrix Spike/Laboratory Fortified Matrix .	An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations
MSD/LFMD	Matrix Spike Duplicate/Laboratory Fortified Matrix Duplicate	Determine method precision in sample concentrations are < 5X the RL.
DUP	Duplicate	Determine method precision in sample concentrations are > 5X the RL.
QCS	Quality Control Sample	A solution of method analytes of known concentrations which is used to fortify an aliquot of reagent water or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance
SRM	Standard Reference Material	Primarily used as a QCS to verify instrument calibration.
LABORATORY ANALYSIS QC		
Acronym	**Description**	**Definition**
ICB	Initial Calibration Blank	Monitors instrument drift at low end of cal curve.
CCB	Continuing Calibration Blank	Monitors instrument drift at low end of cal curve.
ICV	Initial Calibration Blank	Monitors instrument drift at a defined concentration near the mid range of cal curve.
CCV	Continuing Calibration Blank	Monitors instrument drift at a defined concentration near the mid range of cal curve.
IPC	Instrument Performance Check	Monitors instrument drift at a defined concentration near the mid range of cal curve.
MS/LFM	Matrix Spike/Laboratory Fortified Matrix .	An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations
MSD/LFMD	Matrix Spike Duplicate/Laboratory Fortified Matrix Duplicate	Determine method precision in sample concentrations are < 5X the RL.

DUP	Duplicate	Determine method precision in sample concentrations are > 5X the RL.
QCS	Quality Control Sample	A solution of method analytes of known concentrations which is used to fortify an aliquot of reagent water or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance
SRM	Standard Reference Material	Primarily used as a QCS to verify instrument calibration.
IDL	Instrument detection limit	Signal just above baseline. 3-5x the STD DEV of 7 duplicates of a blank. Not used for quantification.
MDL	Method detection limit	Statistical determination of the lowest concentration of an analyte with 95% certainty the analyte is present.
PQL	Practical Quantitation Limit	3-5x the MDL. Lowest level that quantification is determined
RL	Reporting Limit	Value a Laboratory reports results. Usually the PQL.

11.4. Field Instruments

11.4.1. The quality control process for field instruments is accomplished by instrument calibration.

12. *Instrument/Equipment Testing, Inspection, and Maintenance*

12.1. Field Equipment - Pre season Maintenance and Initial Calibration

With the guidance of the VM Certification Program Technical Assistance representatives, the volunteer monitoring group will prepare all field equipment for the field season prior to the field training sessions. Equipment will undergo routine maintenance, initial calibration and subsequently field tested at the training day.

12.2. Analytical Laboratories and Biological Contractors

Contractors are responsible for the routine maintenance of their equipment per manufacturers' instructions. Procedures and frequency for equipment inspection and maintenance must be described in the laboratories Laboratory Quality Assurance Plan (LQAP). A copy of the LQAPs for Energy Laboratories and the Department of Public Health and Human Services laboratory are on file with the QA officer.

13. *Instrument/Equipment Calibration and Frequency*

13.1. Calibration - Laboratory

Analytical method calibration criteria are specified in the reference analytical method from EPA, APHA, or USGS. Calibrations can include initial and continuing calibrations as well as internally calibrated methods such as the Method of Standard Additions (MSA). The reporting of a result under a referenced method is a statement by the laboratory that the calibration criteria for that method have been performed, examined and pass the control limits established in the method. Results reported under a reference method without the calibrations and control limits specified in the method will not be accepted by DEQ.

13.2. Calibration – Field Instruments

Initial calibration of field instruments will be performed prior to the field season. Continuing calibration will occur according to the frequency prescribed in the instrument manufacturers' instructions. Record

calibration information, solution ID, manufacturer, Lot#, expiration date, date of calibration, time and operator name and initials in logbook.

Corrective actions for failed calibrations are detailed in the instrument manufacturers operating manual. Failure to perform and record calibration of field instrument will result in resampling the field site for the field parameters.

14. *Non-direct measurements*

Non-direct measurements are data collected using professional judgment and observation. Examples of these are the Habitat Assessments (DEQ Stream Reach Assessment and NRCS Riparian Assessment). Non-direct measurements are controlled through the use of standardized questions or by prompting the observer to look for certain physical features and provide comment.

Rather than calibrating non-direct measurements, training and feedback is provided to standardize observations and comments among users. Field training for the habitat assessment methods is given in the annual DEQ field-training day.

15. *Data Management*

15.1. Field Forms

All field forms are found in Appendix D.

15.2. Laboratory Reports and Electronic Deliverables

Analytical laboratories and biological contractors are required to return result in a STORET Import Module (SIM) compatible format prior to September 2009. After September 2009, the WQX database will be used. This file must be a text file with values separated by commas (csv). The most current format (as of the publishing date of this QAPP) is provided in Table 5.1.

Part C. Assessment and Oversight

16. *Assessments and Response Actions*

16.1. Laboratories and Biological Contractors

MSUWQ and MTDEQ will rely upon contracted laboratories certification programs (i.e. NELAC & USEPA drinking water certification) and MTDEQ approved list of laboratories. If discrepancies occur, MSUWQ and MTDEQ will notify MTDEQ QA/QC program for advice and rectification.

16.2. Assessment of Field Activities and Corrective Actions

MSUWQ and MTDEQ will visit select field crews once during the field season. This assessment of field crews will serve as follow-up to the field training provided at the beginning of the field season by providing immediate feedback and corrective actions to crews. Each field crew will be visited once, for an entire day. This will result in 2-3 assessments.

The specific items that will be reviewed are:

Field planning and preparedness

- Work plan available and being followed?
- Adequate supplies and consumables?

Reach and site selection

- Discussion between field crewmembers on representative site selection?
- Was site access an issue and how was this mitigated in the sampling design?

Sampling methodology

- Sampling sequence
- Sampling performed in accordance with SOPs
- Field instruments calibrated and log filled out?
- Samples properly preserved, packed?

Documentation and Submittal

- Forms filled out at the time of sampling?
- Courier arranged for mid-week samples?

17. *Reports to Management*

17.1. Laboratory and Field Crew Assessments

MSUWQ and MTDEQ will conduct field reviews of the sampling crews to determine conformity with training, guidance, and standard operating procedures. Results of this field audit will be reported to the VM Project Leader. Recommendations resulting from laboratory and field crew visits will be articulated to the crews at the time of the visit and followed up with written comments. If it is found that monitoring groups are not proficient in accurate field procedures, groups will be required to undergo supplemental training and may lose certification status until proficiency is met.

17.2. Results of Analytical Report and QC Summary Reviews

Review of analytical reports and QC summaries is expected to be an ongoing effort. Where systemic problems are indicated, the VM Project Leader will present a description of the problem and suggested corrective actions to the laboratory. Depending on the nature and extent of the issues involved, assessments of data may be copied to the MTDEQ QA Officer for guidance and response.

Part D. Data Validation and Usability

18. *Data Review, Verification, and Validation*

Data generated by volunteer monitoring groups shall have rigor that correlates with the level of monitoring (Section 4) which acquired the data. With level 1 being the least rigorous and level 3 the most rigorous. Concurrently, the level of rigor shall correlate with the level of QC data review. Level 1 data returned from the laboratories will be QC reviewed only but will not be used for government agency decision making. Level 2 and 3 data will be reviewed and verified but not validated to the level of raw data unless systemic problems become evident from review of results and QC summaries. Verification of analytical reports and quality control summaries are adequate for the decision impaired/not impaired and the selection of probable cause and sources.

18.1. Data Review by Laboratories and Biological Contractors

Laboratories have the responsibility to provide analytical results which conform to the requirements of the methods performed. These methods must be reported under a reference analytical method from EPA, Standard Methods, USGS, or other recognized organization. Where a substantial modification to a recognized method is being performed, the reference must note this by including “mod” or “modified” following the method citation.

18.2. Review by the VM Project Leader

The first review of data returned from laboratories and biological contractors will be a completeness review performed by the VM Project Leader and/or by MTDEQ QA officer if data will be used for

MTDEQ purposes. The completeness review will include checking the results returned against the chain-of-custody, comparing electronic deliverable against the hardcopy to verify that all results are included in both, and checking the invoices against the completed analytical report. Compliance with the 90% completeness goal will be determined on an ongoing basis as data is returned incrementally from the laboratories. If completeness falls below 90%, an investigation of the problem(s) that caused the loss of data will be performed so that corrective actions may be applied.

The QC review by the VM Project Leader and/or by MTDEQ QA officer if data will be used for MTDEQ purposes will include review of the QC Summary for each analytical report to determine compliance with the project required Precision, Accuracy, Comparability, and Sensitivity.

Precision will be verified by reviewing the results of duplicate and MS/MSD results in the QC summary against the criteria included in the Data Quality Indicators and Quality Control Sections of this QAPP.

Accuracy will be verified by comparing the results of the Laboratory Control Samples (LCS) with the criteria established in the Quality Control Section of this QAPP for laboratories and the taxa lists and reference collections required in the DEQ SOPs in SOP WQPBWQM-009.

Comparability & Sensitivity will be verified by comparing the methods and detection limits identified in the reports against those required in this QAPP. For biological results, the use of external reference conditions must be from the timeframe in the index period. If any of the above criteria are not met, a request for the laboratory to reanalyze (if holding times allow) will be made by the VM Project Leader and/or by MTDEQ QA officer or data either rejected or flagged accordingly.

18.3. Data Validation

Where analytical results are being routinely returned from an analytical laboratory or biological contractor with repeated failure to meet the DQI's specified in this QAPP, the VM Project Leader may request all raw data for a data set and perform a full data validation with assistance from the MTDEQ QA officer according to the guidance from EPA's Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8.

Literature Cited

Stribling JB, Moulton II SR, and Lester GT. 2003. Determining the Quality of Taxonomic Data. *Journal of the North American Benthological Society* 22(4): 621-631.

Appendix A.

Addendum A:
Volunteer Monitoring Training and Certification

Introduction

Volunteer water quality monitoring is an opportunity to connect with your community, contribute to the understanding and management of your local water resources, and experience hands on learning opportunities with water monitoring. This addendum is designed for groups and individuals wanting to advance their monitoring skills and be certified to collect data of sufficient quality to be used for water resource management decisions. The goal of the certification program is to train volunteer monitoring groups with technical skills and provide the support needed to collect quality data. This addendum outlines the three levels of training offered by Montana Watercourse including the specific expectations, training and requirements to be considered a certified volunteer water quality monitor.

There is much truth in the saying that an ounce of preparation is worth a pound of cure. Before beginning any project, it is vital to spend some time thinking about exactly how your monitoring program will function. Spending enough time and energy up front planning your project will ensure that the volunteers' time and effort are well spent. The technical terms in water quality speak for this "ounce of preparation" are quality assurance and quality control. These concepts are described on pages 30-33 of the Volunteer Monitoring Guidebook. Trainings will include sessions on quality assurance and quality control. Additionally, Montana Watercourse (MTWC) and Montana State University Water Quality Program (MSUWQ) are available to assist groups with their project plans.

The MTWC in cooperation with MSUWQ and the Department of Environmental Quality is committed to providing high quality monitoring training at the appropriate level for your group. Different training levels are tailored to the goals and experience of each group and are briefly described in Chapter 1 of the Volunteer Water Monitoring Guidebook and in more detail in this addendum. These trainings will provide an important knowledge base for participants and enable them to better understand and achieve the group's goal.

I. Level 1: Education and Awareness: This level provides an introduction to water quality monitoring.

Audience: Groups or individual who have no previous experience or who have had previous trainings but would like a refresher. Community groups, educators, school groups, or individuals will benefit from a level one training.

Training Specifics: The training will consist of 2-4 hours of classroom time and 4-6 hours of field training depending on the needs of your group. Monitors are encouraged to enter their data into Public Folders on the Volunteer Monitoring database repository two times per year. Topics covered in the training will include:

- **i.** Introduction to water quality and monitoring
- **ii.** Starting a volunteer monitoring program
- **iii.** Designing a volunteer monitoring plan
- **iv.** Introduction to Quality Assurance (*optional*)
- **v.** Field based training for testing biological, chemical and physical parameters. The parameters are outlined in the MTWC Volunteer Monitoring (VM) Guidebook.

vi. Introduction to the volunteer monitoring database repository

Equipment: For recommended equipment list see equipment list in MTWC Volunteer Monitoring Guidebook Appendix C, page 75. MTWC will not be able to supply everyone with equipment. Please contact us for details on funding options for purchasing monitoring equipment.

Follow-up: Montana Watercourse will follow up with level one certified groups through emails, phone calls, listserv. Level one volunteers have option of being level two certified.

II. Level 2: Continuous Record This level provides a more advanced training than level one, but is appropriate for first time volunteers who are interested in water monitoring.

Audience: Appropriate for community and school groups with some experience in water quality monitoring. Level two groups collect data that will be used for identifying long term trends or continuous record, educating local decision makers, or for a long term classroom project,. The water quality monitoring techniques are more advanced or may include additional parameters to level one. Level one training is not required to participate in level two training.

Quality Assurance for Level 2: Level two groups will receive and introduction to Quality Assurance / Quality Control (QA/QC) processes and will be encouraged to follow basic QA/QC processes. MTWC and MSU Water Quality Program will be available for assistance with QA/QC.

Training Specifics: The training will consist of 4-6 hours of classroom time and 4-8 hours of field training depending on the needs of your group. Monitors are encouraged to enter their data into Public Folders on the Volunteer Monitoring database repository two times per year. Topics covered in the training will include:

i. Overview of watersheds processes and water quality
ii. Introduction to water quality monitoring methods
iii. Starting a volunteer monitoring program
iv. Quality Assurance and designing a volunteer monitoring plan
v. Field based training for testing biological, chemical and physical parameters. Parameters are outlined in the MTWC Volunteer Monitoring (VM) Guidebook and may include other more advanced methods. For additional parameters, see the EPA Water Monitoring and Assessing website: http://www.epa.gov/owow/monitoring/ .
vi. Volunteer monitoring equipment
vii. Volunteer monitoring database repository
viii. Understanding data.

Recommendations:

i. Participants have some prior experience with chemical, physical and biological data collection methods outlined in MTWC Volunteer Monitoring Guidebook.
ii. Participants or group leader have desire and willingness to upload data to Volunteer Monitoring data repository.
iii. The group or individual monitor at least twice a year.
iv. Participants are willing to commit at least one to two years of monitoring.

Equipment: For recommended equipment list see equipment list in MTWC Volunteer Monitoring Guidebook Appendix C, page 75. MTWC will not be able to supply everyone with equipment. Please contact us for details on funding options for purchasing monitoring equipment.

Follow-up: Montana Watercourse will follow up with level two trained volunteers through phone calls, emails, listserv, and possibly site visits. Committed and experienced level two monitoring groups are encouraged to move towards the certification process.

III. Level 3: Volunteer Certification / Problem Investigation: This training provides advanced level problem investigation training. When participants complete required training and proficiency tests, they will receive an official certification letter and certificate and have a set support system for field assistance, data interpretation and analysis, and data entry.

Audience: Participants must have completed level two training or have significant prior monitoring experience. Significant experience is considered one year monitoring at level two or a college degree or some professional experience with water quality monitoring. Montana Watercourse and MSU Water Quality Program will make the final determination as to what level training is most appropriate for the individual or group. The goals of this level training include collect data that can be submitted to federal or state agencies, determine current baseline conditions, monitoring trends, or assisting the evaluation of best management practices. The participants or their group leader will coordinate closely with the Department of Environmental Quality (DEQ) to ensure that appropriate methods and parameters will be measured.

Training Specifics: Training will consist of 6-8 hours of classroom and 6-8 hours of field time. Monitors must enter their data in the Volunteer Monitoring Data Repository. Training topics will include:

- **i.** Overview of watersheds processes and water quality (optional depending on prior training of group)
- **ii.** Field process for water quality sample collection. At a minimum, groups will collect basic site information (GPS & photographs), stream flow, pH, temperature, electrical conductivity (EC), and dissolved oxygen (DO), and nutrients. Nutrient samples will be sent to a lab for analysis and volunteers will be trained in how to properly collect lab samples. Stream flow, EC, temperature and DO will be measured using a properly calibrated probe. The standard operating procedures for these parameters are included in the QAPP provided.
- **iii.** A more complete list for advanced water quality monitoring methods is included below. If the group needs to monitor additional parameters, they can do so in consultation with DEQ, MTWC or MSU Water Quality Program. Field methods will follow the DEQ standard operating procedures available at: http://www.deq.state.mt.us/wqinfo/monitoring/SOP/sop.asp.
    1. using GPS to locate the site,
    2. photographs,
    3. physical and habitat assessment,
    4. using and calibrating a probe,
    5. width/depth ratio,
    6. pebble counts,
    7. pH,
    8. dissolved oxygen,
    9. electrical conductivity,
    10. riparian vegetation condition,
    11. chemistry sample collection for low level nutrients,
    12. metals,
    13. volatile and semi-volatile organics,

14. streamflow using a flow meter,
15. installation of a continuous monitor and how to download this data,
16. how to install a staff gage
17. periphyton, and
18. macroinvertebrates.

iv. Advanced quality assurance / quality control and designing a volunteer monitoring plan. A standard volunteer monitoring QAPP and Sampling Analysis Plan (SAP) will be provided. The SAP will be adapted to fit the group's needs.

v. How to use and calibrate equipment. Certified volunteers will be trained to use and care for monitoring equipment. Dependent on funding, it is recommended that certified volunteers use probes and if applicable data loggers.

vi. Data management including volunteer monitoring database repository and STORET training.

vii. Data interpretation, how to share and analyze data, data report, and turning data into action.

Quality Assurance for Level 3: Level three groups will be trained and tested on QA/QA processes and must use the standard VM Quality Assurance Project Plan and sampling analysis plan, (QAPP & SAP).

Equipment: Certified volunteers will use reliable monitoring equipment. Please consult with MTWC and MSU Water Quality Program to determine funding options and recommendations for volunteer monitoring equipment.

Requirements:

i. Must attend at least 14 hours of advanced water monitoring training.

ii. A committed VM coordinator within the watershed group that will serve as the contact person and lead on monitoring activities.

iii. Must pass the Volunteer Monitoring Certification Exam with at least a 75% score. Volunteer may take the test up to twice a year. The test will consist of a field and a written portion.

iv. Must follow the DEQ approved Volunteer Monitoring QAPP and SAP provided in this addendum.

v. Volunteers must re-certify every two years.

vi. Equipment check and Quality Assurance field observation by MTWC, MSU Water Quality Program or DEQ at least once every two years.

vii. Two year commitment (three preferred).

viii. Monitor at least two times per year.

ix. Volunteers will be provided with a logbook including field sheets and equipment calibration documentation. Data and equipment calibration must be documented using forms provided. Volunteers will calibrate equipment prior to each use and check it against a second source standard. Volunteer's calibration log will be checked periodically.

x. Data must be uploaded to the MTWC Volunteer Monitoring database repository at least once a year.

Follow-up: Montana Watercourse and MSU Water Quality Program follow up with level three certified groups through emails, phone calls, listserv, possibly site visits and external QA. Montana Watercourse and/or MSU Water Quality Program will encourage and assist certified VM groups with data entry to the VM database and ensure that VM data is uploaded to STORET at a minimum of two times per year. MTWC and MSUWQ will facilitate contact between certified VM groups and DEQ. MTWC and MSUWQ will ensure that DEQ is aware of VM certified groups and their efforts through phone calls and/or emails.

Appendix B.

Careless Creek Sampling and Analysis Plan

2009-2012

Approvals:

_____	_____
Shirley Parrott (Lower Musselshell CD)	Date
_____	_____
Mark Ockey (MT DEQ, Watershed Protection Section)	Date
_____	_____
Mark Bostrom, (MT DEQ, QA Officer)	Date

Table of Contents

1.0 Introduction and Background 3
2.0 Objections and Design of the Investigation 6
3.0 Field Sampling Methods 8
4.0 Sample Handling Procedures 9
5.0 Laboratory Analytical Methods 10
6.0 Quality Assurance and Quality Control Requirements 11
7.0 Data Analysis, Record Keeping, and Reporting Requirements 13
8.0 Schedule 14
9.0 Project Team and Responsibilities 14
10.0 References 14

Table of Tables

Table 1. Sample Storage Requirements. 9
Table 2. Chemistry Sample Specifications 10
Table 3. Method Performance Criteria 11

Table of Figures

Site Location Maps 5
Sampling Site Map 7

1.0 INTRODUCTION & BACKGROUND

Site History: Careless Creek is a tributary to the Musselshell River, located in central Montana within Golden Valley County (USGS HUC 10040201). Careless Creek is sourced from the Big Snowys and the Little Belt mountain ranges and traverses approximately 100 miles from its' headwaters to its' confluence with the Musselshell. Irrigated agriculture and livestock grazing are the principal land uses within the watershed. A large portion of flow within the lower portion Careless Creek during the summer irrigation season comes from Deadman's Basin Reservoir as the creek is used as a conveyance for irrigation water from the Reservoir to the Musselshell River. The lower 15.5 miles of Careless Creek from Deadman's Basin Reservoir's Careless Canal to the Musselshell River has been listed on the 303(d) list. This lower section is classified as a C3 water body. Waters with this classification are suitable for bathing, swimming, recreation, and the growth and propagation of non-salmonid fish and associated aquatic life, but are considered naturally marginal for agriculture and drinking water uses. In 1988 Careless Creek was listed in the Montana Non-point Source Assessment Report as being moderately to severely impaired, with the primary pollutants being sediment and salts. It has been listed on 303(d) lists since that time. The 2006 303(d) lists the creek as partially supporting of aquatic life and warm water fishery. Probable causes listed are alteration in stream-side or littoral vegetative covers and sedimentation/siltation, while probable sources include channel erosion/incision from upstream hydromodifications, impacts from hydrostructure flow regulation/modification, and streambank modifications/destabilization.

The Careless Creek watershed steering committee was formed in 1992 and has done much work to tackle problems within the watershed. This work has included infrastructure improvements in the water delivery system from Deadman's Reservoir which allowed for a reduction in irrigation releases to 100 cubic feet per second (cfs) at the Careless Creek diversion and 80 cfs at the confluence of Careless Creek with the Musselshell River, designed to reduce bank erosion. Additionally a canalized section of the stream was diverted back to its original meandering channel along with bank sloping and tree revetment projects. Agricultural BMPs were also implemented within the watershed including riparian fencing, prescribed grazing, and off-stream watering.

Regulatory Framework: This monitoring protocol seeks to assess current water quality and determine to what extent restoration activities completed as part of the Careless Creek Water Quality Restoration Plan (Montana DEQ, 2001) have changed water quality conditions.

Summary of Previous Investigations: In addition to the TMDL completed (Careless Creek Water Quality Restoration Plan) in 2001, several other reports/investigations have been completed. Known data reports and data collections/sources for Careless Creek are listed below.

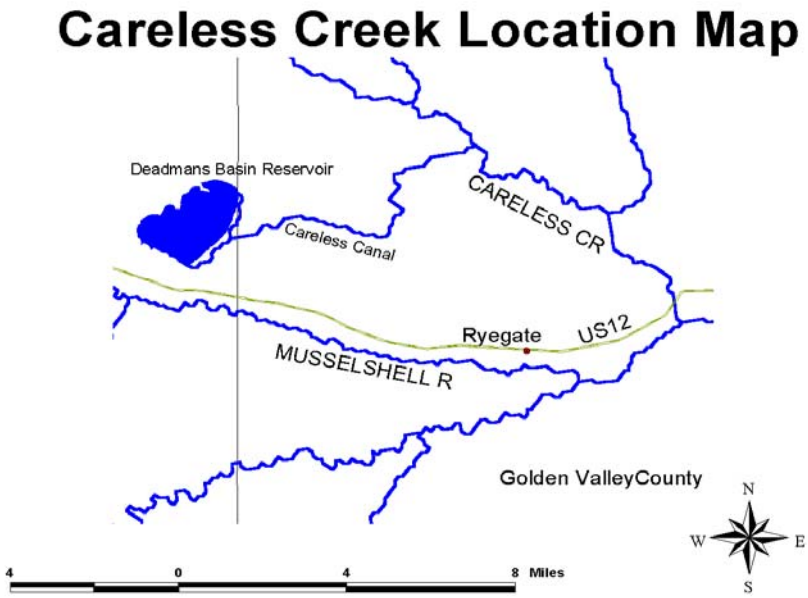
- Musselshell River Basin and Careless Creek Watershed Coordinated Watershed Plan (B. Milton, A. Sellars, Careless Creek Watershed Coordinators, 1998)
- Development of TMDL to Reduce NonPoint Source Sediment Pollution in Careless Creek, Montana (Sellers, 2000)
- Developments on Careless Creek to Reduce NonPoint Source Sediment Erosion on Careless Creek, Montana (Sellers, 2000)
- Careless Creek Assessment Record (Montana DEQ, various years)
- Water Quality data queried from STORET database (data available for 1973-74, 1976-80, 1994, 2002-2003, 2007)
- Major ions and field parameters collected at mouth of Careless Creek as part of study along Musselshell (Montana DEQ, 2002)
- Re-created cross-section surveys of Careless Creek (Montana DEQ and Montana NRCS, 2003)

These investigations state that the lower portion of Careless Creek (from Deadman's to mouth) has been unstable as a result of irrigation flows and storm runoff. Banks have sloughed and the channel has incised which resulted in deteriorating water quality, impacting both the fishery and aquatic life. Sediment and salinity are specific concerns within this watershed. Infrastructure changes which significantly reduced flows down Careless Creek, restoration work, and on-farm changes are believed to have made a significant change in water quality within Careless Creek.

Location of Pollutants:

The lower 15.5 miles of Careless Creek from the confluence with Careless Canal to the mouth of Careless Creek at the Musselshell River is the major source of pollutants within the creek. Contributing flows from Careless Canal result in bank erosion throughout this stretch. Additionally, a recent survey completed by NRCS found that a reconnected stretch of stream is actively downcutting and contributing to the sediment load. The survey also noted car bodies within the stream.

Site Location Maps:



2.0 OBJECTIVES AND DESIGN OF THE INVESTIGATION

Objectives: The intent of this project is to create an updated comprehensive monitoring protocol that will provide guidance for water quality monitoring for the next four years within Careless Creek. Past monitoring data, previous SAPs, data gathered from a scoping trip, DEQ recommendations, and watershed stakeholder input have all been incorporated into this monitoring plan. This SAP defines what should be monitored, who should monitor, and when and how monitoring should occur. Water quality data is needed to address current conditions within Careless Creek.

Study Design: Nutrients (nitrogen and phosphorus), alkalinity, sediment, total dissolved solids, and periphyton will be sampled as part of this sampling plan. All parameters will be sampled within Careless Creek at four sites (CCPreoutlet, CCZaire, CCatHwy238, and CCHwy12W). Sediment will be sampled at these four sites and at an additional two sites (Careless Canal at headgate and Careless Creek at Sterling Rd.). Grab samples for nutrients and alkalinity will be collected three times a year during the growing season. Samples will be collected in July, August, and September, with at least 28 days separating sampling events. Depending on the weather and the recommendation of the DEQ monitoring supervisor sampling events may begin earlier than July. Periphyton will be sampled twice a year during the first full sampling event (which will include nutrients, alkalinity, and sediment) and during the last full sampling event. Total suspended sediment and total dissolved solids will be collected at all sites (6 sites listed below) once a month from April through October to understand sediment patterns during irrigation and non-irrigation time periods. Additionally trutracks will be installed at all monitoring sites for continuous flow monitoring. Trutracks will be programmed to record a water level measurement every 30 minutes. Instantaneous flow measurements will be made at the time of water chemistry and sediment sampling so that rating curves can be established for the trutracks. This study design will need to be evaluated each year following a review of data collected from the previous season.

Sampling Station Locations: 1. Careless Creek Canal at the headgate out of Barber Canal (downstream of Deadman's Basin Reservoir); 2. Careless Creek above the confluence with Careless Canal (DEQ site ID - CCPreoutlet); 3. Careless Creek at the Zaire property, below the confluence with Careless Canal (DEQ site ID - CCZaire); 4. Careless Creek at HWY 238 bridge; 5. Careless Creek at Sterling Rd; 6. Careless Creek at the Highway 12 road crossing, just upstream of the confluence with the Musselshell (DEQ site ID - CCHwy12W).

- **Rationale for station selection:** Sampling sites were selected after a scoping trip to Careless Creek with DEQ and LMCD personnel. Sites selected either have sampling history pre- and post TMDL development or were identified during the scoping trip as locations helpful to defining water quality conditions within Careless Creek. If water quality data collected does not meet the targets and goals within the TMDL or generally accepted thresholds within the scientific community, the location of these sampling sites should tell concerned stakeholders why and where.

- **Site map:**

- **Proposed Reference sites:** Careless Canal at headgate and CCPreoutlet can be considered reference sites in this project. The Careless Canal at headgate sampling site defines water quality and quantity of water being released from Deadman's Reservoir. Sediment and flow calculations will be made at this site. The CCPreoutlet site defines water quality conditions of Careless Creek upstream of the discharge of Careless Canal into Careless Creek.

- **Table showing water depth/flow at proposed station – n/a**

3.0 FIELD SAMPLING METHODS

Sampling Methods: Water chemistry samples will be collected via grab samples. Grab samples will be collected by MSU Extension Water Quality (MSUWQ) personnel or by certified volunteer monitors with the Lower Musselshell Conservation District (LMCD). Water chemistry samples for laboratory analysis will be collected according to the grab sample collection procedures in the DEQ Field Procedures Manual, Section VII (FPM WQPBWQM-020). Depth and width integrated samples will be collected where appropriate. Field measurements (water temp, dissolved oxygen, pH, specific conductivity) will be taken at each sampling site by either MSUWQ or certified volunteer monitors with the LMCD with a YSI multimeter. Periphyton samples will be collected according to procedures described in section VIII B of the DEQ Field Procedures Manual. Staff from the MT DEQ monitoring section will supervise the periphyton sampling during the first monitoring event in 2009. Flow will be measured continuously using trutracks, which will be set to record a water level measurement every 30 minutes. Additionally, instantaneous flow measurements will be made at the time of water chemistry sampling so that rating curves can be established for the trutracks. Instantaneous flow measurements will be made by using a velocity meter and depth rod. DEQ SOPs for flow measurements will be

followed as defined in section XII of the DEQ Field Procedure manual. Digital photos will be taken at each sampling site during sampling visits. A photo log will be kept along with the Site Visit Forms (Attachment 1).

Sampling Equipment: Energy Laboratories, who will be responsible for water chemistry laboratory sample analyses, will be responsible for supplying appropriate sample bottles and reagents before each sampling visit. Rhithron Associates, the laboratory analyzing biological samples, will be responsible for supplying appropriate bottles for periphyton sampling. Field instruments needed, which include the YSI meter and portable flowmeter and rod, will initially be kept during the field season by MSUWQ. Once sampling responsibilities are transferred to the LMCD, the LMCD will keep field instruments during the sampling season. Field instruments will be housed at LMCD during the winter (between final fall event and following year first spring sampling event).

Sample Collection Representativeness: Sample collection will follow procedures described in this section.

Sample Containers, Decontamination Procedures: Energy Laboratories and Rhithron Associates will provide cleaned sample bottles, preservatives, and shipping containers. Both companies are responsible for the disposal of samples sent to their laboratory. Labs will be notified to ship these bottles either to MSUWQ or LMCD, depending on who is in charge of sampling that particular event.

Field Documentation and Sample Labeling Procedures: Sample bottles will be labeled at time of collection. Site visit forms will be filled out immediately after sample collection. Site descriptions and latitude and longitude coordinates for each site will be recorded in field notes recorded on DEQ site visit forms (Attachment 1).

Procedures for Disposal of Contaminated Sediments: n/a

4.0 SAMPLE HANDLING PROCEDURES

Table 1. Sample Storage Requirements:

Parameter	Preservation	Hold Time
Nitrogen, Ammonia	H2SO4 to pH <2, cool, 4□C	28 days
Nitrogen, Nitrate + Nitrite	H2SO4 to pH <2, cool, 4□C	28 days
Nitrogen, Total Persulfate	Cool, 4□C	28 days
Phosphorus, Total	H2SO4 to pH <2, cool, 4□C	28 days
Solids, Total Dissolved	Cool, 4□C	7 days
Solids, Total Suspended	Cool, 4□C	7 days
Periphyton	Formalin solution, cool	NA

Chain of Custody Procedures: Chain of custody procedures will be followed as described in Section 14.0 (Sample Handling and Custody Requirements) of the MT DEQ's Non-Point Source Water Quality and Standard Operating Procedures. Energy Labs supplies chain-of-custody forms for samples slated for analysis at their lab. Rhithron will provide chain of custody forms for periphyton samples. These forms provide documentation of the sample's integrity prior to receipt at the laboratory and communicate sample information such as owner, location, sampling time/date, and tests to be performed.

Delivery of Samples to Analytical Laboratory: Immediately after collection, samples will be placed in iced coolers. Samples will be refrigerated overnight and shipped the next day to Energy Laboratories in Helena. Periphyton samples will also be refrigerated overnight and shipped the following day to Rhithron Associates in

Missoula.

5.0 LABORATORY ANALYTICAL METHODS

Chemical Analyses, Methods, and Target Detection Limits:

18.1.6.1.1. Table 2. Chemistry Sample Specifications

Parameter	Method	Target Detection Limit
Solids, Total Dissolved	A2540 C	10 mg/L
Solids, Total Suspended	A2540 D	1 mg/L
Alkalinity	A2320 B	1 mg/L
Nitrogen, Total Persulfate	A4500 N-C	0.1 mg/L
Nitrogen, Ammonia	E350.1	0.05 mg/L
Nitrogen, Nitrate + Nitrite	E353.2	0.01 mg/L
Phosphorus, Total	E365.1	0.005 mg/L

Biological Analyses: Periphyton will be analyzed by Rhithron Associates. Analysis methods are described following: The taxonomist selects a sample and the appropriate paperwork. Each periphyton sample jar is thoroughly mixed to dislodge epiphytes from filamentous algae and to randomly mix the periphyton sample. A biohomogenizer may be used to aid this process, especially when filamentous green algae such as *Cladophora* are abundant in the sample. After homogenization, each sample is partitioned, as required, into portions. Typically there is a portion for soft-body algae analysis and QA/QC procedures, one for diatom analysis, and one for archiving. If needed, samples may be centrifuged before processing in order to reduce sample volume. Permanent diatom slides are prepared: subsamples of approximately 10-20 mL are taken and treated with concentrated H_2SO_4 and 30% H_2O_2. Samples are neutralized by rinses with distilled water, and subsample volumes are adjusted to obtain adequate densities. Small amounts of each sample are dried onto 22-mm square coverslips. Coverslips are mounted on slides using Naphrax diatom mount. To ensure a high quality mount for identification and to make replicates available for archives, 3 slide mounts are made from each sample. One of the replicates is selected from each sample batch for identification. A diamond scribe mark is made to define a transect line on the cover slip, and a minimum of 800 diatom valves are identified along the transect mark. A Leica DM 2500 compound microscope, Nomarski contrast, and 1000x magnification are used for identifications. Diatoms are identified to the lowest possible taxonomic level, generally species, following standard taxonomic references.

For soft-body algae (live non-diatom algae) samples, the raw periphyton sample is manually homogenized and emptied into a porcelain evaporating dish. A small, random sub-sample of algal material is pipetted onto a standard glass microscope slide using a disposable dropper or soda straw. Visible (macroscopic) algae are also sub-sampled, in proportion to their estimated importance relative to the total volume of algal material in the sample, and added to the liquid fraction on the slide. The wet mount is then covered with a 22X30 mm cover slip. Soft-bodied (non-diatom) algae are identified to genus using an Olympus BHT compound microscope under 200X and 400X. The relative abundance of each algal genus (and of all diatom genera collectively) is estimated for comparative purposes, according to the following system:

- rare (r): represented by a single occurrence in the sub-sample
- occasional (o): multiple occurrences, but infrequently seen
- common (c): multiple occurrences, regularly seen
- frequent (f): present in nearly every field of view
- abundant (a): multiple occurrences in every field of view, but well within limits of enumeration

- dominant (d): multiple occurrences in every field of view, but generally beyond practical limits of enumeration

Soft-bodied genera (and the diatom component) are also ranked according to their estimated contribution to the total algal biovolume present in the sample.

Corrective Actions: By reporting results and citing an analytical procedure the laboratory is certififying that the sample was analyzed within the specification and control criteria of the referenced method. In the event of lab evidence of error, repeat sampling will be undertaken when appropriate, and a flag or qualifier will be applied to all data not meeting acceptance criteria to warn users of quality issues.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

QA/QC for Chemical Analyses: Energy Lab has a comprehensive quality assurance program that follows criteria established by the USEPA, NELAC, A2LA, and various state agencies. Energy Laboratories is certified under the Safe Drinking Water Act. Samples are tracked and monitored by a laboratory management system (LIMS) from receipt to report. Samples are logged in upon receipt and immediately inspected to determine any special handling requirements. All analytical procedures, sample handling, and preservation techniques are USEPA approved (where applicable). QA/QC test samples include matrix spikes and duplicates and comprise greater than 10% of the laboratory's analytical load. Energy Lab duplicates every tenth sample to measure and control the precision of their work. Where applicable, Energy lab also spikes every tenth sample to test their accuracy. Additionally, reference samples from the EPA or from private sources are tested by the laboratory with every set of samples to provide a third measure of the performance of their equipment and personnel.

Field QA/QC of water chemistry samples will be achieved by taking one QC set (blanks and duplicates) at one sampling site per sampling event. The QC set will be rotated each sampling event to a different sampling site.

QA/QC for Biological Analyses: Aspects of periphyton identification and enumeration by Rhithron's taxonomy staff that are important to subsequent data quality include the following: 1. The accuracy and precision of identifications and enumerations is maintained such that Bray-Curtis similarity between quality checked samples is 70% or greater. This percent similarity is recommended by Dr. Loren Bahls; 2. Bias is minimized, and data completeness is assured; 3. The client-specified protocol, including the required taxonomic resolution, is faithfully followed; 4. All client-requested deliverables are provided, including reference collections; 5. A summary of QA/QC procedures and results, and sample processing procedures is documented and delivered along with client-requested deliverables.

Data Quality Assurance Review Procedures: Water chemistry data generated from this sampling project will be reviewed to 1. determine that the methods listed for analysis within this report are the same as cited on the report received from the laboratory, 2. laboratory sample duplicates meet method performance criteria (Table 3), and 3. laboratory control samples for each method as reported in analytical reports meet method performance criteria (Table 3).

18.1.6.1.2. Table 3. Method Performance Criteria

Parameter	Method	Method Blanks	Lab Duplicates (RPD)	Field Duplicates (RPD)	Lab Control (LCS/LFB)	MS/MSD
Solids, Total Dissolved	A2540 C	<10 mg/L	20%	25%	90% - 110%	80% - 120%

Parameter	Method	Method Blanks	Lab Duplicates (RPD)	Field Duplicates (RPD)	Lab Control (LCS/LFB)	MS/MSD
Solids, Total Suspended	A2540 D	<1 mg/L	10%	25%	75% - 120%	NA
Alkalinity	A2320 B	<4 mg/L	20%	25%	90% - 110%	80% - 120%
Nitrogen, Total Persulfate	A4500 N-C	<0.1 mg/L	10%	25%	90% - 110%	90% - 110%
Nitrogen, Ammonia	E350.1	<0.05 mg/L	10%	25%	90% - 110%	90% - 110%
Nitrogen, Nitrate + Nitrite	E353.2	<0.01 mg/L	10%	25%	90% - 110%	90% - 110%
Phosphorus, Total	E365.1	<0.005 mg/L	10%	25%	90% - 110%	90% - 110%

LCS and LFB = Laboratory Control Sample and Laboratory Fortified Blank, respectively
MS and MSD = Matrix Spike and Matrix Spike Duplicate, respectively

Periphyton data accuracy is insured by several QA/QC steps at Rhithron, beginning with the benchsheet review that takes place immediately after a taxonomist completes the identification and enumeration of a sample. A second taxonomist reviews the benchsheet for completeness and confers with the initial taxonomist when deficiencies are noted. A secondary QA/QC check of all data is performed by the Lead Taxonomist and the Data Technician, who review the completed data for an entire project. Deficiencies in completeness are noted, and taxonomists make changes as needed. Accuracy of data entry is checked by rekeying data from 10% of samples by a second person, an experienced data entry technician. The two resulting data files are checked by running a Bray-Curtis similarity calculation. When the similarity is less than 100%, the data entry quality check is regarded as a failure, and another 10% of samples are rekeyed into the database application. Final data versions are reviewed by the Operations Officer before data deliverables are sent to clients. Before sending the report, the compliance document checklist is reviewed to make sure that all deliverables are completed to the specifications of the client's scope of work. A technical summary of QA/QC statistics for each sample and the protocols employed in sample processing and identification is prepared by the Data Technician and reviewed by the Operations Officer, Chief Biologist and Lead Taxonomist, and is sent to the client along with data deliverables. Final decisions about alterations to sample processing or identification protocols are made by the client. Any circumstances or problems that may compromise the validity or usefulness of the data are reported to the client by the Chief Biologist.

7.0 DATA ANALYSIS, RECORD KEEPING, AND REPORTING REQUIREMENTS

Data Interpretation: Data collected will be routinely reviewed and summarized, ongoing throughout this project. A year end summary interpretation report will be prepared by Rhithron Associates for periphyton samples. Interpretations for water chemistry data will be completed by MSUWQ staff. Data interpretations will be used to assess current water quality conditions and to make comparisons with historic data when appropriate.

Record Keeping Procedures: Field personnel will record field measurements and chemistry sample collections on DEQ site visit forms included within this SAP and/or an all-weather (Rite in the Rain) notebook. Field measurements recorded on all-weather notebooks will be transferred to field sheets when weather dictates the necessity. Additionally samplers will be responsible for completing laboratory chain of custody forms. Project samplers will manage all field forms and field books.

Reporting Procedures: Copies of field forms and field notes will be forwarded to MSUWQ staff when LMCD volunteers complete monitoring. Additionally laboratory results will be forwarded from the LMCD office to MSUWQ staff. MSUWQ will enter data into spreadsheets and keep hardcopies of all forms and notes. It will be requested that Energy laboratories provide data electronically in a STORET compatible format. MSUWQ will be responsible for overseeing that electronic data deliverables are loaded into the EPA's STORET database through the WebSIM application at the conclusion of each year's sampling events. STORET guidelines can be found at: http://www.deq.mt.gov/wqinfo/datamgmt/STORET_SIM_Support.asp.
Annual reports of sampling results will be completed by MSUWQ and distributed to the appropriate parties.

8.0 SCHEDULE

The project schedule was presented in Section 2.0 under study design. Additional project milestones are listed below:
April 2009 – May 2010 – Volunteer Training
April 2009-2012 – October 2009-2012 – Collect samples and interpret data
January/February 2010 – 2013 – Annual summary reports will be completed for the previous season's sampling efforts. Meetings will be held with LMCD to review results and discuss sampling needed the following year.

9.0 PROJECT TEAM AND RESPONSIBILITIES

Sampling Personnel: Kim Hershberger, with MSUWQ, will initiate the sampling program and will be the primary sampler during 2009. As volunteers of the LMCD are trained and certified, they will begin to take over sampling responsibilities. MSUWQ will provide guidance throughout the project and will be available to help with two sampling events a year from 2010 – 2012.

Project Team Responsibilities: MSUWQ will initiate the sampling program and will train up to four volunteer monitors to complete water quality monitoring using protocols outlined in this SAP. After volunteers are trained and certified they will perform the majority of sampling/monitoring duties and enter data into the STORET database. Data analysis and data reporting will be the responsibility of MSUWQ. MSUWQ will provide oversight and evaluation for the duration of the project which includes the preparation and updates of the SAP (if necessary), data quality assurance review, and field reviews to ascertain that sample collection remains consistent throughout the duration of this project.

10.0 REFERENCES

Montana Department of Environment Quality. February 2001. Careless Creek Water Quality Restoration plan, Helena, MT. Available: http://www.deq.mt.gov/wqinfo/TMDL/pdf/Careless_Creek_FINAL.pdf

Montana Department of Environmental Quality. 2005. Field Procedures Manual for Water Quality Assessment Monitoring, Helena, MT. Available: http://www.deq.state.mt.us/wqinfo/QAProgram/SOP%20WQPBWQM-020.pdf

Attachment 1 - Site Visit and Photo Log forms

Place Site Visit Label Here

Site Visit Form

(One Station per page)

STORET Project ID:_____

STORET Trip ID :_____

Date: _____ Time: _____ Personnel: _____

Waterbody: _____ Location: _____

Station ID: _____ Visit #: _____ HUC: _____ County: _____

Latitude: ___ ___ . ___ ___ ___ ___ Longitude: ___ ___ ___ . ___ ___ ___ ___ Lat/Long Verified? ☐ By:

Elevation (m): _____ GPS Datum: NAD27 **NAD83** WGS84

Samples Collected:		**Sample ID** (Provide for **all** samples)**:**		**Sample Collection Information/Preservation:**
Water	☐			GRAB
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Sediment	☐			SED-1
Analysis:				Preservative: None Other:
Analysis:				Preservative: None Other:
Chlorophyll a	☐			C=Core H=Hoop T=Template N= No Sample
Transect:		1____ 2____ 3____ 4____ 5____ 6____ 7____ 8____ 9____ 10____ 11____		
Phytoplankton	☐			PHYTOPLANK Volume Filtered (mL):
Algae	☐			PERI-1 OTHER:
Macroinvert.	☐			KICK HESS JAB OTHER:
Kick/Jab Length (ft):		Kick Duration/# Jabs:	# of Jars:	Mesh Size: 1200 1000 500 OTHER:

Field Measurements:			**Field Assessments:**
Temp:	W °C °F	A °C °F	Macroinvertebrate Assessment ☐
pH:			Habitat Assessment: Reach Scale ☐ Site Scale ☐
SC: (umho/cm)			EMAP Assessment ☐
DO: (mg/L)			Substrate: Pebble Count ☐ Percent Fines ☐ RSI ☐
Turbidity: Clear ☐ Slight ☐ Turbid ☐ Opaque ☐			Channel Cross-Section ☐
Flow: (cfs)			Photographs: Digital ☐ Film ☐
Flow Method: Meter ☐ Float ☐ Gage ☐ Visual Est. ☐			Other Assessments:
Flow Comments: Dry Bed ☐ No Measurable Flow ☐			
Site Visit Comments:			

Chemistry Lab Information:		
Lab Samples Submitted to:	Account #:	Date Submitted:
Invoice Address:		
Contact Name & Phone:		
EDD ☒ Format: SIM Compatible	Term Contract Number:	
Relinquished By & Date/Time:	Shipped By & Date/Time:	Received By & Date/Time:
Relinquished By & Date/Time:	Shipped By & Date/Time:	Received By & Date/Time:
Relinquished By & Date/Time:	Shipped By & Date/Time:	Received By & Date/Time:

Lab Use Only - Delivery Temperature (°C): _____ Rev. 2/2007

Site Visit Form Instructions

1.Place a Site Visit Code label in the upper left corner.

2.Place a Trip Label in the upper right corner. (Covering Project ID and Trip ID with label is alright.)

3.**STORET Project ID:** If you do not have a Trip Label, enter the Project ID assigned by Data Management. If you do not know the Project ID contact the STORET Database Manager.

4.**Trip ID:** If you do not have a Trip Label, enter the Trip ID assigned by Data Management. If you do not know the Trip ID contact the STORET Database Manager.

5.**Date/Time:** Enter the date and time of the station visit.

6.**Personnel:** Enter the first and last name(s) of the personnel conducting field activities.

7.**Waterbody:** Enter the name of the waterbody such as "Missouri River".

8.**Location:** Description of sample location such as "upstream from bridge on Forest Service road 100". For confidentiality please DO NOT use proper names of people in the location field.

9.**Station ID:** If you have a Trip Label, enter the established ID or assign a new ID by using the station prefix found on the Trip Label. If you do not have a Trip Label and do not have a Station ID, leave the field blank and Data Management will generate a Station ID when SVF is submitted.

10. **Visit #:** Enter "1" if this is a new station. Leave blank if visit number is unknown.

11. **HUC:** If you do not have a Trip Label, enter the fourth code (8 digit) HUC the station falls within.

12. **County:** If you do not have a Trip Label, enter the county in which the station falls within.

13. **Lat/Long:** Latitude and Longitudes should be obtained in decimal degrees using a GPS unit reading NAD83 whenever possible. If a lat/long is obtained by another method, the datum and method must be recorded in the Site Visit Comments.

14. **Lat/Long Verified:** Latitudes and Longitudes should be verified immediately upon return from the field. Verify by plotting on a paper map or using a mapping website. Once the lat/long has been verified check the Verified box and enter initials after "By".

- Do not make minor adjustments to measured values during verification; they are assumed to be correct within the limitations of the measurement system.
- Gross errors should be corrected as follows: 1) Draw a single line through the erroneous value(s) and initial. Do not erase the original reading. 2) Write the corrected value in the comment field along with the method and datum used to derive the corrected value.

15. **Elevation:** Record elevation collected by GPS and circle the GPS datum used. If elevation is obtained by another method, the datum and method must be recorded in the Site Visit Comments.

16. **Samples Collected:** Check the box next to each activity that is collected during the station visit.

17. **Sample ID:** Write the Sample ID (Site Visit Code-sample identifier) for all of the samples collected.

18. **Sample Collection Procedure:** Circle the appropriate Sample Collection Procedure ID.

- For Chlorophyll a, record the sample collection ID for each transect in the spaces provided.

19. **Analysis Requested:** Record the requested laboratory analysis for each chemistry sample and circle the preservative used.

20. **Field Measurements:** Record your field measurements in the spaces provided.

21. **Field Assessments:** Check the boxes next to each type of field assessment completed.

22. **Site Visit Comments:** Record general comments about the station visit, samples, and field measurements.

23. **Chemistry Lab Information:** If chemistry lab samples were taken, complete this section.

- Lab Samples Submitted to: Enter name of laboratory where samples will be sent.
- Account #: Enter account number at laboratory where samples will be sent.
- Date Submitted: Record date the samples were received by the laboratory.
- Sign and date the form each time the samples change possession.

PHOTOGRAPH LOCATIONS AND DESCRIPTIONS OF REACH AND/OR SITES

Date: **Site Visit Code(s):**

Waterbody: **STORET Station ID:**

Personnel:

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photograph Locations and Descriptions - Continued

Photo No: _____ Lat _____ Long _____

Description: _____

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Photo No: _____ Lat _____ Long _____

Description: _____

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Photo No: _____ Lat _____ Long _____

Description: _____

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Photo No: _____ Lat _____ Long _____

Description: _____

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_____

Photo No: _____ Lat _____ Long _____

Description: _____

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Appendix C.

Place Site Visit Label Here

Site Visit Form

(One Station per page)

STORET Project ID:_____

STORET Trip ID :_____

Date: _____ Time: _____ Personnel: _____

Waterbody: _____ Location: _____

Station ID: _____ Visit #: _____ HUC: _____ County: _____

Latitude: ___ ___ . ___ ___ ___ ___ Longitude: ___ ___ ___ . ___ ___ ___ ___ Lat/Long Verified? ☐ By:

Elevation (m): _____ GPS Datum: NAD27 **NAD83** WGS84

Samples Collected:		**Sample ID** (Provide for **all** samples)**:**		**Sample Collection Information/Preservation:**
Water	☐			GRAB
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Analysis:				Preservative: HNO_3 H_2SO_4 HCL None
Sediment	☐			SED-1
Analysis:				Preservative: None Other:
Analysis:				Preservative: None Other:
Chlorophyll a	☐			C=Core H=Hoop T=Template N= No Sample
Transect:		1____ 2____ 3____ 4____ 5____ 6____ 7____ 8____ 9____ 10____ 11____		
Phytoplankton	☐			PHYTOPLANK Volume Filtered (mL):
Algae	☐			PERI-1 OTHER:
Macroinvert.	☐			KICK HESS JAB OTHER:
Kick/Jab Length (ft):		Kick Duration/# Jabs:	# of Jars:	Mesh Size: 1200 1000 500 OTHER:

Field Measurements:			**Field Assessments:**
Temp:	W °C °F	A °C °F	Macroinvertebrate Assessment ☐
pH:			Habitat Assessment: Reach Scale ☐ Site Scale ☐
SC: (umho/cm)			EMAP Assessment ☐
DO: (mg/L)			Substrate: Pebble Count ☐ Percent Fines ☐ RSI ☐
Turbidity: Clear ☐ Slight ☐ Turbid ☐ Opaque ☐			Channel Cross-Section ☐
Flow: (cfs)			Photographs: Digital ☐ Film ☐
Flow Method: Meter ☐ Float ☐ Gage ☐ Visual Est. ☐			Other Assessments:
Flow Comments: Dry Bed ☐ No Measurable Flow ☐			
Site Visit Comments:			

Chemistry Lab Information:		
Lab Samples Submitted to:	Account #:	Date Submitted:
Invoice Address:		
Contact Name & Phone:		
EDD ☒ Format: SIM Compatible	Term Contract Number:	
Relinquished By & Date/Time:	Shipped By & Date/Time:	Received By & Date/Time:
Relinquished By & Date/Time:	Shipped By & Date/Time:	Received By & Date/Time:
Relinquished By & Date/Time:	Shipped By & Date/Time:	Received By & Date/Time:

Lab Use Only - Delivery Temperature (°C): _____

Rev. 2/2007

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2. Place a Trip Label in the upper right corner. (Covering Project ID and Trip ID with label is alright.)
3. **STORET Project ID:** If you do not have a Trip Label, enter the Project ID assigned by Data Management. If you do not know the Project ID contact the STORET Database Manager.
4. **Trip ID:** If you do not have a Trip Label, enter the Trip ID assigned by Data Management. If you do not know the Trip ID contact the STORET Database Manager.
5. **Date/Time:** Enter the date and time of the station visit.
6. **Personnel:** Enter the first and last name(s) of the personnel conducting field activities.
7. **Waterbody:** Enter the name of the waterbody such as "Missouri River".
8. **Location:** Description of sample location such as "upstream from bridge on Forest Service road 100". For confidentiality please DO NOT use proper names of people in the location field.
9. **Station ID:** If you have a Trip Label, enter the established ID or assign a new ID by using the station prefix found on the Trip Label. If you do not have a Trip Label and do not have a Station ID, leave the field blank and Data Management will generate a Station ID when SVF is submitted.
10. **Visit #:** Enter "1" if this is a new station. Leave blank if visit number is unknown.
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12. **County:** If you do not have a Trip Label, enter the county in which the station falls within.
13. **Lat/Long:** Latitude and Longitudes should be obtained in decimal degrees using a GPS unit reading NAD83 whenever possible. If a lat/long is obtained by another method, the datum and method must be recorded in the Site Visit Comments.
14. **Lat/Long Verified:** Latitudes and Longitudes should be verified immediately upon return from the field. Verify by plotting on a paper map or using a mapping website. Once the lat/long has been verified check the Verified box and enter initials after "By".

- Do not make minor adjustments to measured values during verification; they are assumed to be correct within the limitations of the measurement system.
- Gross errors should be corrected as follows: 1) Draw a single line through the erroneous value(s) and initial. Do not erase the original reading. 2) Write the corrected value in the comment field along with the method and datum used to derive the corrected value.

15. **Elevation:** Record elevation collected by GPS and circle the GPS datum used. If elevation is obtained by another method, the datum and method must be recorded in the Site Visit Comments.
16. **Samples Collected:** Check the box next to each activity that is collected during the station visit.
17. **Sample ID:** Write the Sample ID (Site Visit Code-sample identifier) for all of the samples collected.
18. **Sample Collection Procedure:** Circle the appropriate Sample Collection Procedure ID.

- For Chlorophyll a, record the sample collection ID for each transect in the spaces provided.

19. **Analysis Requested:** Record the requested laboratory analysis for each chemistry sample and circle the preservative used.
20. **Field Measurements:** Record your field measurements in the spaces provided.
21. **Field Assessments:** Check the boxes next to each type of field assessment completed.
22. **Site Visit Comments:** Record general comments about the station visit, samples, and field measurements.
23. **Chemistry Lab Information:** If chemistry lab samples were taken, complete this section.

- Lab Samples Submitted to: Enter name of laboratory where samples will be sent.
- Account #: Enter account number at laboratory where samples will be sent.
- Date Submitted: Record date the samples were received by the laboratory.

- Sign and date the form each time the samples change possession.

PHOTOGRAPH LOCATIONS AND DESCRIPTIONS OF REACH AND/OR SITES

Date: **Site Visit Code(s):**

Waterbody: **STORET Station ID:**

Personnel:

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photo No: _____ Lat _____ Long _____

Description: _____

Photograph Locations and Descriptions - Continued

Photo No: _____ Lat _____ Long _____

Description: _____

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Photo No: _____ Lat _____ Long _____

Description: _____

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Photo No: _____ Lat _____ Long _____

Description: _____

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Photo No: _____ Lat _____ Long _____

Description: _____

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Photo No: _____ Lat _____ Long _____

Description: _____

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7/17/2009

Stream Velocity Data Sheet - METER	
Project ID:	DATE: / / TIME:
Site ID:	Surveyors:
Stream/River:	GPS Coordinates:
Organization/School:	Site Description:
ACTIVITY COMMENT:	
VISIT COMMENT:	

Flow Mate Recording

LOCATION	1	2	3	4	5	6	7	8	9	10
STAGE										
DEPTH										
FLOW (ft/sec)										

LOCATION	11	12	13	14	15	16	17	18	19	20
STAGE										
DEPTH										
FLOW (ft/sec)										

Montana Volunteer Water Monitoring Datasheet: Please return to Montana Watercourse, P.O. Box 170575, Bozeman, MT 59717 or call (406) 994-6671

CALIBRATION LOG

DATE	INSTRUMENT	PARAMETER	READING	TEMP READING	INITIALS

FIELD CHECKLIST

MONITOR_____ **DATE**_____

	√	COMMENTS
FIELD PREP		
Vehicle		
Order bottles		
Calibrate equipment (multi probe)		
Laptop battery charged		
GENERAL SUPPLIES		
Digital camera		
Cell phone		
Extra batteries for equipment		
2 D – flow meter		
Laptop with files and cord for downloading tru-track		
Field Forms (one/site)		
Pens/pencils/sharpies (Fat and skinny)		
Clipboard		
Work gloves for crew		
Air thermometer		
GPS		
Jug with distilled water		
Duct tape		
Waders and rubber boots		
First Aid Kit		
EQUIPMENT		
Flow meter		
Top-setting wading rod		
25 m tape measure		
Multiparameter probe (SpEC, pH, T)		
Probe cords (charging, data)		
Sediment Pump		
SAMPLE COLLECTION		
Sample bottles (Add 1 dup & 1 blank / day / test)		
Bottle labels		
H2SO4 ampoules		
Sample cooler/Food cooler/Ice		
POST FIELD		
Check bottle labels		
Chain of custody forms		
Ship samples		
Clean field equipment		

Appendix D.

Standard Operating Procedures
Field Manual
For
Water Quality Assessment Monitoring

Greater Gallatin Watershed Council
Volunteer Stream Monitoring Program
Gallatin Stream Team

Table of Contents

1 Introduction 55
1.1 Goals and Objectives 55
1.2 The Protocols 55
1.3 Field Crew and Time Estimates 55
1.4 Quality Assurance & Quality Control Procedures 55
1.5 Summary of Water Assessment Monitoring Event 55
1.6 Field Supply List 57
2 PROTOCOL: Laying Out Stream Reaches for Wadeable Streams 58
2.1 Concept 58
2.2 Equipment and Supplies 59
2.3 Procedure – Recording Site Location 59
3 PROTOCOL: Field Instrument Calibration and Measurements 59
3.1 Concept 59
3.2 Equipment and Supplies 59
3.3 YSI 556 Meter Calibration & Maintenance 60
3.4 YSI 556 Meter Field Measurements Procedure 60
4 PROTOCOL: Grab Sampling for Water Chemistry 61
4.1 Concept 61
4.2 Equipment and Supplies 61
4.3 Sampling Procedure 61
4.4 Field Replicate Samples for Quality Control 61
4.4.1 Sample Collection Procedure 62
4.5 Field Blank Samples for Quality Control 62
4.5.1 Sample Collection Procedure 62
5 PROTOCOL: Collecting Benthic Macroinvertebrates in Wadeable Waters Using the EMAP Reach-Wide Method 62
5.1 Concept 62
5.2 Equipment and Supplies 62
5.3 Sampling Procedure –EMAP Reach-Wide Method 63
5.3.1 Determining the Sampling Reach and Sampling Points 63
5.3.2 Sample Collection: Reach-Wide Composite 64
5.3.3 Filling and Labeling Macroinvertebrate Jars 65
5.3.4 Sample Storage and Shipping 66
5.3.5 Macroinvertebrate Habitat Assessment 67
6 Protocol: Measuring Channel Cross Section Profile 69
6.1 Concept 69
6.2 Equipment and Supplies 69
6.3 Procedure 69
7 Protocol: Measuring Stream Velocity for Calculating Stream Discharge Using the Float Method 70
7.1 Concept 70
7.2 Equipment and Supplies 71
7.3 Procedure 71
7.4 Rating Curve (Forming a Stage-Discharge Relationship) 72
8 Protocol: Performing the Wolman Pebble Count for Substrate Composition 73
8.1 Concept 73

8.2 Equipment and Supplies 73
8.3 Procedure 73
9 Protocol: Photo Survey of Riparian Habitat and Instream Algae 74
9.1 Concept 74
9.2 Equipment and Supplies 74
9.3 Procedure 74
APPENDIX A – YSI 556 Multiprobe Meter Calibration Procedures 77
A.1 Calibration Tips 77
A.2 Probe Inspection 77
A.3 Accessing the Calibrate Screen 77
A.4 CONDUCTIVITY CALIBRATION 78
A.5 DISSOLVED OXYGEN CALIBRATION in % SATURATION 79
A.6 pH CALIBRATION 80
A7. TDS (Total Dissolved Solids) 82
Appendix B – Stream Team Technical Advisors 83
Appendix C – Field Data Forms 84

Introduction

18.2. *Goals and Objectives*

The goal of the Gallatin Stream Team Program is to collect data of sufficient quality to be used for long-term trend analysis by local and state agencies. By meeting MDEQ scientific credibility requirements, the data collected could be used by the county and the state to assist in making water quality and land use decisions, as well as help identify specific problems that require further attention or study. GGWC will use the data to educate residents on the connections between land use and water quality.

18.3. *The Protocols*

The protocols contained in this document utilize the work of the MDEQ Water Quality Protection Bureau's "*Field Procedures Manual for Water Quality Assessment Monitoring*" (WQPBWQM-020), Revision 2, April 2005. Some of the protocols have been modified to fit the needs of trend monitoring. The protocol dealing with macroinvertebrate (aquatic insect) sampling is from the U.S. EPA's "*Environmental Monitoring and Assessment Program*" (EMAP). MDEQ has recently adopted this method for reference streams, but has not yet updated the bureau's "*Field Procedures Manual for Water Quality Assessment Monitoring"* at the time this protocol manual was prepared.

18.4. *Field Crew and Time Estimates*

The methods in the following protocols are designed to be completed by either two or three (or more) person field teams. A very experienced field team can expect to complete the full suite of physical measurements and sampling protocols in approximately 2-3 hours. Less experienced crews will probably take closer to 4 hours to complete the work depending on the complexity of the sampling reach. Note that estimates only include time spent at the site, not travel time or preparation time.

18.5. *Quality Assurance & Quality Control Procedures*

The guidelines and requirements for quality assurance and quality control for the GGWC Gallatin Stream Team Program monitoring procedures are outlined in the program's Quality Assurance Project Plan (QAPP). These include guidance covering: field team training requirements and qualifications, training and field audit procedures, procedures for chain of custody documentation, and requirements for measuring precision.

Procedures for meter calibrations are contained in Appendix A.

Stream Team members are strongly encouraged to contact one of the program's technical advisors anytime questions regarding field sampling and monitoring procedures are in question. Technical advisors are listed in Appendix B.

Field Data Forms are located in Appendix C.

18.6. *Summary of Water Assessment Monitoring Event*

Following is a summary of the sequence of monitoring activities to be conducted at each sampling site.

- Identify stream reach(es) for monitoring.
- Determine representative sampling site(s) within each reach.
- Make sure proper landowner permission has been obtained to access site.
- Sample selected site from downstream to upstream (to avoid contaminating later samples).

- ☐ Begin filling out all required field forms for each sampling event.

Sampling Sequence:

- ☐ Field Measurements
  - Calibrate YSI 556 meter and record in the meter calibration and maintenance log book.
  - Measure pH, specific conductivity (SC), water temperature, dissolved oxygen (DO), and total dissolved solids (TDS).
  - Record measurements on the Site Visit Form.
- ☐ Water Chemistry Sampling
  - Record information on all sample container labels using waterproof marker.
  - Collect grab samples for water chemistry (to be sent to Energy Labs for analysis).
  - Complete any required field preservation and/or filtration of samples and place in a Ziploc freezer bag, on ice, in the cooler.
- ☐ Macroinvertebrate Sampling
  - Fill out the sample tags for both inside and outside the sample container(s).
  - Collect sample in the stream reach using the EMAP method.
  - Fill out EMAP Sample Collection Form.
  - Perform macroinvertebrate habitat assessment and complete the form.
  - Record biological samples on the Site Visit Form.
- ☐ Physical/Habitat Measurements
  - Conduct a site map drawing for the stream reach.
  - Conduct a Wolman Pebble Count and complete the Substrate Composition Data Form.
  - Measure channel cross-section and stream flow using velocity float method. Record data on the Cross Section and Stream Flow Form.
  - Conduct photo survey of the sampling site and instream conditions. Record photo descriptions on the Photo Survey Data Form.
  - Identify sampling site with GPS, record latitude/longitude (NAD83) on Site Visit Form.
- ☐ Verify that all pertinent field forms are completed before leaving the site.
- ☐ Make sure to leave the site "as you find it" (no trash, etc.)
- ☐ Record water chemistry samples on the chain-of-custody (COC) and site visit form.
- ☐ Make sure all sample bottles are tight closed, and Ziploc bags are sealed including bags with ice.
- ☐ Place macroinvertebrate samples in a cooler or other storage container **without** ice.
- ☐ Ship water samples to Energy Laboratories via overnight Fed Ex or UPS (except on Friday, Saturday or Sunday).
- ☐ Turn completed field data sheets and COC form in to your Field Leader, who will give them to the GGWC Coordinator/Program Manager.
- ☐ Deliver macroinvertebrate samples to pre-determined storage location for later shipment.
- ☐ Conduct post-sampling readings with YSI meter using the calibration standards and record in the meter calibration/maintenance log book.
- ☐ Put away all equipment, clean, into the GGWC equipment and supplies storage tub.

18.7. *Field Supply List*

This checklist includes field supplies and numbers needed *per site sampled*.

General	☐ GGWC Gallatin Stream Team SOP (field manual) ☐ GGWC Volunteer Monitoring Program QAPP ☐ YSI 556 Multiparameter Meter Instruction Manual ☐ Cell phone and phone numbers (for emergencies) ☐ Field forms/data sheets (photocopied, preferably on "Rite-in-the-Rain" paper) ☐ Energy Labs Chain-of-Custody forms ☐ Pre-made macroinvertebrate sample labels (on "Rite-in-the-Rain" paper) ☐ Clipboard & pens/pencils & Sharpies (waterproof markers) ☐ Calculator ☐ First aid kit ☐ Trash bag ☐ Sunscreen, insect repellent ☐ Rain gear ☐ Hip boots/waders ☐ Paper towels ☐ Kim-wipes ☐ Clear packing tape (for covering bottle labels and shipping samples) ☐ Ziploc freezer bags (gallon-size) for ice ☐ Ice (cubed) ☐ Nitrile, powderless (latex-free) gloves
Physical Attributes	☐ Cross Section and Stream Flow Data Form ☐ Photo Survey Data Form ☐ GPS unit ☐ Maps (topographic, if needed) ***optional*** ☐ Digital camera (with additional memory card and battery) ☐ YSI 556 meter o pH 7.00, pH 10.00, 447 µS TDS (specific conductivity) calibration solutions o calibration log o users manual o extra batteries ☐ 1 – small squirt bottle of deionized (DI) water to clean YSI meter probes ☐ 1 – gravelometer (for Wolman Pebble Count) ☐ 1 – tape measure (100 ft) for determining cross-sections & conducting velocity float trial ☐ 4 – chaining pins or bank stakes ☐ 2 – 2"x4" piece of wood cut to 6" in length (one spare) for conducting velocity float trials ☐ 1 – roll of twine (plus pocket knife or scissors to cut twine) ☐ 1 – line level ☐ 1 – stopwatch **or** wristwatch w/ a second hand

	☐ 1 – yardstick (marked in 1/10 ft) or 4 ft long, ½ in diameter PVC pipe labeled in 1/10 ft with a thick waterproof black marker ☐ 1 – hammer ***optional***
Water Samples	☐ Site Visit Form ☐ DI water (for field blank samples) ☐ Cooler containing: o plastic sample bottles o preservatives o chain-of-custody forms and o pre-paid mailing label (Energy Labs)
Aquatic Insects (macroinvert e-brates)	☐ Macroinvertebrate Habitat Assessment Form ☐ EMAP Sample Collection Form ☐ 2 – 1000 ml (1 liter) wide-mouth plastic jar ☐ 1 – D-frame kick net, 500 µm mesh ☐ 1 – sieve (#35 US Standard, 500 µm) ☐ 1- sorting pan (plastic dishpan or 5-gallon bucket) ☐ 95% ethanol ☐ Tweezers ***optional*** ☐ Turkey baster ☐ Parafilm (to wrap around lid and container seal) ☐ Cooler with suitable absorbent material for transporting ethanol and samples

PROTOCOL: Laying Out Stream Reaches for Wadeable Streams

18.8. *Concept*

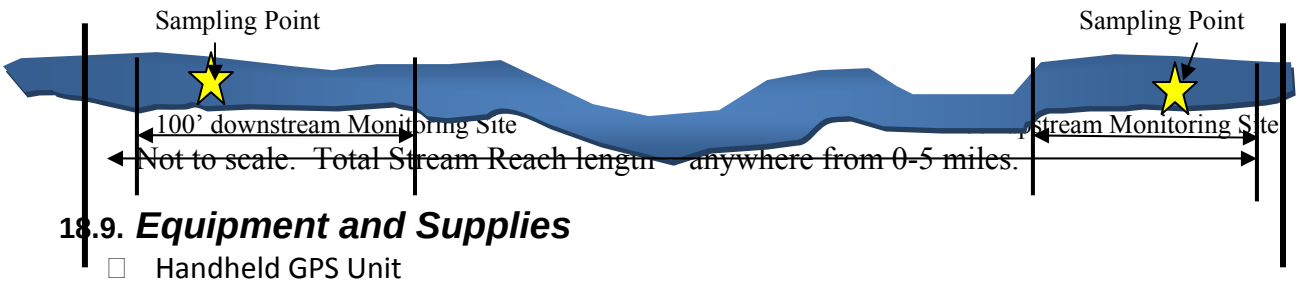
The concept of long-term trend analysis sampling is that randomly selected reaches located on a stream can be used to measure changes in the status and trends of habitat, water quality, and aquatic life (biota) over time if taken in a scientifically rigorous manner per specific protocols. We are applying the MDEQ and MT Watercourse Volunteer Monitoring sampling protocols for this volunteer monitoring program. Instead of randomly selected stream reaches, stream reaches where MDEQ or GLWQD have previously sampled will be monitored.

MDEQ uses a spatial hierarchy of "segment"," reach" and "monitoring site" to describe streams at incrementally smaller scales. GGWC VMP will focus on the reach and monitoring site scale.

- **Segment** is the stream as defined in the MDEQ assessment database. This is the smallest unit for which an impairment determination by MDEQ is made.
- **Reach** represents a homogeneous portion of the stream based on land use or physical land/habitat features (geomorphology). Reach scale measurements are used to document long-term ecological conditions for a reach. The stream reach should have the following characteristics:
  - 0-5 miles in length.
  - Relatively free from evident impacts/obstructions (roads, bridges, cattle, etc.)
  - Water depth greater than 6 inches.
  - Permission to access if located on private property.

Reach breaks should be confirmed by visual observation of the changes in the stream through landforms, land uses, and the influence of major tributary streams, if any.

- **Monitoring Site** is a *100-foot straight section* located within the stream reach. Ideally, a stream reach will have two (2) monitoring sites, located at the *upstream* and *downstream* ends of the reach. <u>If this is not possible, the monitoring site will be located at the downstream end of the reach</u>.
    - The **sampling point** in the monitoring site should be representative of the stream reach. For example, if the reach is mostly "high gradient" (riffles), then a riffle should (generally) be selected as the representative sampling point.



18.9. *Equipment and Supplies*

- Handheld GPS Unit
- Site Visit Form

18.10. *Procedure – Recording Site Location*

1. Begin filling out the **Site Visit Form** (date, volunteers, Site ID, Location, etc.)
2. Use a handheld GPS unit to obtain the latitude and longitude reading.
    - Set the map datum to NAD83
    - Set the coordinate system to decimal degrees.
3. Record the lat/long on the Site Visit Form and note which GPS datum was used to take the reading (NAD83).

Note: If the GPS unit does not display decimal degrees, only degrees, minutes and seconds, then write down the reading and then use the computer online conversion program for latitude and longitude at: http://www.geology.enr.state.nc.us/gis/latlon.html or http://www.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html

PROTOCOL: Field Instrument Calibration and Measurements

18.11. *Concept*

Field instrument measurements include water temperature, pH, specific conductivity (SC), dissolved oxygen (DO), and total dissolved solids (TDS). These parameters are "single point in time" measurements and only relate to the sampling point (water column) at the instant the reading is taken. The GGWC VMP uses the YSI 556 multiprobe meter with internal barometer to obtain these measurements.

18.12. *Equipment and Supplies*

- YSI 556 multiparameter meter
- Callibration standards (pH 7.00, pH 10.00, Conductivity 447 µS)
- Calibration log
- DI water

- ☐ Tap water
- ☐ Kim-wipes
- ☐ Waste container (cup, etc.)
- ☐ Site Visit Form

18.13. *YSI 556 Meter Calibration & Maintenance*

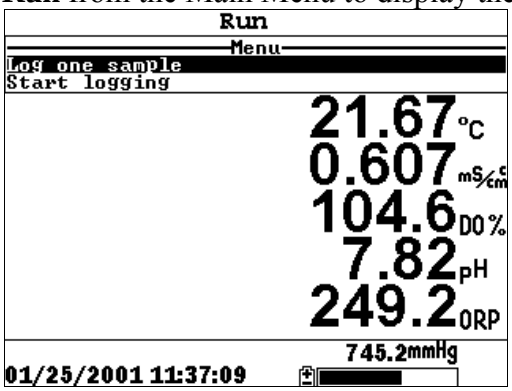
The YSI 556 meter must undergo annual inspection and maintenance prior to the monitoring field season according to the manufacturer's specifications. This must occur within a time-frame that allows for any needed parts to be ordered and installed prior to use, so plan ahead.

NOTE: Step-by-step calibration procedures are located in the back of this SOP in Appendix A. Calibration must be performed prior to taking measurements at sampling sites.

For a detailed review of calibration and maintenance procedures, go to the YSI 556 multiprobe meter instruction manual. The instruction manual must remain with the meter at all times for quick reference. Calibration logs for recording calibration activities must remain with the meter. Training for use of the meter will be given at the annual volunteer monitoring training/refresher workshop.

18.14. *YSI 556 Meter Field Measurements Procedure*

1. Do not proceed with this step until you have performed calibration for all parameters.
2. Keep probe attached to the meter after calibrating.
3. Install probe sensor guard in place of the calibration/transport cup.
4. Press the **On/Off** key and select **Run** from the Main Menu to display the run screen.



Screen shot sample

5. Carefully enter the stream moving out as close to the center of the stream as is safely possible.
6. While facing upstream, place probe in the water. Completely immerse all the sensors.
7. Standing in place, gently yet rapidly move probe through the stream (provides fresh sample to DO sensor).
8. When the readings on the display stabilize, record them on the Site Visit Form.
9. Turn off meter, rinse probe with DI water and dry. Place tap water (**do not use DI water)** in the calibration/transport cup. Replace sensor guard with the calibration/transport cup containing 1/8 inch of **tap water**. **(Do not store the probe sensors in DI water!)**. Remove probe cord from meter and place both into carrying case.

PROTOCOL: Grab Sampling for Water Chemistry

18.15. *Concept*

Water grab samples are "single point in time" measurements. They only relate to the sampling point (water column) at the instant the sample is taken. Water samples have the shortest temporal (time) and spatial (area/location) coverage of all measurements taken by GGWC VMP.

Water samples are collected for total suspended solids (TSS), nutrients (total persulfate nitrogen, nitrate-nitrite as nitrogen, total ammonia as nitrogen, total phosphorus), total recoverable metals (copper, iron, lead, mercury, zinc), and hardness as calcium carbonate. All sample bottles and preservatives are provided by Energy Laboratories in Billings which provides analytical services.

18.16. *Equipment and Supplies*

- ☐ Cooler, bottles, preservatives, chain-of-custody form, prepaid shipping label from Energy Labs
- ☐ Ziploc freezer bags
- ☐ Ice
- ☐ Site Visit Form, pen/pencil, Sharpie
- ☐ Clear packing tape (optional)

18.17. *Sampling Procedure*

1. Fill out the sample bottle labels using a waterproof Sharpie (sample ID, collection date & time, stream name, collector's name).
2. Place strip of clear packing tape over label to prevent possible ink smearing (if needed).
3. Stand facing upstream in the center of the stream (or as close as safely possible).
4. Rinse sample bottles 3 times with the stream water: partially fill the bottle, placing the lid over the bottle, shake several times, then pour out the water downstream.
5. After the triple rinse, fill the bottles with stream water (collected upstream from *any previous disturbances* to avoid contaminating the sample) by completely submerging the sample bottle into the water. Recap the bottle while it is still underwater.
6. Add the appropriate preservative to each sample type (color-coded lids and preservatives), affix lid securely and mix the sample well by gently inverting 3-5 times.
   - Nitric Acid (HNO_3) for metals = red cap
   - Sulfuric acid (H_2SO_4) for nutrients = yellow cap (Note: There will be a separate bottle for Total Persulfate Nitrogen. It <u>does not</u> get preserved with H_2S0_4)
   - **NO** preservative for TSS = white cap
7. Be sure lids are tight and that no leaking will occur.
8. Place sample bottles in a 1-gallon Ziploc freezer bag and keep samples in a cooler on ice. The ice should also be stored in 1-gallon Ziploc freezer bags.
9. Record the water chemistry sampling event on the Site Visit Form.
10. Complete the Energy Labs chain-of-custody form.

18.18. *Field Replicate Samples for Quality Control*

To assess both precision and representativeness of the sampling technique, volunteers will collect replicate grab samples for all chemical measurements during each sampling event beginning in July through September. The results of the replicate samples will verify that volunteers are collecting samples consistently.

18.18.6. Sample Collection Procedure

1. Collect replicate samples (sets of samples) following EXACTLY Steps 1-10 in Section 4.3 on page 13. This will result in 2 sets of samples being collected at 1 site.
2. Replicate samples should be labeled using the following: "SampleID-A" An example would be: BOZMC01-A and BOZMC01-B
3. Note: Replicates must be handled identically (temperature, preservation, etc.).
4. Include a remark in the comment section of the Site Visit Form that a replicate was collected at this site and include the SampleID for the replicate as a reference.
5. Include field replicates on the chain-of-custody form and ship with samples to the laboratory.

18.19. *Field Blank Samples for Quality Control*

To assess the potential for false positive results due to site contamination, volunteer s will collect field blanks during each sampling event beginning in July through October. The results of the field blanks will verify that false positive results are not obtained either from the site conditions or through cross-contamination during transport.

18.19.6. Sample Collection Procedure

1. DI water stored in a plastic container should be transported to the sampling site and kept in a location where it does not become exposed to excessive dust, mud, or come in contact with other equipment.
2. At the sampling site, fill a set of the same bottles used for the grab samples with the DI water. Preserve them with the appropriate preservative, if needed.
3. Bottles are sealed and labeled exactly the same as the grab samples and replicate samples along with a unique SampleID (i.e., BOZMC02-C).
4. Record the field blank SampleID in the comments section of the Site Visit Form.
5. Include field blanks on the chain-of-custody form and ship with samples to the laboratory.

PROTOCOL: Collecting Benthic Macroinvertebrates in Wadeable Waters Using the EMAP Reach-Wide Method

18.20. *Concept*

Macroinvertebrates (aquatic insects) are a direct measure of aquatic life use support and are excellent indicators of instream habitat health and water quality. Also, because many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, macroinvertebrate community structure is a function of present or past conditions. By evaluating the diversity and abundance of aquatic insects, we can assess the environmental conditions which are present in the stream over a period of time. Diversity measures are based on the concept that certain high-quality streams support a greater diversity of organisms than poor-quality streams where insects that are sensitive to pollution cannot live. Typically, poor-quality streams will have low species diversity; dominated by organisms that are tolerant of pollution.

18.21. *Equipment and Supplies*

- ☐ Kick-net (500 micron mesh net)
- ☐ Watch with timer or second hand or a stopwatch
- ☐ Sieve (U.S. Standard #35, 500 micron)
- ☐ Turkey baster

- ☐ Tweezers (optional)
- ☐ 100-ft reel-type tape measure
- ☐ Flagging for marking off the transect cross-sections (labeled "A" – "K" with a sharpie)
- ☐ Sorting pan (white plastic dishpan) or plastic bucket, 8- to 10-quart capacity
- ☐ 2-3 sample containers, 1-liter (plastic, wide-mouth)
- ☐ 95% ethanol in a proper container
- ☐ Cooler (with suitable absorbent material) for transporting ethanol and samples
- ☐ Sample labels (2 per sample bottle) printed on Rite-in-the-Rain Paper, pencil
- ☐ Site Visit Form and Macroinvertebrate Habitat Assessment Form
- ☐ Parafilm
- ☐ Clear packing tape strips

18.22. *Sampling Procedure –EMAP Reach-Wide Method*

18.22.6. Determining the Sampling Reach and Sampling Points

1. Each sampling location will consists of a reach of a stream. This stream reach must be **40 times** the wetted width of the stream or a minimum of 150 meters (500 feet), whichever is larger.

   Note 1: *If the stream average wetted width is >10 meters (30 feet), then use a reach length of 250 meters (820 feet). Your reach length will then be divided into 11 equally-spaced intervals (82 feet).*
   Note 2: *The reach length can be shorter than 150-meters (~500 ft) if upstream and/or downstream barriers preclude a 150-meter (~500 ft) reach length.*

   Note 3: *When the exact reach location is not restricted by the sampling design, attempt to position reaches upstream of bridges and other barriers to avoid this influence.*

2. Measure the wetted with at 5 random places from the "F" site (central GPS located sampling site)…2 upstream, 2 downstream and 1 at the "F" site. Then calculate average wetted width and round to the nearest foot (ex.):
   - 15, 14, 14.8, 15.2, 15 = 74 ÷ 5 = 14.8 feet average wetted width
   - Multiply the average wetted width by 40: 15 x 40 = 600 ft sampling reach
   - Divide by 10 to determine the width of spacing between sampling transects: 600 ÷ 10 = 60-foot transect intervals

3. Measure out the 11 equally-spaced intervals, equally, up and downstream of the "F-site". These transects are designated "A" through "K". Then downstream end of the reach should be flagged as transect "A". Refer to the diagram on page 17.

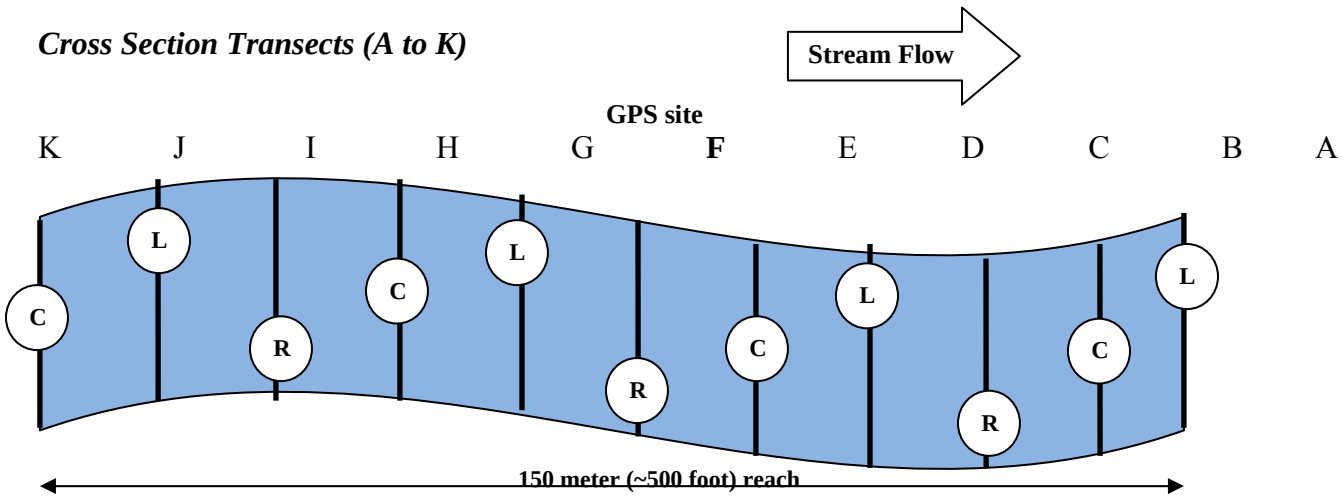
4. Proceed upstream from Transect A with the tape measure and flag the position of 10 additional transects (labeled "B" through "K" as you move upstream) at intervals equal to 1/10 of the reach length. **Enter channel <u>only</u> when necessary to avoid disturbing the stream prior to sampling.**

5. At Transect F, determine the geographic coordinates using a hand-held GPS receiver (decimal degrees using NAD83 datum setting). Record this information on data sheet.

6. Each transect (A-K) needs to be sampled at one of three points: Left (L), Center (C), or Right (R). To randomly select the first sampling point, use a digital wristwatch and note the last digit on the watch.
   Digit 1 – 3: Left sampling point
   Digit 4 – 6: Center sampling point
   Digit 7 – 9: Right sampling point
   Subsequent sampling points beginning with Transect B are sampled following the sequence Left, Center, Right, etc. For example, if the sampling point assigned to Transect A was "Center", then Transect B is assigned "Right", Transect C is "Left", Transect D is "Center", etc.

   See next page:

Cross Section Transects (A to K)



18.22.7. Sample Collection: Reach-Wide Composite

1. A kick net sample is to be collected from each transect cross-section beginning with Transect A at the assigned sampling points (Left, Center or Right) for a total of 11 samples.
   - ***NOTE:*** *At transects assigned a "Center" sampling point* where the stream width is between one and two net widths wide, pick either the "Left" or "Right" sampling point instead. If the stream is only one net wide at a transect, place the net across the entire stream width and consider the sampling point to be "Center". If a sampling point is located in water that is too deep or otherwise unsafe to wade, select an alternate sampling point on the transect at random.
2. If there is sufficient current in the area at the sampling point to fully extend the kick net, classify the habitats "riffle/run" and proceed to Step 3. If not, classify the habitat as "pool/glide" and proceed to step 3.
   - ***Note:*** *If there is too little water to collect the sample with the kick net, spend 30 seconds hand-picking a sample from about 1 ft^2 of substrate at the sampling point. Place the contents of this hand-picked sample into the "REACH-WIDE" bucket/sorting pan. Go to Step 5.3.3 "Filling and Labeling Macroinvertebrate Jars".*

Riffle/Run Habitats:

3. With the net opening facing upstream, position the net securely on the stream bottom to eliminate gaps under the frame. Visually identify a sampling quadrant one net width wide and one net width long (1 ft^2) section of the stream directly in front of the net opening.
4. Sample the1 ft^2 area in front of the net by holding the bottom of the kick net against the substrate. Pick up any loose rocks or other larger substrate particles (sticks, etc.) within the sampling quadrant. Use your hands to dislodge organisms so that they are washed into the net. Large rocks that are less than halfway into the sampling area are pushed aside. After scrubbing the rocks, set them aside, outside of the sampling quadrant.
5. Keep holding the net securely in position. Start at the upstream end of the quadrant and vigorously kick the remaining finer substrate for 30 seconds (use a watch).
6. Let the water run clear, then pull the net out of the water with a quick upstream motion to wash the organisms to the bottom of the net.
7. Invert the net into the bucket/sorting pan, which is about ½ full of water, to rinse organisms out of the net. Inspect the net for clinging organisms. Remove any organisms from the net and place them in the bucket/sorting pan using the turkey baster or tweezers. Carefully inspect any large objects (rocks, sticks, leaves) in the bucket/sorting pan and wash any organisms found off of the objects into the bucket/sorting pan before discarding the object. Remove as much detritus as possible without losing any organisms.
8. Have your team partner place an "X" in the appropriate channel-type box ("riffle/run", "pool/glide") and the appropriate substrate-type box for the transect on the Sample Collection Form:
    - Fine/sand: not gritty to gritty, up to ladybug size.
    - Gravel: fine to coarse gravel (ladybug to tennis ball sized)
    - Coarse: Cobble to boulder (tennis ball to car sized)
    - Other: bedrock (larger than car sized); hardpan (firm, consolidated substrate), wood of any size, aquatic vegetation, etc. Note the type of "other" substrate in comments on the field form.
9. Proceed upstream to the next transect and repeat steps 1-8 above.
10. Combine all kick net samples ("riffle/run" and "pool/glide" habitats) into the bucket/sorting pan.

Pool/Glide Habitats: If there is insufficient current in the area at the sampling point to fully extend the net, classify the habitat as "pool/glide".

- ***Note:*** *If the pool is too deep (> about 1m) to sample safely at the designated spot, move downstream until a safe sampling spot is found.*
- ***Note:*** *If there is too little water to collect the sample with the kick net, stir up the substrate with your gloved hands and use the U.S. Standard #35 sieve to collect the organisms from the water in the same way the net is used in larger pools.*

11. Follow Steps 2-10 above.

18.22.8. Filling and Labeling Macroinvertebrate Jars

1. Pour the entire contents of the bucket/sorting pan through a U.S. Standard #35 sieve (500 micron mesh size). Remove any large objects and wash off any clinging organisms back into the sieve before discarding.

2. Using a turkey baster and stream water, rinse all the organisms from the bucket/sorting pan into the sieve. This is the composite sample for that habitat for that site.
3. Estimate the total volume of the sample in the sieve. The sample material should not exceed ½ of the total container volume to ensure adequate preservation of the sample. You will probably need to use more than one jar for the samples.
4. Wash the contents of the sieve to one side by gently agitating the sieve in the water. Wash the sample into a jar using as little stream water as possible. Use the turkey baster if necessary. Carefully examine the sieve for any remaining organisms and use the turkey baster or tweezers to place them into the sample jar.
5. Add 95% ethanol to fully fill the sample jar. Gently agitate the container to ensure thorough mixing of alcohol and sample.
    - ***Note:*** Prepared composite samples can be transported back to the vehicle before adding ethanol if necessary.
6. Place a label written on <u>waterproof</u> paper (*Rite in the Rain* paper, using a pencil) inside the container and one label written in pencil on the outside of the container (secured with clear packing tape) with the following information:
    - Stream name
    - Sample ID
    - Date/time
    - Sampler name(s)
    - EMAP Sampling Method: Reach-Wide
    - GGWC Volunteer Monitoring Program
    - ***Note:*** If a second jar is needed, add the following information to the labels: "container 1 of 2" and "container 2 of 2".
7. Tightly replace the cap on the jar. Seal the jar with parafilm.

18.22.9. Sample Storage and Shipping

1. Store labeled composite samples in a cooler with absorbent material that is suitable for use with 95% ethanol until transport or shipment to the laboratory.
2. For long-term storage, samples should be regularly checked for alcohol loss and degradation of the sample.
    i. Within one week of sample collection, replace alcohol with new alcohol. A second and final replacement of alcohol should be conducted on the samples three weeks after sample collection. The samples can be stored up to one year in the final replacement alcohol.
    ii. Inspect alcohol level in samples every three months and refill as necessary.
3. Samples should be stored in a cool dry place at less than or equal to 25°C until shipped to the laboratory.
4. Place each sample container into a 1-gallon Ziploc freezer bag and seal. Put the sealed sample containers into a cooler and pack with absorbent material and packing material to prevent container movement during shipping. Inside a Ziploc bag, place a copy of the Habitat Assessment Form and EMAP Macroinvertebrate Collection Form along with letter to Rhithron Associates requesting sample analysis. The letter should include: billing information and shipping information for returning the cooler and the final analysis report to GGWC. Ship samples to:

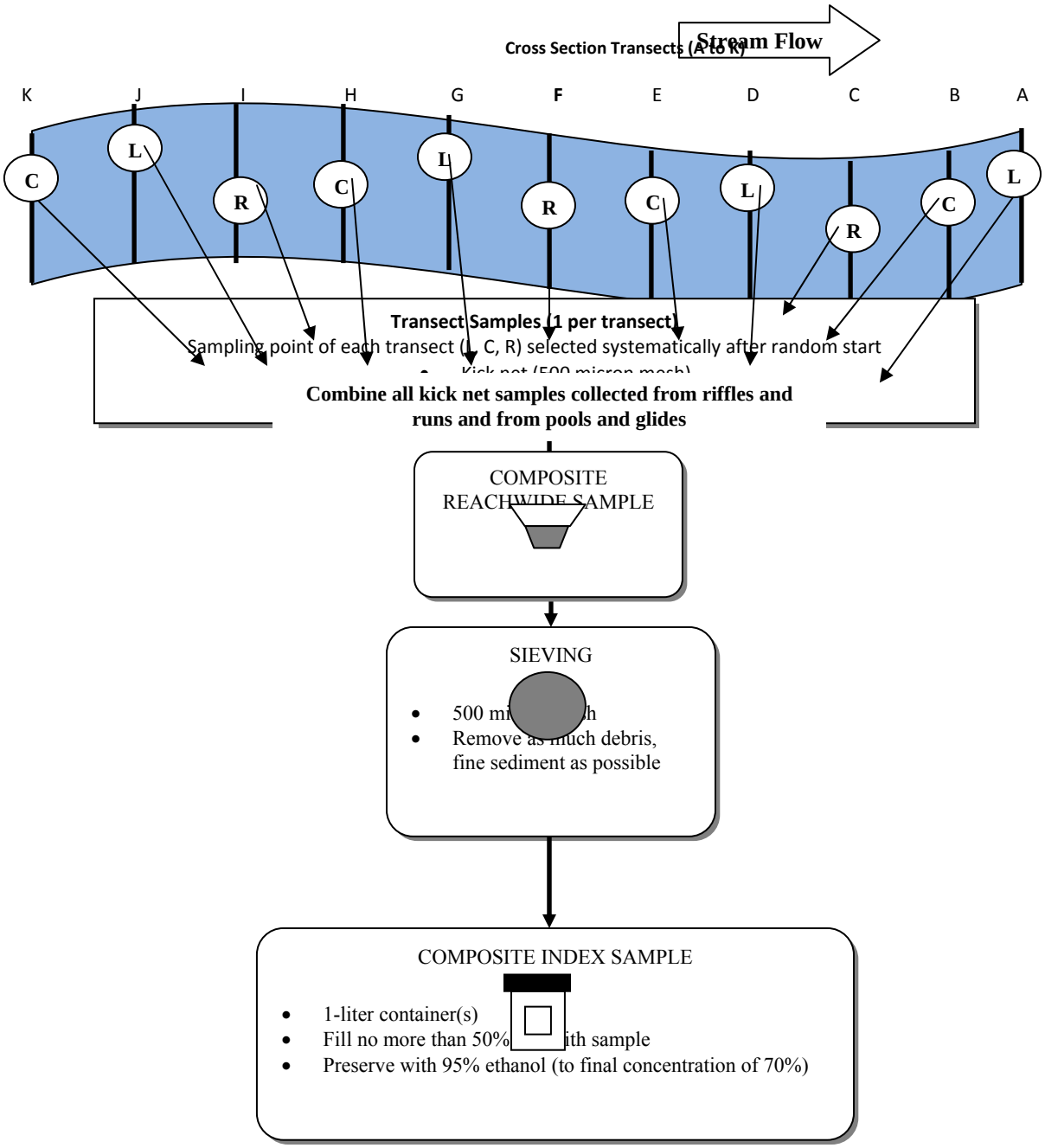
    Rhithron Associates, Inc.

29 Fort Missoula Road
Missoula, MT 59804

18.22.10. Macroinvertebrate Habitat Assessment

1. Complete the Macroinvertebrate Habitat Assessment Data Sheet (Riffle/Run) only if you have collected a macroinvertebrate sample at the site and if there were riffles and/or runs within your sampling reach.
2. For each of the habitat parameters, carefully read each of the options, select a numeric score that best represents the conditions where the samples were collected.
3. Send a copy of this data sheet to the laboratory with the samples.

EMAP Reach-Wide Sampling Design for Benthic Macroinvertebrates



Protocol: Measuring Channel Cross Section Profile

18.23. *Concept*

The shape of a stream's cross-section profile is a reflection of current and recent flow conditions. These conditions influence the streambed shape. Regular monitoring of a stream's cross-section profile allows for documentation of changes in stream condition. Two measurements are taken when conducting a cross-section profile: "bankfull depth" and "water depth". Bankfull depth is also known as "high-water mark" or "flood stage". Bankfull is the level at which water completely fills the active stream channel and begins to overflow onto the adjacent floodplain. Sometimes, identifying the bankfull depth is tricky. In this case, it can be identified by the following features:

- Change in vegetation
- Change in slope along the stream bank
- Change in particle size of bank material (i.e., boundary between gravels and silt/clay)
- Color change, stain lines on the lower limit of lichens on streamside boulders

Note: *If a stream channel is degraded, then it may not be accessing its floodplain. The GGWC Gallatin Stream Team will conduct channel cross section profiles annually to ensure that bankfull indicators are accurate.*

18.24. *Equipment and Supplies*

- ☐ 100-ft reel-type tape measure
- ☐ 2 survey pins/stakes
- ☐ Hammer (optional)
- ☐ Yardstick or stadia rod (made from PVC pipe) with markings in 1/10-feet
- ☐ Twine
- ☐ Line level (optional)
- ☐ Cross-section Data Sheet

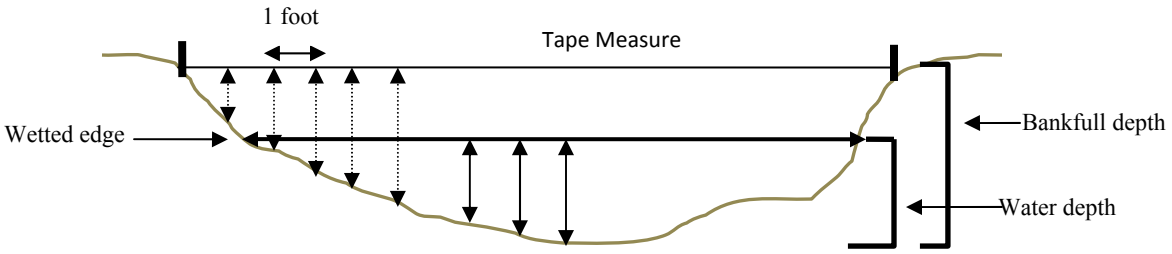
18.25. *Procedure*

1. Identify a riffle cross-section in the stream reach, which is representative of the form of the stream. Select a fairly straight section where the channel is somewhat constricted, where you can avoid large boulders and big deadfalls, which alter the form and lateral (side-to-side) movement of the channel.
2. Install stakes at the bankfull elevation of each side of the channel and attach twine to the stakes at bankfull height, keeping the twine tight. Attach a line level to the twine and adjust twine to make sure you have a uniform horizontal plane to measure to.
3. Starting at the left bank, attach the tape measure to the stake. Pull tight and attach the other end to the right bank stake. Take a reading of the bankfull stream width and the stream width from wetted edge to wetted edge. Record these measurements on the data form under Step 2.
4. Start at the left bank (facing downstream) and, using the stadia rod, move along the tape measure. Stop at each 1-foot interval to record the vertical distance from the streambed to the string level. Record these measurements on the data sheet as "bankfull depth". When an interval has water in the channel, measure the vertical distance from the streambed to the water surface and record as "water depth" on the data sheet.

- ***Note:*** *At least 20 interval measurements are recommended. So, if the stream is less than 20 feet wide, take measurements at 0.5 foot intervals. If the stream is greater than 20 feet wide, divide this into 20 equal intervals (e.g. stream width WE to WE equals 30 feet, 30 ÷ 20 = 1.2 foot intervals).*
- ***Note 2:*** *Be sure to record the horizontal distance to the left and right wetted edges of the channel on the data sheet (the "wetted edge" is where the water comes in contact with the streambank).*

5. Notations must indicate left bank wetted edge (LB WE), right bank wetted edge (RB WE), and thalweg (THWG).
    - **Thalweg** = The flow path, along the length of the stream channel, of the deepest water.
6. Call out the measurements to your team partner who will record the information on the data sheet. Record on the Site Visit Form that a channel cross-section has been done.
7. Do not remove this cross-section if you plan to measure stream velocity.

Cross-Section Profile



Protocol: Measuring Stream Velocity for Calculating Stream Discharge Using the Float Method

18.26. *Concept*

Stream flow (discharge) is the rate at which a volume of water passes through a cross section per unit of time. This is expressed as "cfs" (cubic feet per second – ft^3/sec). Discharge is an important component of an aquatic environment because it helps determine riparian and streambed habitats, temperature, the interaction between surface water and ground water, aquatic species diversity, and the concentration of various chemical substances in the water. Velocity is the speed of water moving past a given point. To calculate discharge, you must first measure velocity.

Stream staff gages will be installed for the GGWC VMP at each of the sampling sites. Volunteers will then measure cross-sectional area and stream velocity a minimum of 4 times (4 site visits) using the ***float method*** to develop a rating curve for the staff gage. This rating curve will then be used to chart future staff gage readings for determining stream discharge (flow).

The float method is a semi-quantitative method for determining stream flow. It is important to note this method tends to underestimate the flow due to slower velocity near the surface, but it is more accurate than a visual estimate.

18.27. *Equipment and Supplies*

- ☐ 100’ reel-type tape measure
- ☐ 4 survey pins or stakes
- ☐ hammer (optional if needed)
- ☐ twine
- ☐ wood block (2” x 4” cut 6” in length)
- ☐ stopwatch or watch with second hand

18.28. *Procedure*

1. Using the stream cross-section from Protocol #6 as your upstream point, identify a length of stream from this point that is straight, as well as uniform in width and depth.
2. Using the tape measure, mark off 100-feet of stream length from your first cross-section and mark the downstream end with stakes on each stream bank.

   Note: *If a 100-ft straight length of stream is not available, use a shorter length that meets the above criteria in Step 1.*
3. Stretch a length of twine across the downstream bank and attach to stakes at each bank.
4. Determine mean width of the stream (from the wetted edge) by taking measurements at two additional transects within this 100-foot segment (at the downstream transect and a random transect within the sampling length). Record on the data sheet.

   Note: *Use the stream width from the cross-section profile measurements you completed from Protocol #6 as one of your stream width measurements.*
5. Station one person just above the upstream cross section with the wood block.
6. Station another person at the downstream cross section with the stopwatch.
7. A third person (if available) is also stationed across from the upstream line.
8. The upstream person should gently release the wood block into the water just slightly above the cross-section twine.
9. The third person calls out the time as the wood block crosses the upstream line. (If only two volunteers the person who releases the block must call the start time).
10. The downstream person records the time as the wood block crosses the downstream line.
11. Capture the wood block.
12. Record the time on the data sheet.
13. Repeat Steps 6-13 at least five times.
14. Perform calculations as indicated on the data form and record the stream flow in cfs on the data sheet.
15. Record staff gage reading on data sheet.
16. Once rating curve is developed, volunteers only need to perform a staff gage reading, then use the rating curve graph to record the stream discharge on the data sheet.

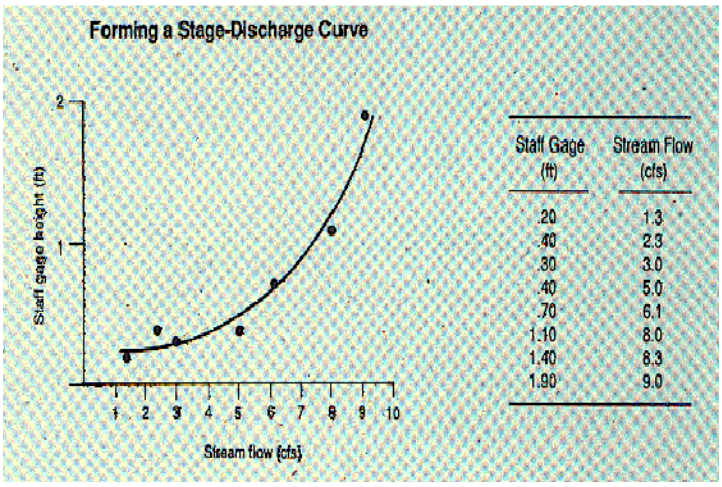
NOTE: If the wood block’s movement is obstructed by branches, rocks, eddies, etc., repeat the trial.

Staff gage on Bozeman Creek

18.29. *Rating Curve (Forming a Stage-Discharge Relationship)*

Each time you take a flow measurement, you should take a staff gage reading. On a sheet of paper or in a computer file, keep a record of each flow measurement you take and the corresponding staff gage reading. Once you have enough data, simply plot these two variables on a graph and draw or compute the resulting curve.

1. Draw a graph with an x-axis and y-axis. The x-axis, the horizontal line, will be the streamflow measurement. The y-axis, the vertical line, will be the staff gage reading.
2. Place a dot on the graph where each streamflow and corresponding staff gage measurement intersect.
3. Draw a smooth, curved line between the points. Now you have a stage-discharge relationship. From now on you can simply take the gage reading and estimate the stream flow from your prediction curve.



Staff Gage (ft)	Stream Flow (cfs)
.20	1.3
.40	2.3
.30	3.0
.40	5.0
.70	6.1
1.10	8.0
1.40	8.3
1.90	9.0

As convenient as a stage-discharge relationship is, it still needs to be supported by real data. The more data points you use to develop your graph, the better.

Note: *The graph is accurate only for the stream flows that fall within the data range you used to create the graph*. **Example:** If all your measurements were taken during July – September when stream flows were low, the graph could not be used to predict high flows in December.

Be sure to collect data during a wide range of conditions (taking personal safety into account also). In general, if you have about four data sets from low-flow period and four from the high-flow period, you can comfortably prepare the rating curve graph.

For long-term monitoring, make periodic checks of the discharge curve, especially after periods of flooding. Recalibrate the curve if the periodic checks indicate the relationship has changed. Eventually, natural changes in the stream bottom will result in a change in the relationship between flow and gage height.

Protocol: Performing the Wolman Pebble Count for Substrate Composition

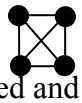
18.30. *Concept*

The bed and bank material of a stream are key elements in the formation and maintenance of channel morphology. These materials influence channel stability and provide resistance to scour during high flow events. The frequency of bed load transport can be critically important to fish spawning and other aquatic organisms that use the substrate for cover. The Wolman pebble count procedure requires taking measurements of substrate on an increment within the bankfull channel and is used to determine particle size distribution in the stream channel.

18.31. *Equipment and Supplies*

- ☐ Gravelometer
- ☐ Substrate Composition (Pebble Count) form

18.32. *Procedure*

1. The sampling points are determined by paced transects across the channel from bankfull to bankfull using the "zig-zag" method (including the top, middle and bottom of the riffle). A minimum of 100 particles must be observed and recorded.
2. Start at one end of the downstream cross-section. Without looking directly at the substrate, step forward (by walking heel-to-toe). Reach down and pick-up the first particle at the end of your foot touched by your finger. DO NOT LOOK while you are selecting the substrate to ensure a random sample is collected.
3. Measure the intermediate diameter of the particle by inserting it through the first opening in the gravelometer the particle will fit through (known as the "Pass/No Pass Method"). Call out this measurement to your team partner.
4. Tally this sample measurement by the size categories outlined on the data form. Use the Dot/Slash system to record pebble counts. 10 = 
5. Repeat Steps 1-4 until 100 particles have been observed and recorded.
6. Calculate the cumulative percent total for each class size. This can be done after you leave the field site, but before the data sheet is turned in to your Field Team Leader.

Protocol: Photo Survey of Riparian Habitat and Instream Algae

18.33. *Concept*

Completing a photographic record of your sampling station can provide valuable information for the future. A photo will be able to provide a clear representation of how the stream site has changed over time. It will also provide objective data that will be an important supplement to other water quality data. Documentation of instream aquatic vegetation (algae) can be useful for providing general qualitative information on the extent of nutrient impacts to a stream. This does not, however, substitute for chlorophyll-a sampling and analysis (which is beyond the scope of work for GGWC at this time).

18.34. *Equipment and Supplies*

- ☐ Digital camera
- ☐ Photo Survey Data Sheet
- ☐ GPS unit

18.35. *Procedure*

1. Pick a specific location that can be used every time. Use an existing man-made structure or a distinctive tree to help mark your site.
    - ***Note:*** *If these markers do not exist, mark the site with stakes or flags.*
2. GPS this location and record it on the data sheet.
3. From this location, take a North, East, South and West, plus an upstream and downstream photo.
4. Record these photos on the data sheet.
5. To document periphyton (algae – aquatic plants) growth in the stream, take instream photos representative of the algae growth present in your stream reach. Also remove several rocks from the stream that are representative of algae growth, place on a surface with a pen or other item for "scale" and take a photo.
6. Record these photos on the data sheet.
7. Include all of the following in the photo survey:
    - Direction of photograph (upstream, downstream, facing North, East, South, West)
    - Date
    - Time of day
    - Time of year
    - Focal length of lens
8. Repeat the photo survey at your sample site every time you sample so you can document the current conditions.

Literature Cited – Protocols Adapted From:

- *A Citizen's Guide to Understanding and Monitoring Lakes and Streams*, Michaud, Joy P., Envirovision – Environmental Consulting Service, Olympia, WA (1991). (Illustration by Sandra Noel).

- *EMAP-Western Pilot Study Field Operations Manual for Wadeable Streams, Section 11 (Benthic Macroinvertebrates)*, Revision 2, Peck, David V., Lazorchak, J. M., and Klemm, D. J. (April 2001).
- *Field Procedures Manual for Water Quality Assessment Monitoring* (WQPBWQM-020), Water Quality Protection Bureau, Montana Department of Environmental Quality, 2005.
- *Volunteer Water Monitoring Guidebook*, Montana Watercourse (2007).

APPENDICES

APPENDIX A – YSI 556 Multiprobe Meter Calibration Procedures

A.1 Calibration Tips

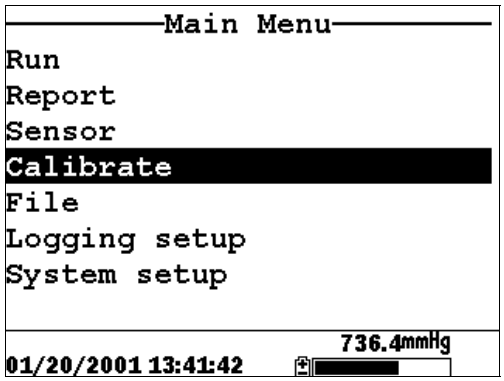
- The transport/calibration cup that comes with the probe serves as a calibration chamber for all calibrations and minimizes the volume of calibration solutions required.
- Perform all calibrations with the Probe SensorGuard installed.
- Ensure all sensors are immersed in the calibration solution. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.
- Make sure to loosen the seal of the transport/calibration cup prior to the DO calibration to allow pressure equilibration.
- For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe. You may wish to shave old calibration standards for this purpose.
- Put some deionized (DI) water at ambient temperature to rinse the probe between calibration solutions.
- Have several clean, absorbent paper towels or Kim-wipes available to dry the probe between rinses and calibration solutions. Shake excess rinse water off the probe. Dry off the outside of the probe and sensor guard. (Making sure the probe module is dry reduces carry-over contamination of calibration solutions and increases the accuracy of the calibration.

A.2 Probe Inspection

- Ensure the o-ring is installed in the o-ring groove of the transport/calibration cup and that the bottom cap is securely tightened. **NOTE:** Do not overtighten!
- Remove the probe sensor guard, if installed.
- Remove the o-ring, if installed, from the probe and inspect for defects. Replace with extra o-ring if defects found.

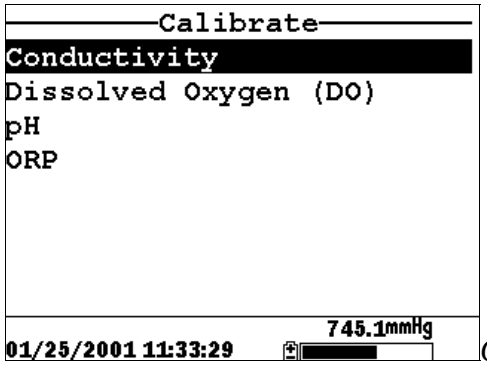
A.3 Accessing the Calibrate Screen

1. Press the **On/Off** key to display the run screen
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **Calibrate** selection.



Main Menu Screen

4. Press the **Enter** key. The Calibrate screen is now displayed.

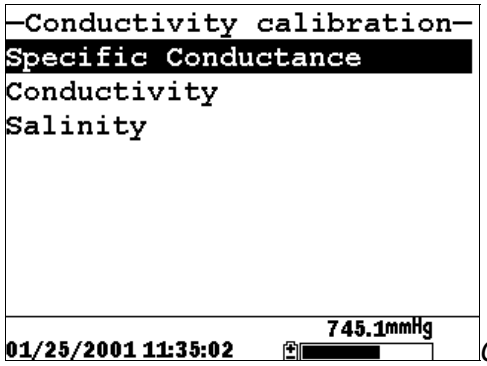


Calibrate Screen

A.4 CONDUCTIVITY CALIBRATION

This procedure calibrates specific conductance (SC) and conductivity. Calibrating any one option automatically calibrates the other.

1. Go to the calibrate screen as described in Section 3.2.3. Accessing the Calibration Screen.
2. Use the arrow keys to highlight the **Conductivity** selection.
3. Press **Enter**. The Conductivity Calibration Entry Screen is displayed.

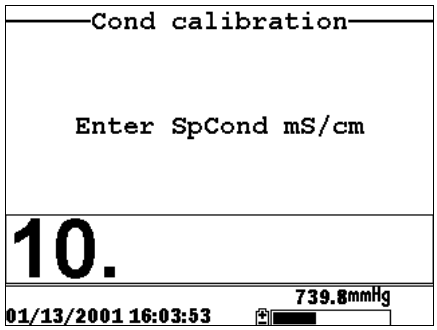


Conductivity Calibration Screen

4. Open **2 (two)** TDS 447 calibration solution packets and pour into the transport/ calibration cup.
   NOTE: Before proceeding, ensure the probe sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of 447 standard that can be discarded.
5. Carefully immerse the sensor end of the probe (past its vent hole) into the solution. Ensure that the vent hole is covered with calibration solution.
6. Gently rotate and/or move the probe up and down to remove any air bubbles from the probe.
7. Screw the calibration cup on the threaded end of the probe and tighten.

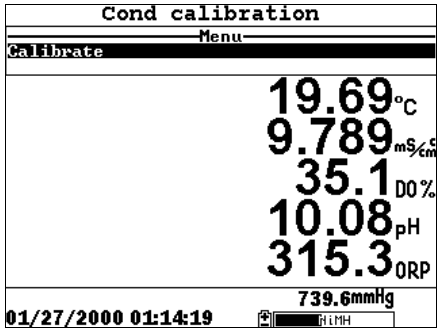
8. Use the keypad to enter the calibration value of the standard you are using. We are using **447 µS/cm**, so you will need to enter: ".447" (mS/cm). Be sure to input the decimal point and enter just as shown.

   NOTE: The YSI 556 is set-up for "temperature compensation" which means you will always use the value for your calibration standard at **25 C**.

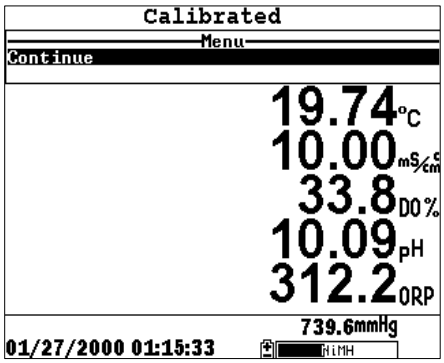


Here you enter ".447 mS/cm"

9. Press **Enter**. The Conductivity Calibration Screen is displayed.



10. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
11. Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press Enter again to Continue.

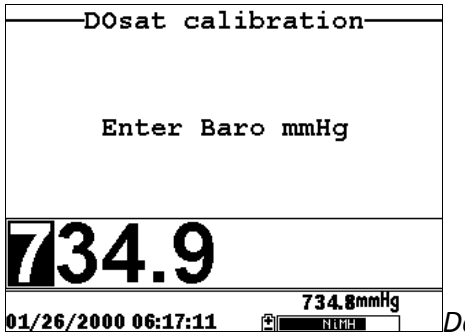


12. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen.
13. Press **Escape** to return to the Calibrate Menu.
14. Rinse the probe and sensors in tap or DI water and dry with a Kim-wipe.

A.5 DISSOLVED OXYGEN CALIBRATION in % SATURATION

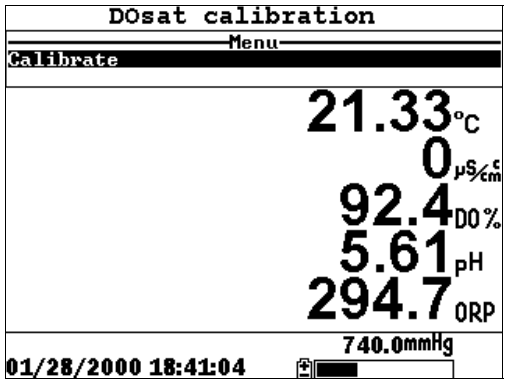
1. Use arrow keys to highlight DO% selection

2. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.



Do NOT enter barometric pressure

3. Place approximately 1/8 inch of water in bottom of calibration cup.
4. Place probe into calibration cup. **NOTE:** Make sure the DO and temperature sensors are **not** immersed in the water.
5. Engage only 1 or 2 threads of the calibration cup to ensure the DO sensor is vented to the atmosphere.
6. **DO NOT ENTER THE BAROMETRIC PRESSURE.** This YSI 556 meter has an internal barometer.
7. Press **Enter**. The DO% saturation calibration screen is displayed.



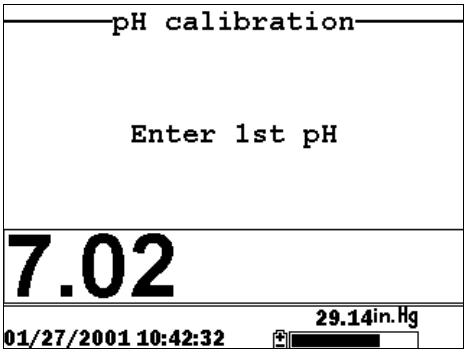
8. Allow approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate before proceeding.
9. Observe the reading under DO%. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate the calibration has been accepted.
10. Press **Enter**. This returns you to the DO calibration screen.
11. Press **Escape** to return to the calibration menu.
12. Rinse probe and sensors in tap or DI water and dry with a Kim-wipe.

A.6 pH CALIBRATION

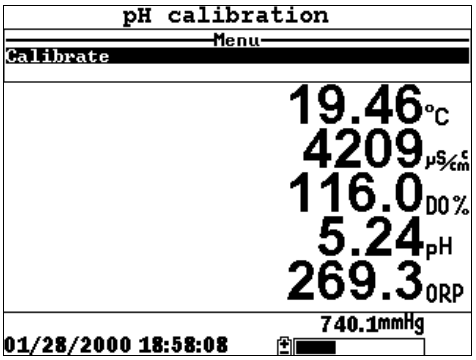
1. Go to the calibrate screen as described in Section 3.2.3. Accessing the Calibration Screen.
2. Use the arrow keys to highlight the **pH** selection.
3. Press **Enter**. The pH calibration screen is displayed.
    - Select the **1-point** option only if you are adjusting a previous 2-point calibration.

- Select the **2-point** option to calibrate the pH sensor using two calibration standards. Waters we will be monitoring are known to be "basic" (pH range 7.00 – 14.00), so we will use pH 7.00 standard and pH 14.00 standard.

4. Use the arrow keys to highlight the **2-point** selection.
5. Press **Enter**. The pH Entry Screen is displayed.



6. Place the contents of 1 pH 7.00 buffer packet into the calibration cup. (Ideally, rinse the pH sensor with a small amount of buffer than can be discarded.)
7. Immerse the sensor end of the probe into the solution. **NOTE:** The sensor must be completely immersed in the solution.
8. Gently rotate and/or move the probe up and down to remove any air bubbles from the sensor.
9. Screw the calibration cup on the threaded end of the probe and tighten.
10. Use the keypad to enter the calibration value of the buffer you are using.
    NOTE: The YSI 556 is set-up for "temperature compensation" which means you will <u>always use the value for your calibration standard at **25 C**</u>.
11. Press **Enter**. The pH calibration screen is displayed.



12. Allow at least 1 minute for temperature equilibration before proceeding.
13. Observe the reading under pH. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate the calibration has been accepted and prompt you to press Enter again to continue.
14. Press **Enter**. This returns you to the Specified pH Calibration Screen.
15. Rinse the probe, calibration cup and sensors in tap or DI water and dry with a Kim-wipe.
16. Repeat steps 6-13 using the pH 14 calibration buffer.

17. Press **Enter** to return to the pH Calibration Screen.
18. Press **Escape** to return to the calibrate menu.
19. Rinse the probe and sensors in tap or DI water and dry with a Kim-wipe.

A7. TDS (Total Dissolved Solids)

1. There is no calibration procedure for TDS. TDS is calculated internally based on the specific conductivity reading (in mS/cm) and a TDS constant (between 0.3 and 1.00) which has been preset to default to 0.65 on the YSI 556 meter.

Instructions excerpt from:
YSI 556 MPS Multi Probe System Operations Manual, YSI Environmental Incorporated. May 2002.

Appendix B – Stream Team Technical Advisors

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Appendix C – Field Data Forms

- Site Visit Form
- Macroinvertebrate Habitat Assessment Form
- EMAP Macroinvertebrate Sample Collection Form
- Cross Section and Stream Discharge Form
- Wolman Pebble Count (Substrate Composition) Form
- Photo Survey Documentation Form