Stream monitoring

October 2019

Watershed Pollutant Load Monitoring Network: Standard operating procedures and guidance

MINNESOTA POLLUTION CONTROL AGENCY

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This report is available in alternative formats upon request, and online at www.pca.state.mn.us.

Document number: wq-cm1-02

Foreword

The Minnesota Pollution Control Agency's Watershed Pollutant Load Monitoring Network (WPLMN) staff and local partners should follow the Standard Operating Procedures and Guidance (SOPG) outlined in this manual. This SOPG will be updated as needed. WPLMN staff should be consulted with any questions regarding sampling methods used in the WPLMN program.

Contents

1. Scope and application

This standard operating procedures and guidance describes the methods followed by the Minnesota Pollution Control Agency's (MPCA) Watershed Pollutant Load Monitoring Network (WPLMN) staff and local partners regarding water quality sample collection and management of related data.

2. Monitoring overview

2.1 Overview

The WPLMN is designed to measure and compare pollutant load data from Minnesota's rivers and streams and track water quality trends. This long-term program utilizes state and federal agencies, Metropolitan Council Environmental Services (MCES), state universities, and local partners to collect water quality and flow data. This data is used to calculate pollutant loads. Monitoring sites span three ranges of scale:

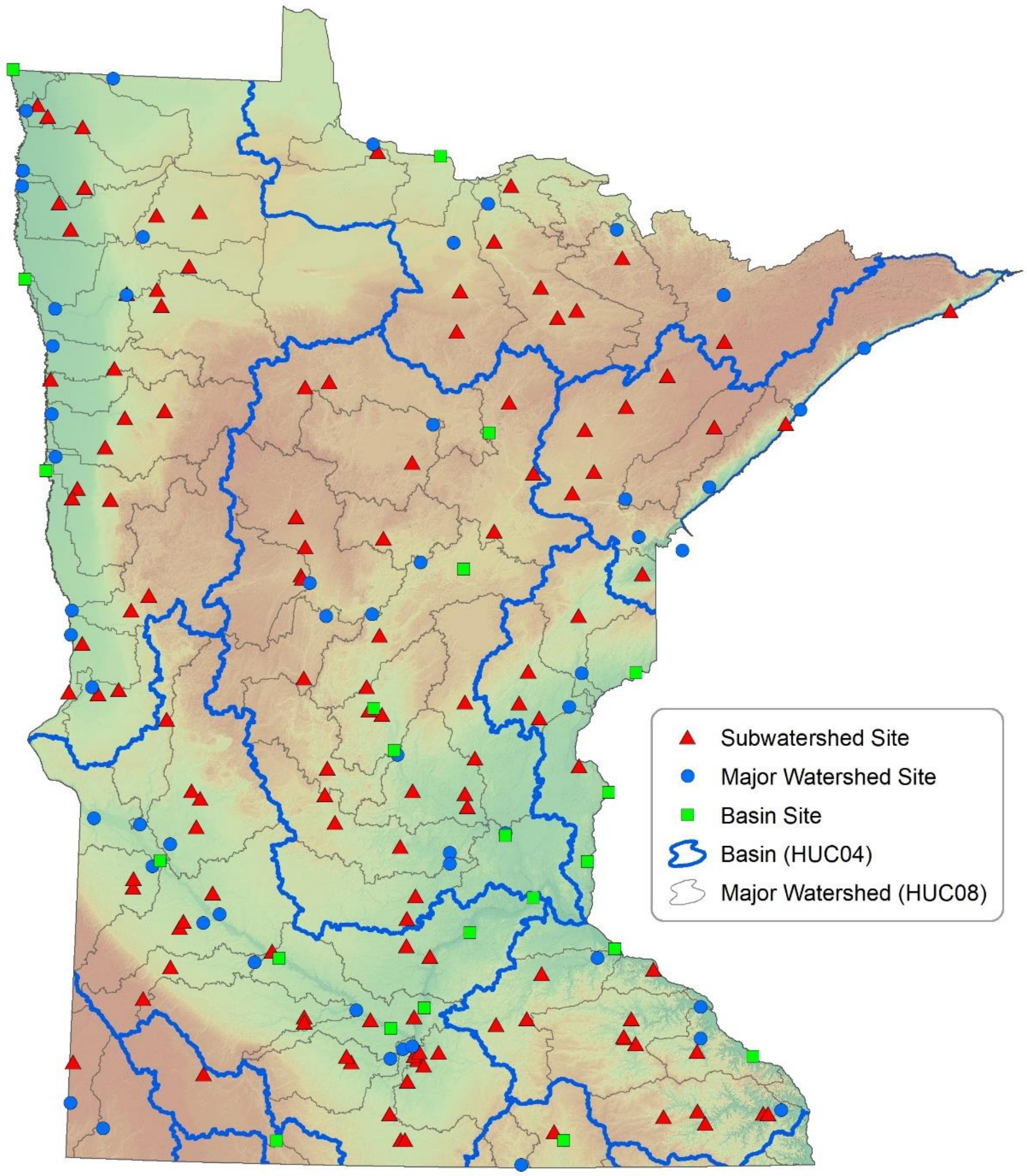
Basin – major river main stem sites along the Mississippi, Minnesota, Rainy, Red, St. Croix, Des Moines, and Cedar rivers

Major Watershed – tributaries draining to major rivers with an average drainage area of 1,350 square miles (8-digit HUC scale)

Subwatershed – major branches or nodes within major watersheds with average drainage areas of approximately 300-500 square miles and/or have a unique land use or land type

Establishment of basin and major watershed sites within the network began in 2007 following the passage of Minnesota's Clean Water Legacy Act with subsequent funding from the Clean Water Fund of the Minnesota Clean Water, Land and Legacy Amendment. Subwatershed monitoring sites were established between 2011 and 2015. There are approximately 198 sites within the WPLMN. (Figure 2). Major watersheds contained mostly outside of Minnesota were not included in the network. Site specific stream flow data is computed at all sites by the Minnesota Department of Natural Resources (DNR) or the United States Geological Survey (USGS). Water quality data is collected by the MPCA, local units of government, state universities, nonprofit organizations, Minnesota Department of Agriculture, and MCES. Stream discharge data is coupled with water quality data to compute pollutant loads for all river monitoring sites. Site-specific stream flow and links to water quality data as well as site pictures, and other information can be found at: http://www.dnr.state.mn.us/waters/csg/index.html.

Figure 1. Watershed Pollutant Load Monitoring Network



2.2 Program goals

The WPLMN is tied to the goals of the 1972 Clean Water Act for restoring and protecting the multiple beneficial uses and ecological integrity of America's waters.

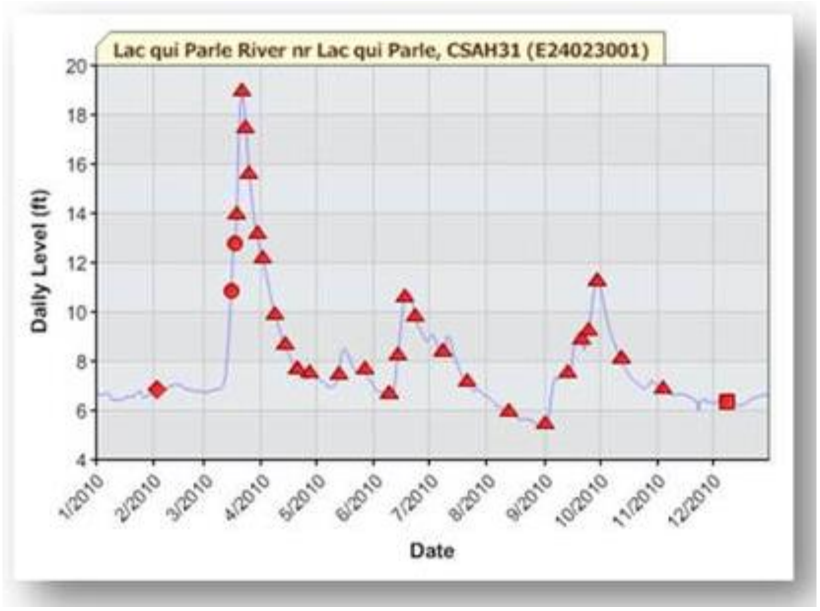
***Primary goals include*:** measuring and comparing regional differences and determining long-term trends in water quality.

Data will also be used to assist with: impaired waters assessments; watershed and water quality studies and reports; watershed modeling efforts; and measuring the ongoing effectiveness of major watershed protection and restoration plans.

2.3 Monitoring strategy

Intensive water quality sampling occurs at all WPLMN sites. Approximately 28-35 water quality samples are collected annually at basin and major watershed sites and 20-25 samples collected seasonally (ice out through October 31) at subwatershed sites. All major runoff events are sampled intensively to account for correlations between storm and seasonal differences that may exist in concentration and flow. Computation of accurate pollutant loads requires frequent sampling of all major runoff events. Low flow periods are sampled less frequently as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach results in samples being well distributed over the entire range of flows (Figure 3). Annual water quality and daily average discharge data are coupled in the "FLUX32" pollutant load model to create concentration/flow regression equations, which are used to estimate pollutant concentrations and loads on days when samples were not collected. Primary outputs include annual and daily pollutant loads and flow weighted mean concentrations (FWMC). Loads and FWMC are calculated for TSS, TP, DOP, NO_3+NO_2-N and TKN.

Figure 2. Lac Qui Parle River 2010 hydrograph with sample collection dates plotted



Laboratory samples are analyzed for:

- Total suspended solids (TSS)
- Dissolved orthophosphate phosphorus (DOP)*
- Total phosphorus (TP)
- Nitrate+nitrite nitrogen (NO_3+NO_2-N)
- Total Kjeldahl nitrogen (TKN)

*DOP only analyzed at major watershed and basin sites beginning in 2017.

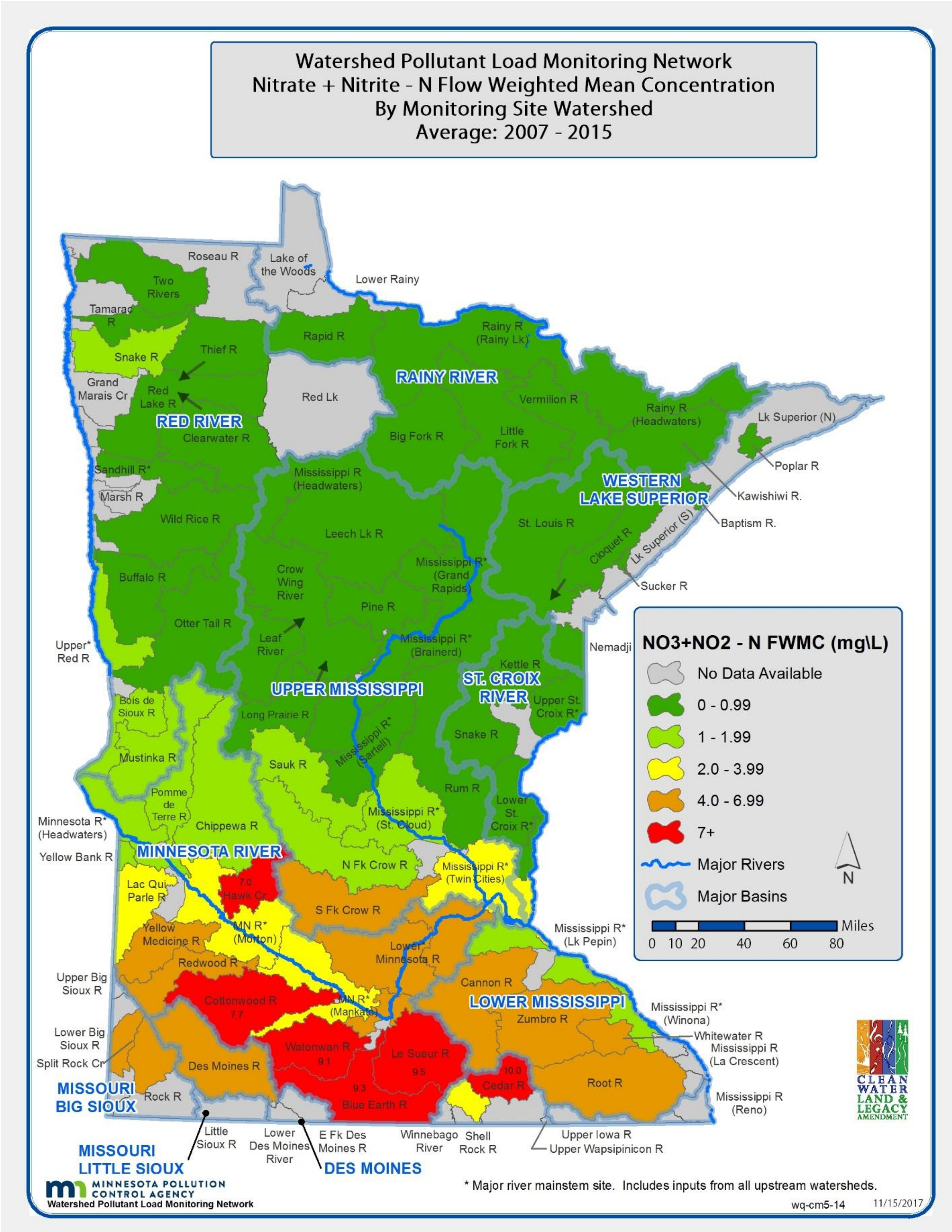
In-field measurements include: pH, temperature, specific conductance, dissolved oxygen, and transparency.

Results

Figure 4 illustrates the average flow weighted mean NO_3+NO_2-N concentration by major watershed from 2007 to 2016. Annual and average pollutant loads and water quality maps are available at: https://www.pca.state.mn.us/wplmn/products.

The WPLMN Data Viewer provides WPLMN's pollutant load data in an easy to access downloadable format. The online tool can be found here: https://www.pca.state.mn.us/wplmn/data-viewer.

Figure 3. Average 2007 – 2016 FWMC by watershed



3 Site information

3.1 Site locations and maps

Site information documents give site-specific information along with a map showing the nearest city or landmark. Local partners are encouraged to develop site information documents for their respective sites. Each document should contain the WISKI and EQuIS site identifiers, latitude and longitude coordinates, and sampling location(s) for summer, winter and flood stage. If available, annual hydrographs with three to 10 years of flow data with generalized sampling frequency information is also beneficial. A template of the site information document is included in Appendix A and is available in alternative format upon request.

4 Records

4.1 Field notes

Sample collection in the field requires adequate documentation for quality assurance and control. Field notes can be recorded electronically in the field using the GoCanvas application (see description below) or documented in a field book or field datasheet (Appendix B). Field datasheets templates are available in alternative formats upon request. The field book should contain the same information that is collected on the field sheet Because of their importance as an official record, make these as legible and complete as possible. The field notes checklist below outlines important items that should be documented.

GoCanvas is a cloud-based software service in which the MPCA has developed an application to collect field notes and conditions for electronic submittal to WISKI. The MPCA has licenses for WPLMN staff and local partners. The application can be installed on an electronic device such as a smart phone, laptop, or tablet for use in the field. The application can also be used on a desktop computer. If using a field book or field sheet is preferred, the field notes will then need to be entered into the GoCanvas application.

Field notes checklist

- ☐ Site name including the EQuIS and WISKI ID
- ☐ Date
- ☐ Military time and zone
- ☐ Reference Point (RP)
- ☐ BTW (bridge to water)
- ☐ Measured stage level (RP minus BTW, or ‘tape down’; wire weight gage reading)
- ☐ Difference between measured stage level and gage height
- ☐ Error range and description
- ☐ Gage height (data logger reading)
- ☐ Datalogger battery voltage (optional)

- ☐ Control type and condition
- ☐ Appearance
- ☐ Recreational suitability
- ☐ Stream condition
- ☐ Field meter parameters:
    - Water temperature
    - Specific conductance
    - Dissolved oxygen
    - pH
- ☐ Secchi tube reading
- ☐ Name of person collecting the sample

Other field notes

Documenting stream and watershed conditions is also important; below is a list of questions to aid in describing conditions.

- ☐ Past weather conditions – has it rained in the last week (if so, when and how much)? Has it been dry or abnormally dry? Wet?
- ☐ Current weather conditions – sunny, raining, cloudy, windy, cold, warm, etc.
- ☐ Is the river rising or falling? Compare with the last time you collected a sample.
- ☐ Water appearance/observations (brown, turbid, clear, green with algae or diatoms) – can you see bottom sediment, rocks, gravel, sand? Any debris in the water (leaves, twigs, branches, large trees)?
- ☐ Accuracy of stage level reading – Make note of wind, water turbulence, or other factors that may be affecting the accuracy of a stage level measurement
- ☐ Obstructions in the channel or backwater? Is the flow controlled or altered by channel obstructions – Ice? Debris? Weeds? Log jam? Beaver dam?
- ☐ Is the river at bank full? Out of the banks? Very low? Not flowing? Flow restricted to one side of the channel?
- ☐ Velocity – is flow fast, moderate, slow?
- ☐ Landscape observations – Is there water ponded in fields and/or ditches? Is overland flow occurring or has it occurred? Are subsurface tiles flowing?
- ☐ Canopy cover and level of development for crops, grasses, trees
- ☐ Frost presence
- ☐ Biological observations – minnow's present, dead fish, unusual species, etc.
- ☐ Were photos taken?

4.2 Photos

It is recommended to establish a set location where photos are taken at each visit. Photos should be taken upstream and downstream at each location. The channel or section control should be captured, especially if the control is affected by ice, vegetation or debris. A photo of a clear plastic bottle filled with stream water should also be collected at each visit. Figure 5 shows a good example of photos taken capturing the stream condition. Photos should also be taken of unusual or remarkable situations, such as high or low water levels, flooding, construction, excessive algae or sediment, etc. Any comments that help describe the photos should be documented.

Figure 4. Good photo examples

If using GoCanvas, the photos will be archived to the WISKI server. If there are more photos collected than the GoCanvas submission allows, those photos should be submitted to WPLMN staff by January 1, May 1, August 1 or November 1, annually. Photos can be submitted via email (size dependent) or through an online photo storage website. Photos can also be provided to WPLMN staff on a CD, DVD, or flash drive. All photo files should be labeled using the naming convention below:

SSSSSSSSdtMMDDYYss[location].jpg

SSSSSSSS – 8-digit WISKI ID (without the 'H', 'E', or 'W')

dt – the letters 'dt' for date

MMDDYY – the month, day, year the photo was taken

ss – the letters 'us' or 'ds' for upstream and downstream direction of the photo

[location] – optional description of the location

Example naming convention: 26057001dt062315ds.jpg

4.3 Laboratory chain of custody forms

Because a water sample is physical evidence, chain of custody (COC) procedures are used to maintain and document sample possession from the time the sample is collected until it is delivered to the lab for analysis. It is imperative these forms are filled out completely and accurately. Failure to do so may result in lost, compromised, or indefensible data or problems with invoicing.

If water samples are shipped to the lab, the COC should completed, signed, dated, and placed in the cooler before sealing. If water samples are delivered directly to the lab, the COC should accompany the cooler and will need a signature from the person delivering the samples as well as lab personnel receiving the cooler. If the samples are delivered to after-hours night drop-off boxes, the COC record should note such a transfer and be locked with the sealed samples inside sealed boxes.

Most labs have electronic COC, which can be useful for completing some of the required information prior to sampling. It is recommended to use these electronic forms to avoid typographical errors. Labs are required to submit analytical data directly to the MPCA using LAB_MN. There are specific fields on the COC that need to be completed in order for accurate uploading to EQuIS via Lab _MN. Appendix C shows an example COC form. The MPCA has a general COC form that can be used can be found at: https://earthsoft.com/products/edp/edp-format-for-mnpca/

4.4 Calibration log book

A calibration logbook should be established and maintained for each field meter. The logbook should contain the make, model, and serial number of the instrument. The logbook should also include all preventative maintenance, repair, and calibration procedures that are conducted on the field meter. All logbooks should include the date and the person's name who is conducting the procedure. In addition, all field meter problems must be recorded and repaired promptly.

Calibration logbook examples for YSI and HACH multi-parameter probes can be found in Appendix D and are available in alternative formats upon request.

5 Health and safety

5.1 Chemical safety

The most common acid preservatives used in water quality monitoring are sulfuric and nitric acid. Sulfuric acid is used for nutrient preservation and nitric acid is used for metals preservation. Material Safety Data Sheets (MSDS) shall be filed in an easily accessible location near the chemical storage and handling area and consulted for first aid measures and proper handling, storage and disposal requirements. General information regarding preservatives:

- When handling sample preservatives, always use extreme care; wear splash-proof goggles and non-contaminating gloves.
- Avoid contact between preservatives and skin, eyes, nose and mouth.
- Sulfuric and other acids will eat through clothing. Immediately wash shoes and clothes that come in contact with acid.
- Leave ample room at the top of the sample bottle for the addition of preservatives and room for mixing.
- Store chemicals and preservatives in a safe place. Do not store chemicals where they will be subject to temperature extremes or long-term direct sunlight. Follow storage and handling requirements spelled out in the MSDS.
- When using pre-measured preservative vials from a lab, dispose of the empty vials in a sealed plastic bag and dispose of properly. Contact the lab for specific instructions.

5.2 General sampling safety

- The safety of MPCA and local partner sampling staff is of utmost importance. Water quality samples are to be collected **only** if they can be collected using one of the defined sampling methods described in Section 6 Water Quality Sampling.
- Attend all required MPCA training prior to or within the allotted time periods before commencing with monitoring activities. Water quality samples should be collected using the sampling methods and procedures as described in this SOPG.
- Always wear a United States Coast Guard certified personal floatation device (PFD) when collecting samples directly from the stream (the wading method).
- Use past records and visual examination of current flow and depth to evaluate conditions using the rule of 10's: (max depth) X (max velocity) is less than 10.
- If the value exceeds 10, do not enter water.
- When wading to collect samples, wear hip boots or waders, which protect from the cold, pollutants, and other potentially dangerous field conditions. Be aware of your surroundings while wading; look for debris upstream, use a wading rod or walking stick, if possible, to determine what the stream is like in front of you, especially if you cannot see the bottom.
- Always let someone know where you are, your planned return time, and what to do if not back (or cannot be reached) by the appointed arrival time.
- Develop a safety plan. Determine the location and telephone number of the nearest medical centers within your defined sampling area. Determine directions on how to get from the nearest medical centers to your sites in case you need to give directions during an emergency.
- Store your wallet and keys in a safe place.
- Keys for accessing stage equipment should be on a floating key ring, separate from vehicle or office keys.
- Site accessibility and safety precautions can differ between sites. Collecting samples from a bridge with large shoulders and speeding traffic can be much different than a remote site requiring a hike into a gorge with an extended pole. In the first instance, flashers, cones and reflective wear are imperative. While in the second instance, safety precautions may involve protective outwear, waders and bug repellent. Regardless, sampling personnel are required to understand the differences in accessibility and safety precautions for each site and plan accordingly.

5.3 Road and vehicle safety

One of the most dangerous components of water quality sampling is the risk of injury posed by oncoming traffic. The Minnesota Department of Transportation (MnDOT) has guidance relating to road safety. WPLMN staff and local partners are required to abide by the requirements when working on Minnesota's roadways. Use of traffic control devices are essential and should be used as needed based on site location.

Whenever possible, park the vehicle in a nearby field approach, driveway or public parking lot. If off road parking is not available, please refer to the *Minnesota Temporary Traffic Control Field Manual January 2018* (http://www.dot.state.mn.us/trafficeng/publ/fieldmanual) for guidance. The Temporary Traffic Control Field Manual 2018 or the most up to date version must be followed. It is recommended that each person obtain a copy of the manual in the field vehicle.

Different protocols should be implemented depending on location and access to sampling site. In most situations, layouts 6 and 8 can be used. This is dependent on traffic volume and site-specific situations.

Traffic control devices

These devices are commonly used in the layout diagrams to direct and warn traffic. WPLMN staff and local partners should have these items, as needed based on-site location.

- **Vehicle warning lights** – amber in color, should be turned on when parking on the shoulder of the road and visible to drivers from 360 degrees. Vehicle warning lights attract the attention of road users and can result in a potentially hazardous situation.
- **Work zone warning sign** – a 36” x 36” ROAD WORK AHEAD sign may be needed depending on the site. Placement should be far enough from vehicle to slow traffic and give drivers adequate time to react.
- **Cones** – Must be orange, contain retro-reflective bands and be at least 36 inches high. Spend the least amount of time necessary to set up and remove the cones to limit exposure to oncoming traffic.
- **Personal Protection Gear** – High visibility safety apparel with retro-reflective material should be worn at all times. The minimum requirement is a Class 2 safety vest. In low light conditions, it is recommended to wear additional safety apparel such as a retroreflective hat and pants.

Driving safety training

The MPCA staff must complete the Defensive Driving course due to the amount of driving that is required to cover all the sampling sites every three years. The course covers how to drive safely in a variety of driving conditions. WPLMN local partners are encouraged to attend driving safety courses as needed.

Vehicle safety checklist

The following equipment should be with the sampling vehicle:

- ☐ Emergency medical kit
- ☐ Cell phone
- ☐ State road map
- ☐ Class 2 retroreflective safety apparel
- ☐ 360 degree vehicle warning beacon
- ☐ 36 inch traffic cones
- ☐ Road work sign
- ☐ Winter survival kit

5.4 Poor weather and flood conditions

Monitor current and forecasted weather conditions prior to field sampling. Extra precaution should be taken when poor weather conditions exist. Heavy snow and rain may limit visibility of the road and the traffic sharing the road. Minimize speed and possibly seek a safe place to wait out the storm. Parking on the roadside during low visibility or slippery conditions should be avoided.

Flood or high water events may cause unsafe sampling conditions. Some rivers are subject to flash flooding and should be monitored closely during a potential flood period. Remain aware of the weather conditions in the immediate area and upstream of your sampling location. Roadbed washouts can occur and are often obscured by floodwater. Do not drive through moving floodwaters (overland flow or washouts). Samples should not be collected during lightning storms. Heavy snow and ice can hide hazards, take extra caution when sampling in these conditions.

5.5 Winter sampling safety

If no open water exists at the gaging station or a relatively short distance (within 500 feet) upstream or downstream from the site, sampling through the ice should occur with the following caveats:

- Potential sampling locations should be identified prior to stream freeze up. It is helpful to have multiple locations per site chosen and documented. Often times, a sample cannot be collected at the same location throughout the winter due to ice thickness variability.
- Acceptable low velocity/shallow water sites are defined as those with velocities of no more than two feet per second and with a maximum depth of three feet.
- The sampler must wear PFD and have easily accessible ice picks. The sampler must venture cautiously on the ice progressively checking ice thickness with an ice chisel. Do not continue if the ice is less than four inches thick.
- Ice cleats or snowshoes improve traction and should be worn on boots when needed.
- Work in teams during winter conditions, especially if sampling through the ice.

6 Water quality sampling

6.1 Personnel qualifications/responsibilities

Field staff must be familiar with proper sampling techniques, sample handling, safety procedures, and record keeping. New staff must be trained and accompanied in the field by experienced staff until competence is assured. New staff will be provided procedural documents and all required equipment.

The primary water sampler is responsible for finding replacement staff while gone for an extended period of time. The regular sampling staff is required to train a substitute and ensure the backup sampling staff has all the necessary equipment to conduct sampling. The MPCA’s WPLMN staff are available to assist with training.

Training

The MPCA staff are required to complete a variety of training to ensure sound sampling practices are followed. The training includes but not limited to:

- Enterprise Learning Management – MPCA required courses
- Defensive Driving
- First Aid and CPR
- Field/Water Safety
- YSI Sonde Training

The MPCA provides classroom and field training for local partners. Additional training may be requested which include water and traffic safety, water quality and field sample collection methods, and field meter care, maintenance and calibration.

6.2 Limitations

In no case should a sampler put themselves at risk when sampling rivers. Water quality samples are to be collected **only** if defined sampling methods are adhered to. If samples cannot be collected using approved methods, sampling shall not occur.

6.3 Sampling preparation

6.3.1 Equipment preparation

Equipment should be prepared, checked and organized prior to each sampling trip. Winter equipment should be included for November through April sampling trips, depending location of sampling sites.

Clean sample containers and preservatives are provided by laboratories. Sample bottles should be checked for deformities on the threads and lids. Coolers may need to be purchased by the sampling organization. In some cases, the laboratories may provide coolers. If samples are shipped, contact the lab prior to shipping to determine cooler return procedures. Sample bottles should be ordered approximately one month prior to sampling. It is recommended to have a supply of at least three sets of extra bottles on hand. Consult with your designated laboratory on how to obtain sampling bottles. Bottles from the MDH can be ordered online at: https://survey.vovici.com/se/56206EE334A197B4.

Water samples require low-temperature storage and some samples need preservation with chemicals to maintain their integrity during shipment and before analysis in the laboratory. Some laboratories provide pre-preserved bottles filled with measured amounts of preservatives while others provide the preservative in a separate vial.

When containers and preservatives are received from the laboratory, check for leaking bottles. Be aware that many preservatives can burn eyes and skin and must be handled carefully (Section 5.1). Make sure you can tell which containers are pre-preserved, because extra care must be taken not to overfill them when collecting samples in the field. Check with the laboratory about quality control procedures when using bottles with preservatives added.

Coolers used for sample shipment must be large enough to store containers, packing materials and ice. Obtain extra coolers, if necessary. Never store coolers and containers near solvents, fuels or other sources of contamination or combustion. In warm weather, keep coolers and samples in the shade. Sampling bottles should be labeled with type of preservative used, site location, date and time. A chain of custody form should be included in the cooler that matches the site locations, date and time shown on the sample bottles.

6.3.2 Field meter calibration

Calibration is required for pH, specific conductance, and dissolved oxygen. Calibrations should be conducted weekly during the active monitoring season for pH and specific conductance. It is recommended to calibrate dissolved oxygen at the beginning of each sampling day. During baseline conditions and the winter season, calibrations should be conducted prior to sampling. The field meter should be calibrated at least monthly to ensure equipment performance. For winter storage of meters and probes, please refer to the manufacturer's guidelines. All manufacturers' recommended calibration and storage instructions should be followed. For detailed YSI and HACH calibration procedures, see Appendices E and F, respectively.

6.3.3 Equipment and supply checklist

A variety of sampling equipment is needed for surface water sample collection depending on conditions. The checklist of supplies below is a useful guide for sampling needs. Only MPCA approved sampling devices should be used.

Check all electronic equipment and batteries for proper operation. If you have any doubts about the condition of a piece of equipment, bring along a replacement, if available.

If sampling in a stream that has known aquatic invasive species (AIS), consult the *Standard Operating Procedures-Water Quality Monitoring in AIS Infested Locations* (http://www.pca.state.mn.us/index.php/view-document.html?gid=19867).

Field survival

- ☐ First aid kit
- ☐ Insect repellent (wash hands thoroughly after applying)
- ☐ Sunscreen
- ☐ Rain gear
- ☐ Personal floatation device (PFD)
- ☐ Cell phone
- ☐ GPS unit (optional)
- ☐ Replacement batteries
- ☐ Toolbox with basic tools
- ☐ Flashlight
- ☐ Safety Rope

Field equipment and documentation

- ☐ Camera
- ☐ Secchi Tube
- ☐ Weighed tape measure (in tenths)
- ☐ Calibrated field meter with pH, specific conductance, temperature and dissolved oxygen probes
- ☐ Field notebook or field sheet
- ☐ Waterproof pens and pencils
- ☐ Chain of Custody form
- ☐ MPCA's *Permit to Appropriate and Transport Water for Water Quality Sampling*

- [ ] USGS/DNR wire weight key

Surface water sampling equipment

- [ ] Sample bottles (including extra sets)
- [ ] Telescoping rod, 12 foot and/or 24 foot
- [ ] Weighted bucket and/or horizontal sampler (i.e. Van Dorn)
- [ ] Sampler spare parts for repair
- [ ] Coolers and ice
- [ ] Permanent markers
- [ ] Hip waders or wading boots

Winter sampling equipment

- [ ] Ice auger
- [ ] Auger tool box with extra blades
- [ ] Short-handled shovel
- [ ] Vertical grab sampler
- [ ] Ice chisel
- [ ] Snow shoes
- [ ] Safety ice picks
- [ ] Float coat
- [ ] Winter boots with cleats
- [ ] Slotted metal spoon
- [ ] Sand
- [ ] Lighter/matches
- [ ] Safety Rope

Equipment decontamination

- [ ] Distilled water
- [ ] Sprayer

6.4 Water quality-sampling procedures

Samples should be collected from the thalweg of the channel, approximately one foot below the surface with a weighted bucket or horizontal type sampler (such as a Van Dorn or Lab line sampler), sampling rod, or by wading and filling the sample bottles directly. WPLMN staff recommend using a Van Dorn sampler whenever possible to ensure procedural consistency. When possible, several samples should be collected on the rising limbs of all major runoff events. A sample should also be collected at or near the peak of the event as well as on the falling limb of the runoff event. During stable flow periods (moderate to low flow), sample collection frequency can be extended to once every one to four weeks depending on discharge. Winter samples are collected monthly. Site-specific hydrographs and hydrologic response times to major runoff events (to aid in determining sample collection frequency) are available. If assistance is needed in determining sampling frequency, consult the MPCA's WPLMN staff.

In general, the more altered watersheds (urban, agriculture, etc.) require more samples to accurately characterize outflow from the watershed. Shifting concentration/flow relationships can occur in all watersheds but tend to be more pronounced and/or frequent from watersheds where land use has been substantially altered from natural conditions. Field measurements can often indicate when a shift from the norm is occurring. Be aware and sample accordingly.

Collection of samples from rivers and streams involves transporting all necessary items to the water quality sampling location, setting up,   and collecting surface water samples and field instrumentation data. The stage level information should be recorded first; then recording the time on the sample bottles, field sheets and GoCanvas submission. Collection of field meter data and samples should follow shortly thereafter. Sample preservation, equipment cleaning, decontamination, and storage round out the sampling visit. Equipment should be rinsed with distilled water before moving to the next sampling location. For AIS sites, decontamination of equipment should follow protocols outlined in the *Standard Operating Procedures-Water Quality Monitoring in AIS Infested Locations* (http://www.pca.state.mn.us/index.php/view-document.html?gid=19867).

6.4.1 Cautions and interferences

Contamination of the sample can occur if a field meter or sampling device is not properly rinsed prior to sample collection. Sample contamination can also occur if the bottom sediments are disturbed during sample collection. If contamination of a sample is suspected, the sampling device should be emptied, rinsed, and resampling should occur. The sample may need to be taken from a different location in the cross-section or upstream to avoid disturbed bottom sediments. To reduce the chance of sample contamination, care must be taken to avoid touching the inner surfaces of the lid, bottle, and sampling equipment.

6.4.2 Field measurements

Field measurements should be collected with every sample and should be recorded in a field notebook or field datasheet and GoCanvas.

Field notes
Documenting additional details about the surrounding floodplain and watershed, recent weather, water conditions, and stream characteristics are helpful when analyzing the data. Section 4 provides more information about documenting conditions.

Measured Stage Level (water level measurement)
Measured stage level may be obtained by one of several methods including: reading a staff gage, measuring the distance with a wire weight gage; measuring the distance from a known reference point to the surface of the water and then subtracting this distance from the reference point elevation (tape down method).

Tape down (or bridge to water measurement) https://youtu.be/A5xMz8ViS6g

1. Locate the established reference mark (yellow arrow, chisel/marker lines, etc.) on the bridge or culvert.
2. Lower the weighted tape to the water surface. It may be difficult or impossible to take an accurate measurement during high winds.
3. Determine the length from the reference point to the water surface to the nearest 1/100th of a foot on the field sheet. Subtract this number from the established elevation and record.

4. Document error range based on field conditions. Typically a value between 0.0-0.05’, an error range attempts to provide a value with the amount of error in the tape down reading. Windy conditions and turbulent flow can make tape down measurements very difficult.

Wire weight https://youtu.be/NhkFh5sUl4A

1. Open wire weight house attached to the bridge using USGS/DNR key.
2. Carefully lower, the wire weight until it touches the water surface. If water is surging, lower the weight until it is mid distance between the peak and trough of the surging water.
3. Record the measurement.
4. Document error range based on field conditions. Typically a value between 0.0-0.05’, error range attempts to provide a value with the amount of error in the wire weight reading. Windy conditions and turbulent flow can make wire weight measurements very difficult.
    a. The error range is not a difference between the measured stage level and the gage reading.
5. If the wire weight gage is broken or inaccessible, use an alternative reference point location for collecting a tape down measurement. Site description documents from the DNR or Cooperative Stream Gaging website list alternative reference point locations. Copies of site description are also available in the gage house.

Staff gage

1. Record the staff gage reading in decimal feet.
2. Apply offset, if needed.
3. If the staff gage is tilted or tipped, take an average of the high point and low point. This is not an accurate reading so the DNR should be consulted when this occurs.
    a. Document an error range and add comments about obtaining the reading.
4. If the staff gage is dirty and accessible, use a scrub pad to remove the dirt and debris.

Gage reading from an automatic water level gage https://youtu.be/1EVMJcWQss8

1. Using the USGS/DNR key, open the gage house door.
2. Inside the gage house, there is a datalogger keypad and screen. There are two options for recording the datalogger reading: turning the display on and using the keypad or pressing a black button on the right side and scrolling through to the level value.
    a. The DNR recommends using the keypad for obtaining the stage level. Appendix G includes a tutorial for obtaining the stage level and troubleshooting help.

Field meter measurements

1. Calibrations should be conducted no more frequent than weekly and no less frequent than monthly depending on sampling season (unless in long-term storage mode). Calibrate dissolved oxygen before each daily use.
2. Prepare field meter for deployment by removing caps and adding protective guards.
3. Turn on the field meter.
    a. If the field meter is equipped with wiper blades, be sure all sensor wiper blades are operational. This is especially important during low flow conditions so any trapped air bubbles can be dislodged prior to the measurement.
4. Lower the field meter until all the probes are fully submerged in the water column. Allow the numbers to stabilize by leaving the field meter in the water while chemistry sampling is occurring. If

it is unsafe to leave the field meter in the water, fill the sampler with water and take measurements from the sampler as quickly as possible. Note this in the field notes.

5. Once stabilized, record the measurements.

Secchi tube measurement

1. Rinse the tube with sample water, using the most appropriate sampling technique.
2. Carefully fill the tube to the top with sample water.
3. Remove sunglasses and turn your back to the sun to prevent direct sunlight from entering the tube to read the tube.
4. While looking down the top of the tube, slowly pull the string to raise the disk until it reappears. Lower and raise the disk until you have found the midpoint between disappearance and reappearance of the disk.
5. Pinch the string against the side of the tube to hold the disk at the midpoint depth. Look at the side of the tube, across the top of the disk, to see the closest whole centimeter mark on.

6.4.3 Sampling parameters

- Total phosphorus
- Orthophosphate phosphorus, dissolved (only major watershed and basin sites)
- Nitrite plus nitrate nitrogen
- Total suspended solids
- Total Kjeldahl nitrogen

Additional analytes may also be collected periodically for other MPCA programs.

6.4.4 Sample bottle preparation

Depending on laboratory requirements, bottles should be labeled with the following:

- Site Name
- EQuIS ID
- Date
- Time (local time)
- If a field replicate or equipment blank is collected

For AIS sites, provide AIS identification on the bottles as specified by the lab (neon green sticker, notation, etc.).

6.4.5 Sampling methods

No single sampling procedure can be applicable to all sampling situations, therefore, no single procedure is recommended. Flowing surface water is generally sampled using one of the following methods:

- **Van Dorn sampler –** equipment is lowered to water surface using a rope. Use of a weighted bucket or Lab Line sampler may also be used.
- **Telescoping rod –** collection of sample from shore or low bridge using a bottle attached to a fiberglass-telescoping pole.
- **Hand-collected sample –** bottle in hand for collection of sample on shallow streams.
- **Vertical rod –** collection of sample through cut hole in the ice**.**

Van Dorn sampler https://youtu.be/MeWMxhHuqEI

1. Bring sampler and necessary bottles to the bridge above the sampling location where flow assures representative sample.
2. Ensure the sampler is securely attached to the rope. Rinse the sampler three times in the stream.
3. Lower the sampler into the stream. Be sure to carefully uncoil the rope, so that it does not scrape against the bridge wall or pick up excess debris from the bridge deck.
4. Once filled, retrieve the sample, taking care to avoid scraping the rope against the bridge and shaking particles from the rope into the sample.
5. Without touching the inside of the bottle or lid, pour the stream water into the sample bottles before sediment has time to settle. Be sure to leave enough space for the sample to be shaken in the laboratory; filling to the shoulder typically provides enough sample volume and enough headspace. Add preservative, if needed.
6. Repeat Steps 3 through 5 if additional samples are needed. If collecting a field replicate for a quality control check, remember to fill these bottles from a separate dip of the sampler.
7. Return to the vehicle from the sampling site and place the samples in a cooler with ice.

Telescoping rod https://youtu.be/6oDez3aWi-0

1. Bring telescoping rod and necessary bottles to the shoreline adjacent to the sampling site where flow assures representative sample.
2. Ensure the collection bottle on the rod is securely attached. Rinse the bottle three times in the stream.
3. Extend the telescoping rod to the length necessary to reach the point of flow. Dip the rod into the water with the bottle opening facing the water.
4. Invert the bottle and fill from just below the water surface.
5. Carefully retract the rod and bring the collection bottle to shore.
6. Remove the lid from the sample bottle.
7. Without touching the inside of the bottle or lid, pour the contents of the collection bottle into the sample bottle. Be sure to leave enough space for the sample to be shaken in the laboratory; filling to the shoulder typically provides enough sample volume and enough headspace. Add preservative, if needed.
8. Repeat Steps 3 through 6 if additional samples are needed.
9. Return to the vehicle from the sampling site and place the samples in a cooler with ice.

Hand-collected sample https://youtu.be/mqHYARlnYOk

1. Enter the stream downstream of the sampling location. Be sure to bring enough bottles to collect the proper aliquot of water necessary for lab analysis.
2. Walk upstream to the sampling location where flow assures representative sample.
3. Remove the lid from the sample bottle.
4. Facing upstream and without touching the inside of the bottle or lid, lower the bottle upside down into the stream.
5. Invert the bottle just below the water surface and allow it to fill. Be sure to leave enough space for the sample to be shaken in the laboratory; filling to the shoulder typically provides enough sample volume and enough headspace.
6. Raise the bottle to the surface, taking care to avoid any surface material.

7. Add preservative (if needed) and cap the bottle.
8. Repeat Steps 3 through 7 for any additional bottles.
9. Return to the vehicle from the sampling site and place the samples in a cooler with ice.

6.4.6 Quality assurance/Quality control (QA/QC)

Field replicates and equipment blanks should be collected throughout the monitoring season to ensure consistency in field and lab procedures.

The MPCA WPLMN staff should collect one field replicate for every 10 samples collected. WPLMN local partners are required to collect two field replicates at subwatershed sites and three major watershed or basin sites each year. Guidelines for collecting a field replicate:

a. Label bottles as noted under Section 6.4.4; add 'FR' on the label, to identify the sample as a field replicate. The time should be recorded 1 to 5 minutes after the original sample is collected.
b. Collect the sample using the one of the methods described in Section 6.4.5.
c. Add preservative, if needed and place sample bottles in coolers with ice.
d. Be sure to note the appropriate *Sample Type* on the chain of custody form for a field replicate. See Appendix C for an example COC that illustrates the changes when doing a field replicate.

One equipment blank should be collected at one site one time per year for MPCA's WPLMN staff and local partners. Guidelines for collecting an equipment blank:

a. Label the bottle as 'Blank' to identify the sample as a equipment blank. The time should be recorded as 1-5 minutes after the original sample is collected.
b. Rinse sampler three times with distilled water.
c. Fill the sampler a fourth time with distilled water and pour into the sample bottles.
d. Add preservative, if needed and place sample bottles in coolers with ice.
e. Be sure to note the appropriate *Sample Type, Sampling Method, Lab Matrix and Field Matrix* on the chain of custody form for an equipment blank. See Appendix C for an example COC that illustrates the changes when doing an equipment blank.

6.4.7 Winter sampling

Winter water quality samples are to be collected only if methods described below can be followed. If conditions cannot be met, please contact MPCA's WPLMN staff to discuss further options. See Section 5.5 for Winter Safety guidelines. Sampling staff are required to wear a PFD, such as a float coat; they must carry ice picks and frequently check the ice thickness using an ice chisel. It is also important to dress accordingly so that weather is not a safety concern. It is recommended that winter sampling be conducted with two staff.

Winter sampling locations may be open, partially open (shore ice with open water at the thalweg or riffles), or completely frozen. The extent of freeze-up will determine which low risk to human safety method is followed. All sites should be evaluated prior to winter freeze-up to determine if the site needs to be relocated. If the site needs to be relocated, the potential winter sampling location needs to be evaluated for water depth, water velocity, slope, streambed material, and winter sampling access.

Open water sampling

Samples should be collected from the thalweg of the channel, approximately one foot below the surface using the one of the methods described in Section 6.4.5.

Partially frozen water sampling
If the regular sampling methods for a site cannot be used due to frozen water at the sampling location, the sampling location can be moved upstream or downstream 500 feet. Once open water is located at a safe location, open water-sampling procedures should be followed.

Frozen water sampling
If the primary sampling location is frozen and a nearby open water location does not exist, sampling may occur through the ice in shallow water. An ice chisel is essential to determine if the ice is safe to walk on. While walking to your sampling location, continuously check the ice depth in front of you. **Do not** continue if the ice is less than four inches thick. Water depth and velocity for winter sampling need to be determined in the summer and fall reconnaissance (note: landmarks such as rocks, staff gage, etc.). Acceptable shallow water sites are those with a maximum depth of three feet and a maximum velocity of two feet per second or less.

a. Once a safe location is determined, use an auger to drill a hole into the ice. Using sharp blades will minimize time spent on the ice. Take care when breaking though the ice to minimize disturbing the bottom sediment. At shallow sites, it is recommended to wait 5 minutes or more before collecting a sample to ensure a representative sample.

b. Using the metal slotted spoon, scoop all the ice and debris from the hole.

c. Bale the hole to ensure fresh, uncontaminated stream water is collected for analysis.

d. Grab a sample using a vertical rod or using the hand dip method. Surface water samples must be collected from flowing water; avoid sampling in stagnant or backwater.

e. Add preservative, if needed and place sample bottles in coolers with ice.

6.5 Post-trip requirements

Once the sampling route is complete and the sampler has returned to the office, all samples should be removed from the vehicle and prepared to be shipped to the laboratory for analysis within specified holding times.

Table 1. Laboratory holding time by analyte

Parameter	Preservation	Holding Time
Total suspended solids	<6°C	7 days
Dissolved orthophosphate phosphorus	<6°C	48 hours
Total phosphorus	<6°C and 10% H_2SO_4	28 days
Nitrate-Nitrite nitrogen	<6°C and 10% H_2SO_4	28 days
Total Kjeldahl nitrogen	<6°C and 10% H_2SO_4	28 days

Minnesota Department of Health laboratory:

1. Unload all samples from vehicle and transfer to a refrigerator or prepare the cooler for shipping to the MDH lab. The cooler should have enough ice to keep the samples cold until they reach the MDH lab.
2. Fill out the MPCA's MDH COC completely. See Appendix C for an example.
    a. Program code is TA. Add sampler name and phone number to the appropriate fields. The MPCA PM should be the WPLMN Coordinator.
    b. Only one Project ID can be used per lab sheet. The Project ID for the WPLMN is PRJ00330.
    c. Include the location ID, field name/lake name, date, and time. Print legibly – these sheets will be hand entered into a database at a later date.
    d. Quality assurance samples must be recorded in their own column. Be sure to include the Quality Assurance code (FR: field replicate and EB for equipment blank).
    e. Include the Analysis Group Code. The code for the major and basin sites is TA-12 and TA-11 for subwatershed sites. If other analysis is requested, include those analytes and check the boxes under the same column.
    f. Upon completion of the COC, be sure to sign and date. The signed lab sheets are to be placed in the outgoing lab sheet folder on the cooler at the Field Operation Center at the MPCA office. If shipped to the MDH lab, place COC in a Ziploc bag and taped to the inside of the cooler.
3. Be sure all lids on the samples are tight and that the cooler is taped closed.

Master contract laboratories

1. Unload all samples from vehicle and prepare the cooler for shipping or delivery. The cooler should have enough ice to keep the samples cold until they reach the designated lab.
2. Fill out the Chain of Custody sheet if it has not already been done. A sample COC can be found in Appendix C. Please note the following:
    a. The Project ID for the WPLMN is PRJ00330.
    b. Include the field name, sample ID, date, time and purchase order number. Print legibly to ensure proper laboratory sample analysis, tracking and billing.
    c. QA/QC samples should be properly identified.
    d. Check the boxes for the analytes requested or enter the analytes in the column headings. Be sure you check the boxes under the same column in which you entered the sample information. Currently, analytes include NO_3+NO_2-N, TKN, TP, and TSS. DOP is only analyzed at major watershed and basin sites.
    e. Include the number of bottles submitted, collection method and other required information.
3. Sign and date the Chain of Custody.
4. Samples should be either shipped or delivered to the respective master contract laboratories.

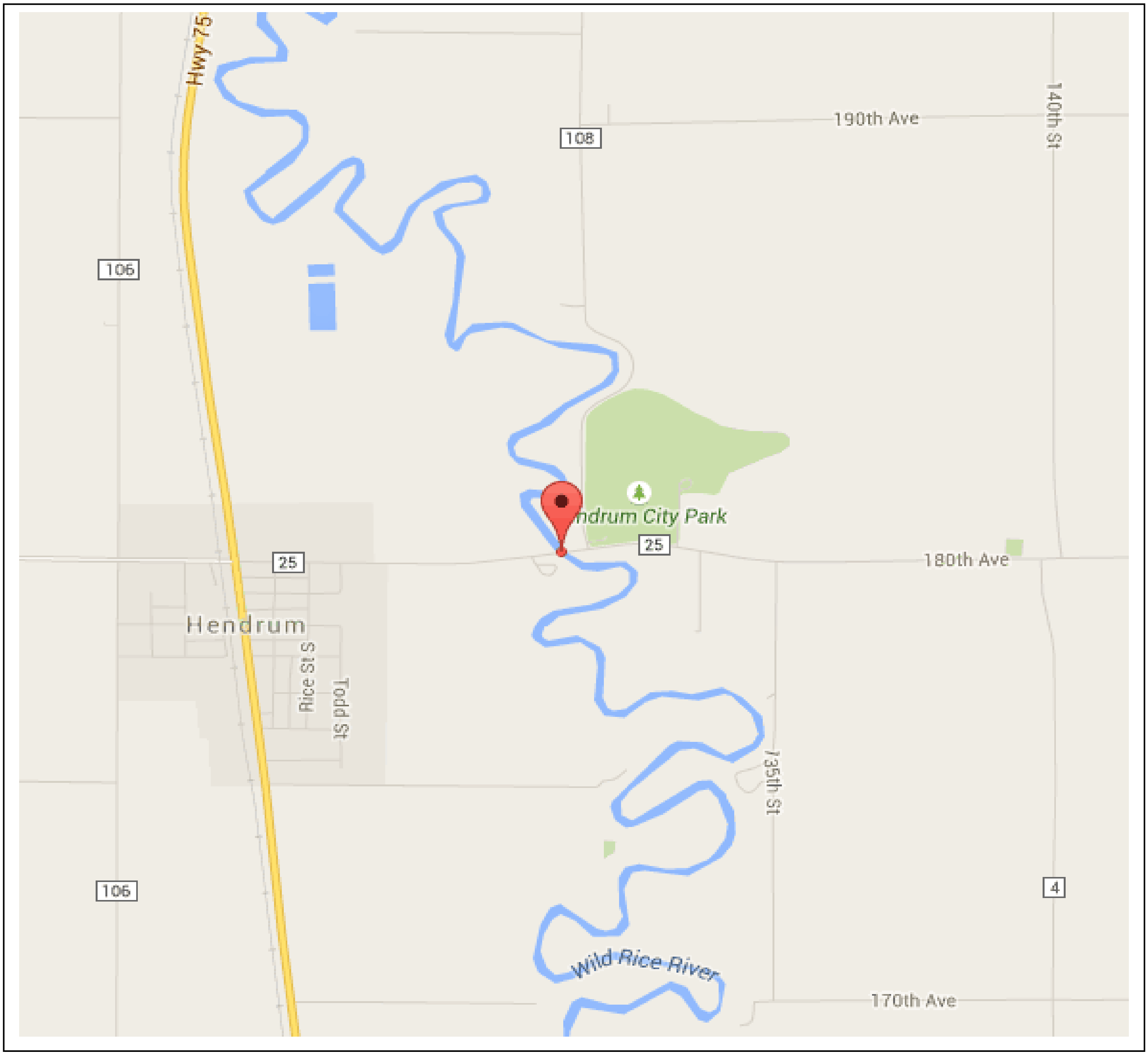
Appendix A – Site information

Wild Rice River nr Hendrum, CSAH25

EQuIS ID: S002-102

Lat/Long: 47.266767, -96.796939

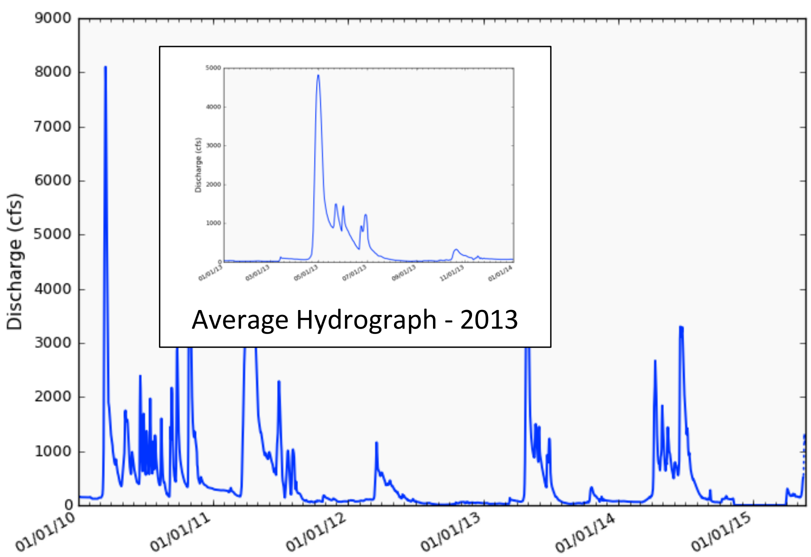
WISKI ID: E60112001



Directions from Borup:

1. Head west on CSAH39 for 13.8 miles.
2. Turn right (north) on US75 for 6.0 miles.
3. In Hendrum, turn right (west) on CSAH25 for 0.7 miles

Flow Data http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=ge



SAMPLING FREQUENCY

Avg rise: 5-8 days **Avg fall**: 10-15 days

3+ samples per event – rise, peak and fall

Avg # of storm events/year: 4

High Stage: 16 ft **High Flow**: 8,000cfs

NOTES:

SAFETY CONCERNS

The road is not very busy with traffic, wear a safety vest, cone and flashers on the car.

SAMPLING LOCATION

Summer : Sample from the upstream side of the bridge in the thalweg. **Winter:** Samples are collected about 20 ft from the old upstream, right bank bridge pier.

STAGE READING

A USGS WWG measurement is taken at the downstream side of the bridge.

SAMPLING EQUIPMENT

Appendix B – Field datasheets

WPLMN Field Sheet

WISKI ID:	EQuIS ID:	Site Name:
Sampler Name:		

Date (MM/DD/YY)		Water Temp (C)	
Military Time		DO (mg/L)	
Level (Stage) method	Staff WWG BTW	DO saturation (%)	
RM Used (RM1, RM2, etc)		pH	
RP elevation (ft)		Specific Conductance (uS/cm)	
Bridge-to-Water (ft)		Secchi Tube (cm)	
Measured Stage Level (ft)		Photos taken	Yes No
Logger Gage Height (ft)		Rained in the last 24 hrs?	Yes No Amount:
Difference (MS-GH)		Current precipitation	none light rain heavy rain sleet snow
Logger voltage		Thunder present	Yes No
Staff Gage (ft)		Air Temperature (F)	
Datum Offset (ft)		Wind Conditions	Calm Light (5-10 mph) Moderate (11-20 mph) Very Windy (21+ mph) Gusty or variable
Error Range			
Error Range Description	Wind Turbulent Human RM edge Kinked tape Other:	Cloud Cover	Sunny Mostly sunny (6-25%) Partly Cloudy (26-50%) Partly Sunny (51-69%) Mostly cloudy (70-87%) Cloudy (88%+)

Sample Collection Procedure	Bottle Van Dorn Rod Ice Rod Weighted Bucket Bucket
QA Sample	FD EB Time:
Out of Banks? Yes No	US Left Bank US Right Bank DS Left Bank DS Right Bank
Backwater present?	Yes No
Any debris in the water? Yes No	leaves twigs branches large trees crop residue
Stream stage trend	Rising Falling Stable Unknown
Appearance	Clear Tea Color Cloudy Muddy Green Muddy & Green
Recreational Suitability	Very Good Good Fair Poor Very Poor
Stream condition	High Normal Low Zero Flow // Swift Moderate Slow // Clear Muddy Other
Type of Ice	Anchor Ice Sheet Ice Shore Ice
Ice cover (%):	Ice thickness (in):
Control type	Riffle Section Channel Overbank
Control condition	Clear Ice Vegetation Debris Scour Deposition
Amount of Vegetation or Debris	Light Moderate Heavy
Other Comments (runoff source - overland, tile, snowmelt; description of control condition; reason for visit - water sampling or site visit)	
Sonde SN:	Handpad SN:

Watershed Pollutant Load Monitoring Network Field Sheet

Sampler name: **Sonde SN:** **Handpad SN:**

	A	B	C	D	E
EQuIS ID					
WISKI ID					
Site Field Name					
Date (MM/DD/YY)					
Military Time (hh:mm)					
QA Sample (FD, EB)					
QA Sample Time					
Sample Device: Bottle; Van Dorn; Rod; Ice Rod; Bucket; Weighted Bucket					
Sample Device					
Level (Stage) Method	Staff WWG BTW	Staff WWG BTW	Staff WWG BTW	Staff WWG BTW	Staff WWG BTW
RM Used					
RP Elevation (ft)					
BTW (ft)					
Measured Stage Level (ft)					
Logger Gage Height (ft)					
Difference (MS-GH)					
Staff Gage (ft)					
Datum Offset (ft)					
Logger Voltage					
Error Range (ft)					
Error Range description	Windy Turbulent RM edge Kinked tape Human Other:	Windy Turbulent RM edge Kinked tape Human Other:	Windy Turbulent RM edge Kinked tape Human Other:	Windy Turbulent RM edge Kinked tape Human Other:	Windy Turbulent RM edge Kinked tape Human Other:
Control Type	Riffle Section Channel Overbank	Riffle Section Channel Overbank	Riffle Section Channel Overbank	Riffle Section Channel Overbank	Riffle Section Channel Overbank
Control Condition	Clear Ice Veg Debris Scour Deposition	Clear Ice Veg Debris Scour Deposition	Clear Ice Veg Debris Scour Deposition	Clear Ice Veg Debris Scour Deposition	Clear Ice Veg Debris Scour Deposition
Amount of Debris or Vegetation	Light Moderate Heavy	Light Moderate Heavy	Light Moderate Heavy	Light Moderate Heavy	Light Moderate Heavy
Type of Ice	Shore Anchor Sheet	Shore Anchor Sheet	Shore Anchor Sheet	Shore Anchor Sheet	Shore Anchor Sheet
Ice Cover (%)					
Ice Thickness (in)					
Backwater Present?	Yes No	Yes No	Yes No	Yes No	Yes No
Water Temp (°C)					
DO (mg/L)					
DO saturation (%)					
pH					
Sp. Conduct. (uS/cm)					
Secchi Tube (cm)					
Appearance: 1A-Clear 1B-Tea-colored 2-Cloudy 3-Muddy 4-Green 5-Muddy & Green					
Appearance					
Recreational Suitability: 1-Very Good 2-Good 3-Fair 4-Poor 5-Very Poor					
Recreational Suitability					

Appendix C – Chain of Custody Help

Minnesota Pollution Control Agency

MPCA Chain-of-Custody Form

* indicates a required field

Work Order Number: | COC Type: Standard | Page: 1 of 1

Turnaround Time: Standard | COC ID:

PROJECT/CLIENT INFO | LABORATORY | FOR LAB USE ONLY

Facility | Project N | Project Ma | Potential H | Lab Work Order Sticker

WPLMN samplers (complete yellow highlighted areas):

1. Add MN Location ID (EQuIS ID), Field Name, date, time, AIS, any comments and analysis required for each sample.
2. Enter name, organization, and phone #. Please type or write legibly.
3. Sign on Sampler signature line.
4. Complete the billing information. If Account number starts with a 0, use "#" first. Ex: # 025478 versus 25478
5. Add Courier name, if shipping.
6. Sign and date on Relinquished By line.

SAMPLE TYPES
Sample=Routine Sample
QC-FB=Field Blank Sample
QC-FR=Field Replicate Sample
QC-TB=Trip Blank Sample
QC-EB=Equipment Blank
Trtmnt-Mid=Treatment system sample
Trtmnt-Post=Treatment system sample

D-T=Discrete,time-paced w/AS
D-F=Discrete,flow-paced w/AS
SW-GAS=Gas Sampling
Unknown=Unknown

Air=Air

QC-BLANK=Artificial Blank Water
Leachate=Leachate Sample
Air-Indoor=Indoor Air
Gas-Soil=Soil Gas

MN Location Identifier*	Field Name	Sample Type*	Start Date* (mm/dd/yyyy)	Start Time* 24 hr (hh:mm)	Depth: Start	Depth: End	Units (m or ft)	Sampling Method*	End Date (mm/dd/yyyy) (Complete ONLY if Method is CT, CF, D-T, or D-F)	End Time 24 hr (hh:mm)	Lab Matrix*	Field Matrix*	AIS	Sampler Comments (filter volume, special handling, etc.)	# of Cont	ANALYSIS*	TP	TKN	NO3-NO2-N	TSS	DOP		Lab Sample No.	#
		Sample						G			NW	Wtr-Surf			2									1
		Sample						G			NW	Wtr-Surf			2									2
Documenting a field duplicate: Changes noted in orange.																								3
S002-193	Clontarf	Sample	3/2/2018	13:15				G			NW	Wtr-Surf	N		2		X	X	X	X				4
S002-193	Clontarf	QC-FR	3/2/2018	13:20				G			NW	Wtr-Surf	N		2		X	X	X	X				5
Documenting an equipment blank: Changes noted in orange.																								6
	Blank	QC-EB	3/2/2018	12:00				QC-Blank			OT	QC-Blank	N		2		X	X	X	X				7
Two samples collected at the same site, different days need an unique identifier in Comment and on bottles.																								8
S002-193	Clontarf	Sample	3/2/2018	13:15				G			NW	Wtr-Surf	N	A	2		X	X	X	X				9
S002-193	Clontarf	Sample	3/4/2018	8:20				G			NW	Wtr-Surf	N	B	2		X	X	X	X				10

Sampler's Name:* | Phone#: | Billing Organization: | Acct#:

Sampler's Signature:* | Address:

Sampler's Organization: | Courier Name: | Tracking#:

Receiving Comments:

Relinquished By/Affiliation	Date/Time	Accepted By/Affiliation	Date/Time
(Sampler)			

MDH Lab COC for MPCA's WPLMN Samplers

Minnesota Pollution Control Agency

COC Type: Standard | Page: 1 of 1

PROJECT/CLIENT INFO

Facility Code:*	MNPCA	Program Code (MDH Lab Only):	TA
Project Name:*	Watershed Pollutant Load Monitoring Network	Project Task Code:*	PRJ00330
Project Manager:	Patrick Baskfield	507-344-5240	patrick.baskfield@state.mn.us
Potential Hazard?	N	If yes, add information to Sampler Comments field	

LABORATORY

Lab Name:	MDH
Address:	601 Robert Street N, PO Bo
	St. Paul, MN 55164
EPA Lab ID:*	MN00006

MPCA WPLMN samplers (complete yellow highlighted areas):

1. Add MN Location ID (EQuIS ID), Field Name, date, time, AIS and any comments for each sample.
   TA-12 is for basin and major watershed sites (includes DOP).
   TA-11 is for subwatershed sites.
2. Enter name, organization, and phone #. Please type or write legibly.
3. Sign on Sampler signature line.
4. Sign and date on Relinquished By line.
5. If you have more than 1 COC, update page # in upper right.

SAMPLE DETAILS

SAMPLE TYPES
Sample=Routine Sample
QC-FB=Field Blank Sample
QC-FR=Field Replicate Sample
QC-TB=Trip Blank Sample
QC-EB=Equipment Blank
Treated-Mid=Treatment system sample
Treated-Post=Treatment system sample

SAMPLING METHODS
G=Grab sample
CT=Composite, time-paced w/AS
CF=Composite w/AS
D-T=Discrete, time-paced w/AS
D-F=Discrete, flow-paced w/AS
SW-GAS=Gas Sampling
Unknown=Unknown

LAB MATRICES
DW=Drinking Water
NW=Nonpotable Water
SD=Soil/Solid
AR=Air
BL=Biological Material
OT=Other
TS=Tissue

FIELD MATRICES
Wtr-Ground=Groundwater
Wtr-Surf=Surface Water
Wtr-Drink=Drinking Water
QC-BLANK=Artificial Blank Water
Leachate=Leachate Sample
Air-Indoor=Indoor Air
Gas-Soil=Soil Gas

MN Location Identifier*	Field Name	Sample Type*	Start Date* (mm/dd/yyyy)	Start Time* 24 hr (hh:mm)	Depth Start	Depth End	Units (m or ft)	Sampling Method*	End Date (mm/dd/yyyy) (Complete ONLY if Method is CT, CF, D-T, or D-F)	End Time 24 hr (hh:mm)	Lab Matrix*	Field Matrix*	AIS	Sampler Comments (filter volume, special handling, etc.)	# of Cont	ANALYSIS* / PRESERV. FF	TA-12 (None & H2SO4: N)	TA-11 (None & H2SO4: N)					Sample No.	#
		Sample						G			NW	Wtr-Surf			2		X							1
		Sample						G			NW	Wtr-Surf			2			X						2
Documenting a field duplicate: Changes noted in orange.																								3
S002-193	Clontarf	Sample	3/2/2018	13:15				G			NW	Wtr-Surf	N		2			X						4
S002-193	Clontarf	QC-FR	3/2/2018	13:20				G			NW	Wtr-Surf	N		2			X						5
Documenting an equipment blank: Changes noted in orange.																								6
	Blank	QC-EB	3/2/2018	12:00				QC-Blank			OT	QC-Blank	N		2		X							7

Sampler's Name:*		Phone#:	
Sampler's Signature:*			
Sampler's Organization:			

Billing Organization:	MPCA	Acct#:	
Address:	520 Lafayette Rd N St. Paul, MN 55155		
Courier Name:	Spee-Dee	Tracking#:	

Receiving Comments:

Relinquished By/Affiliation	Date/Time	Accepted By/Affiliation	Date/Time
(Sampler)			

Appendix D – Calibration sheets

WPLMN Daily Dissolved Oxygen Calibration Log Sheet

Sonde Model #: ________________ Sonde Serial #__________ Handpad Serial #: __________________

Date	Time	Barometric Pressure*	%DO Sat Initial	%DO Sat Final	Gain/Slope	Technician

*Please include units.

WPLMN YSI Sonde Calibration Sheet

Date: ________________ Time: ____________ Technician: __________________________

Sonde Model #: ____________ Sonde Serial #: ___________________ Handpad Serial #: _______________

Battery voltage: ____________ Spec. cond. solution temp: __________ Barometric pressure: _____________

Record the following diagnostic numbers after calibration:

		Range
Spec. cond. cell constant	___________	**5.0 ±0.5**
pH mV Buffer 4	___________	**180 ±50 mV**
pH mV Buffer 7	___________	**0.0 ±50 mV**
pH mV Buffer 10	___________	**-180 ±50 mV**
pH Span	___________	**165 – 180 mV**

Note: mV span between pH 4-7 and 7-10 should be ~165 to 180 mV.

DO charge	___________	**50 ±25**
DO gain	___________	**1.0 (-0.3 to 0.5)**

Record Calibration Values

	Before Calibration	After Calibration	Temp Correction
Spec. cond.	_________	___________	NA
pH 4	_________	___________	________
pH 7	_________	___________	________
pH 10	_________	___________	________
LDO	_________	___________	NA

Sonde Temperature Check:

Last Date Checked _________

Sonde _________ NIST-traceable thermometer ________

Standard	Cat. Number	Lot Number	Expiration Date	Date Opened
Specific Conductance:				
pH 4:				
pH 7:				
pH 10:				

	Vendor/Model & Date Purchased:	Serial #:	Vendor Calibration Date:
NIST Traceable Thermometer:			

Notes: Document the temperature corrected pH, which is dependent on specific conductance calibration solution temperature. The label on the pH buffer charts the buffer strength incrementally against buffer temperature.
The conversion for barometric pressure is (Inches of Hg x 25.4 = mm Hg).

Was there maintenance completed? Yes No If yes, explain:

Date: ____________

Meter Model and Serial #: ____________

Meter Purchased: ____________

Battery Voltage: ____________

Technician:

Specific Conductance	
Calibration Standard:	____________
Date purchased:	____________
Expiration date:	____________
Last calibration date:	
Calibration results	
Conductivity:	____________
Temperature:	____________
K:	

Dissolved Oxygen	
Last calibration date:	
Calibration results	
Percent saturation:	____________
DO:	____________
Temperature:	____________
Slope:	____________
Offset:	____________
Pressure (hPa)	

Replacement Parts	**Date**
LDO sensor cap	____________
LDO iButton	____________

pH
Calibration Standard (7):
Date purchased:
Expiration date:
Last calibration date:
pH:
Temperature:
milliVolts (0 ±30 mV):
Calibration Standard (10):
Date purchased:
Expiration date:
Last calibration date:
pH:
Temperature:
milliVolts (-180 ±30 mV):
mV difference of pH 7-10
Span between should be about 165 -180 mV
Slope mV/pH: (should be close to -58.0)
Slope %: (about 98 to 103% at 25 °C)
Offset mV: (should be close to 0.00)
r^2: (should be close to 1.000)

Notes:

NIST Traceable Thermometer:	
Vendor/Model:	
Date Purchased:	
Serial #:	
Vendor Calibration Date:	

HACH meter calibration sheet

Date:	
Meter Model and Serial #:	
Meter Purchased:	
Battery Voltage:	
Technician:	

Specific Conductance	
Calibration Standard:	
Date purchased:	
Expiration date:	
Last calibration date:	
Calibration results	
Conductivity:	
Temperature:	
K:	

Dissolved Oxygen	
Last calibration date:	
Calibration results	
Percent saturation:	
DO:	
Temperature:	
Slope:	
Offset:	
Pressure (hPa)	

Replacement Parts	**Date**
LDO sensor cap	
LDO iButton	

NIST Traceable Thermometer:
Vendor/Model:
Date Purchased:
Serial #:
Vendor Calibration Date:

pH	
Calibration Standard (7):	
Date purchased:	
Expiration date:	
Last calibration date:	
pH:	
Temperature:	
milliVolts (0 ±30 mV):	
Calibration Standard (10):	
Date purchased:	
Expiration date:	
Last calibration date:	
pH:	
Temperature:	
milliVolts (-180 ±30 mV):	
mV difference of pH 7-10	
Span between should be about 165 -180 mV	
Slope mV/pH: (should be close to -58.0)	
Slope %: (about 98 to 103% at 25 °C)	
Offset mV: (should be close to 0.00)	
r^2: (should be close to 1.000)	

Notes:

Appendix E – YSI calibration procedures

his procedure describes the field sonde calibration methods followed by the WPLMN. Standardization of calibration methods is essential for quality control and assurance. Field data is collected at designated stream monitoring sites for the purpose of assessing water quality. Field data is collected in conjunction with a field visit and sampling event.

Scope and limitations

This procedure applies to field sondes used by the MPCA's WPLMN staff and local partners. Standardization of equipment is also essential for quality control and assurance. The MPCA's WPLMN staff is issued standard field equipment consisting of a multi-parameter sonde and the following field probes: temperature, specific conductance, pH, and optical dissolved oxygen. Calibration is required daily for the optical dissolved oxygen probe and once a week for the remaining probes. Ideally, all sonde probes would be calibrated daily, before and after sampling, but cost of the traceable standards inhibits this calibration frequency.

Requirements

Staff qualifications

The MPCA's WPLMN staff and local partners must be familiar with basic chemistry and able to show proficiency in the calibration methods discussed in this protocol. Important acquired skills and knowledge include experience in operating, maintaining and calibrating water quality testing equipment. Troubleshooting equipment malfunction requires staff to observe, note and investigate potential deviations that may lead to equipment malfunction. For example, erratic or unstable readings indicate a deviation in normal probe performance and should be noted and investigated. Calibration results may fall within acceptable limits but the probe may be coming to the end of its useful life expectancy.

Safety equipment

When calibrating, there may be exposure to chemical buffers, solutions and dispersions. Protective eyewear is required when working with chemicals and an easily accessible eyewash shall be made available in the laboratory environment.

Responsibilities

Field staff

Implement the procedures outlined in the action steps and ensure that the data generated meets the standards and objectives of the WPLMN.

Management staff

Provide adequate training and standard equipment capable of producing acceptable results.

Quality assurance and quality control

Compliance with this procedure will be determined by performing annual internal reviews. In addition to adhering to the specific requirements of this calibration protocol and any supplementary equipment specific procedures, the minimum quality assurance and quality control requirements for this activity are as follows:

Control of deviations

Deviation in initial sensor readings, optical dissolved oxygen gain, conductivity cell constant and delta pH mV will influence precision and accuracy and shall be investigated. Deviation shall be sufficiently documented to allow for thorough investigations in light of suspect data. Acceptance criteria are noted on the calibration worksheet and shall be adhered to. Unacceptable calibration results require recalibration and may involve equipment maintenance or replacement.

Calibration standards

Only certified, traceable calibration standards are used in the calibration process. Standard manufacturer, stock number, lot number, expiration date and opened date are documented on the calibration worksheet. Expired standards are not used and are properly discarded. pH buffer expires after six months of the date opened. Conductivity solution expires one month of opening. Initial calibrant readings must be within the acceptable limits for that parameter.

Verification

The MPCA WPLMN staff will conduct annual reviews of calibration log worksheets to ensure calibrating field equipment is in accordance with this protocol. If an outlier is identified, further investigation will be conducted.

Training

The MPCA's WPLMN staff and local partners shall receive instruction from field meter manufacturer. Major revisions in this procedure require that all personnel be re-trained in the revised protocol by experienced personnel.

Trainers will provide in-lab training or verification in the case of previously trained personnel.

Procedure

Equipment operation and maintenance

This procedure assumes that the equipment has been maintained in accordance with the manufacturer's specifications and is in proper working condition. Sealed clean probes, charged batteries and o-ring lubrication and replacement are examples of proper maintenance and condition.

Warm-up period

Turn the sonde on and begin a discrete run. The sonde should be on and in run mode for at least 15 minutes prior to calibration initiation.

Cleaning and rinsing

The equipment must be thoroughly cleaned and rinsed prior to calibration.

1. Rinse the sonde barrel, the probes and the cal cup with warm tap water.
2. Clean the conductivity probe nickel electrodes with the provided brush.
3. Wipe the pH probe bulb and the optical probe lens with a new Q-tip.
4. Add one drop of liquid soap to the cal cup and mix while filling with room temperature water.
5. Place the cal cup over the probes and activate 'clean optics' for wiper and lens cleaning.
6. Rinse the sonde barrel, the probes and the cal cup with warm tap water.
7. Fill the cal cup with warm tap water, submerse the probes and activate 'clean optics'.
   Rinse the barrel, probes and cal cup with de-ionized water.

Calibration standard rinse

Prior to each probe calibration step, the barrel, probes and cal cup are thoroughly rinsed with the standard. Previously used standard solutions are saved and used in this standard rinse or wash step.

Conductivity sensor calibration

The conductivity probe should be calibrated weekly during the primary field season. A one-point calibration is performed with a 1.0 mS/cm standard solution. It is recommended to calibrate this probe first.

1. Calibrate conductivity as specific conductance. Temperature corrections are made and results are reported at 25°C.
2. Ensure the standard solution is at ambient room temperature.
3. Enable the specific conductance output.
4. Rinse the cal cup and sensors with the 1.0 mS/cm conductivity wash solution and discard.
5. Fill the cup with working standard so that the conductivity sensor (including vent hole) is completely submerged in standard solution.
6. Record solution temperature. The temperature is used during the pH calibration.
7. Record the initial specific conductance and the calibrated specific conductance on the worksheet.
8. When the calibration has been accepted, document the conductivity cell constant. The acceptable range for the YSI 6560 probe is 5.0 +/- 0.5.
9. If initial conductance readings or the conductivity cell constant does not fall within the acceptable limits, investigate and recalibrate.
10. Do not use a probe that has given "Calibration Error" or "Out of Range" warnings.

pH probe calibration

The pH probe should be calibrated weekly during the primary field season.

1. Select the appropriate buffers to bracket the expected sample pH. Either pH 4 and pH 7 buffers Often pH 7 and pH 10 buffers are used in a two-point calibration. In certain parts of the state or if the expected pH is unknown, a three point calibration with pH 4, 7, and 10 buffers may be used.
2. Ensure the standard solutions are at ambient room temperature.
3. Enable pH and pH mV output.
4. Recondition or replace the probe if a slow response has been reported.
5. Rinse the cal cup and sensors with the pH 7 wash solution and discard.
6. Fill the cup with pH 7 working buffer so that the pH probe and temperature probe are submerged.

7. Record the initial pH value, the calibrated pH value and the mV reading. Always start with pH buffer
8. Rinse the cal cup and sensors with de-ionized water and repeat Steps 5-7 with pH buffer 10.
9. Record the slope of the sensor by determining the mV span (delta mV) between the two calibration points. The acceptable range is 165 – 180 mV.
10. If initial pH or delta mV does not fall within the acceptable range, investigate and recalibrate.
11. Do not use a probe that has given "Calibration Error" or "Out of Range" warnings.

Optical dissolved oxygen probe calibration

The optical dissolved oxygen (ODO) probe should be calibrated daily. A one-point calibration is performed based on water-saturated air. The cal cup is filled with water to approximately a half to one inch from the bottom of the ODO probe.

Enable the ODO sat% and ODO mg/L outputs.

1. Allow the ODO output to stabilize prior to calibration.
2. Once stabilized, dry the temperature probe and the surface of the diffusion layer.
3. Replace the cal cup and allow for output re-stabilization. The cal cup should be place over the probe and make a half revolution turn, it is important not to pressurize the cal cup. Let the DO stabilize for about 15 minutes.
4. Once stabilized, calibrate.
5. When the calibration has been accepted, document the ODO sat % gain. The acceptable range for the YSI 6150 probe is 1.0 +/- 0.3.
6. Record the initial and calibrated ODO sat %, atmospheric pressure and ODO sat % gain in the calibration log.
7. If the ODO gain does not fall within the acceptable range, investigate and recalibrate.
8. Do not use a probe that has given "Calibration Error" or "Out of Range" warnings.

Temperature probe check

Temperature should be verified at least twice per year. A NIST-traceable thermometer must be used. NIST-traceable thermometers should be accurate to ±0.3°C. A liquid-in-glass or digital thermistor may be used. NIST-traceable thermometers should be replaced or sent in every five years to have lab calibrate over a range of 0°C to 40°C.

1. Fill large vessel with tap water and allow stabilization for 24 hours in order to reach ambient temperature.
2. Place the NIST-traceable thermometer and YSI sonde in a room temperature bath for at least two minutes or until the temperature stabilizes. The temperature sensor is located on the specific conductance probe. The thermometer should be as close as possible to the temperature sensor on specific conductance probe. It may be helpful to use tape or a rubber band to secure the thermometer to the probe.
3. Record the NIST-traceable thermometer and YSI sonde temperature on the YSI Calibration Log sheet. Be sure to read the thermometer while it is submersed.
4. If the difference between the NIST-traceable thermometer and the probe is greater than 0.5°C, replace probe.

Appendix F – HACH calibration procedures

Display must be in single display mode to calibrate. This can be done by pressing the arrow up or down keys to select pH.

A minimum of 1-point calibration is needed.

1. Press the *Blue/left* key under calibrate.
2. Rinse probe with used buffer.
3. Place probe in new, clean (unused) buffer.
4. Press the *Green/right* key under Read. The meter will automatically detect which buffer is being used.
5. When the reading is stable, the display will highlight the buffer that has been read and display the temperature corrected pH value. Temporary correction is automatic.
   a. Report the pH, temperature, and mV in the calibration log.
6. Rinse probe with distilled water.
7. Once you have calibrated using the first buffer, *done* appears above the up key. Press to complete the calibration. Pressing *Up* will then display the calibration summary.
8. Report the slope, offset and r-squared in the calibration log.
9. Press *Store* to record the calibration details.

OR (for a 3-point calibration)

1. Rinse probe with used buffer.
2. Place probe in new, clean (unused) buffer 2.
3. Press the *Green/right key* under Read.
4. Report the pH, temperature, and mV in the calibration log.
5. Rinse probe with distilled water.
6. Rinse probe with used buffer.
7. Place probe in new, clean (unused) buffer 3.
8. Press the Green/right key under Read.
9. Report the pH, temperature, and mV in the calibration log.
10. Press *done* above the up key. Pressing *Up* will then display the calibration summary. If the calibration is successful, the display will show OK in the upper left corner.
11. Report the slope, offset and r-squared in the calibration log.
12. Press *Store* to record the calibration details.

HQ40d conductivity calibration

Display must be in single display mode to calibrate. This can be done by pressing the arrow up or down keys to select conductivity.

A minimum of 1-point calibration is needed.

1. Press the *Blue/left* key under calibrate.
2. The display will show the required standard.
3. Rinse probe with previously used standard.
4. Place in new, clean standard.
5. Press the *Green/right* key under Read.
6. When the reading is stable, the display will show the conductivity value.

7. Rinse probe with distilled water.
8. Press *done* above the up key. Pressing *Up* will then display the calibration summary. If the calibration is successful, the display will show OK in the upper left corner.
    a. Report the conductivity and cell constant (cm^{-1}) in the calibration log.
9. Press *Store* to record the calibration details.

HQ40d dissolved oxygen calibration

Display must be in single display mode to calibrate. This can be done by pressing the arrow up or down keys to select DO.

1. Add room temperature water to narrow top bottle and shake vigorously. You want to create a saturated environment.
2. Insert DO probe so sensor is 1 inch from top of water. It should not be touching the water. Make sure the sensor is not wet.
3. Let set for a few minutes.
4. Press the *Blue/left* key under Calibrate.
5. Press the *Green/right* key under Read.
6. When the reading is stable, the display will show the DO value.
7. Press *done* above the up key. Pressing *Up* will then display the calibration summary.
8. If the calibration is successful, the display will show OK in the upper left corner.
    a. Report the percent saturation, slope, temperature, offset, DO, and hPa in the calibration log.
9. Press *Store* to record the calibration details.

Temperature probe check

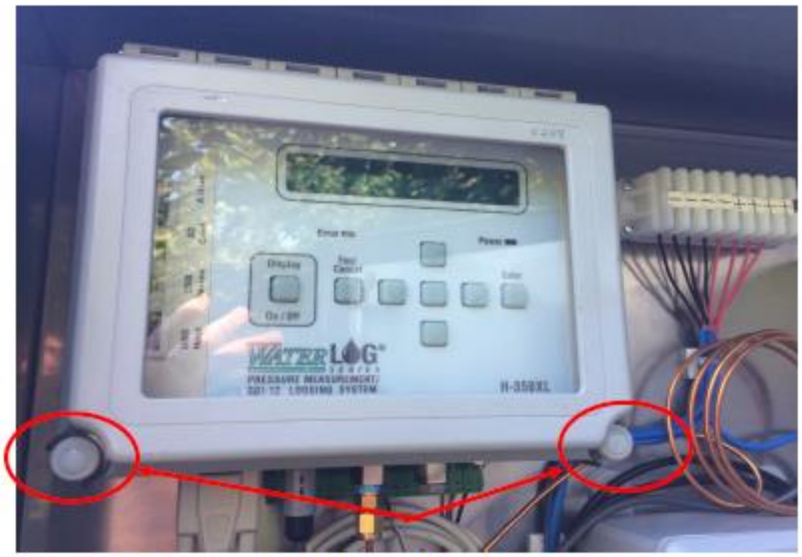
Temperature should be verified at least twice per year. A NIST-traceable thermometer must be used. NIST-traceable thermometers should be accurate to ±0.3°C. A liquid-in-glass or digital thermistor may be used. NIST-traceable thermometers should be replaced or sent in every five years to have lab calibrate over a range of 0°C to 40°C.

1. Fill large vessel with tap water and allow stabilization for 24 hours in order to reach ambient temperature.
2. Place the NIST-traceable thermometer and HACH probe in a room temperature bath for at least two minutes or until the temperature stabilizes. There are temperature sensors on each of the probes. The thermometer should be as close as possible to the temperature sensor on the probe your are checking. It may be helpful to use tape or a rubber band to secure the thermometer to the probe.
3. Record the NIST-traceable thermometer and HACH probe temperature on the Calibration Log sheet. Be sure to read the thermometer while it is submersed.
4. If the difference between the NIST-traceable thermometer and the probe is greater than 0.5°C, replace probe.

Appendix G – DNR datalogger manual

Logger Checks Tutorial

*Note: A station that has Climate equipment installed will cause the logger to freeze for 20 seconds every minute. So you will have to wait until the 20 seconds are up to continue going through the instructions below. The logger should wake up at the same spot you were at before it froze.



Open the datalogger by unclipping both bottom corners.

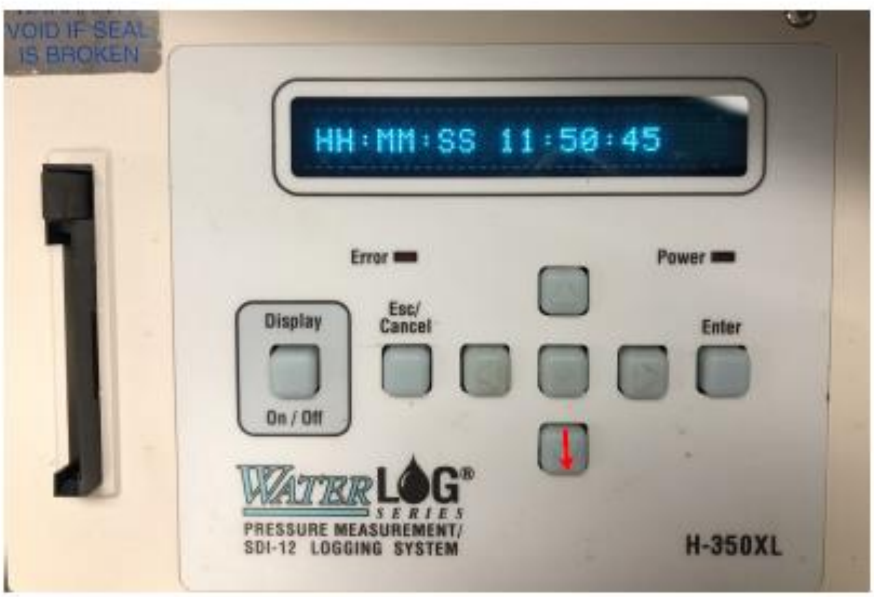
Turn on the logger: Press Display On/Off button

Logger Inspection 1

DEPARTMENT OF NATURAL RESOURCES

The date will appear on the screen

Hit the down arrow to scroll through the menu. The current time will be displayed the next screen.



**Order may vary slightly for the next options displayed depending on the equipment that is installed at the site.*

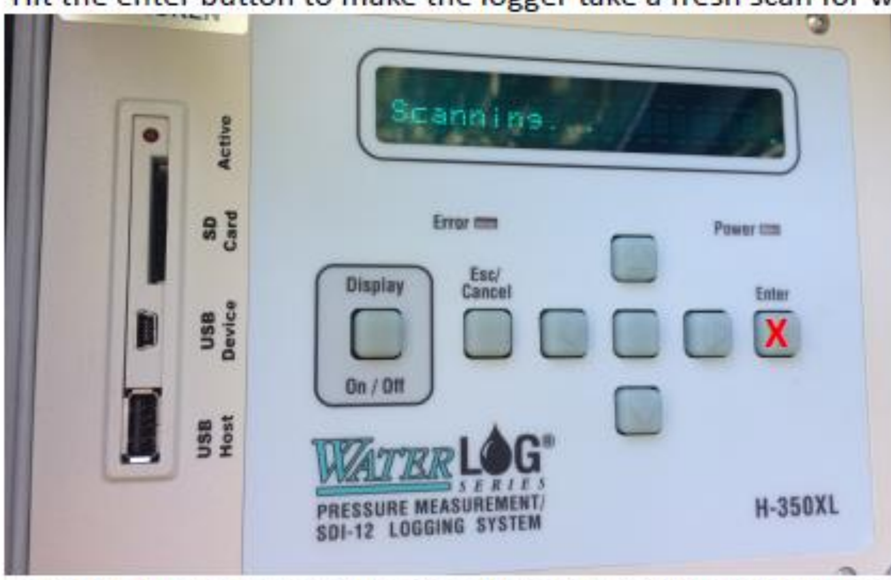
Logger Inspection 2

DEPARTMENT OF NATURAL RESOURCES

Hit the down arrow again to get to “Level” (gage height). You may need to continue to hitting the down arrow to get to “Level“ if there’s a bubbler and radar installed at the site. “Level” will be primary and “Level2” will be the secondary sensor.

**Value will be the last 15 minute scan made by the logger.*

Hit the enter button to make the logger take a fresh scan for water level.



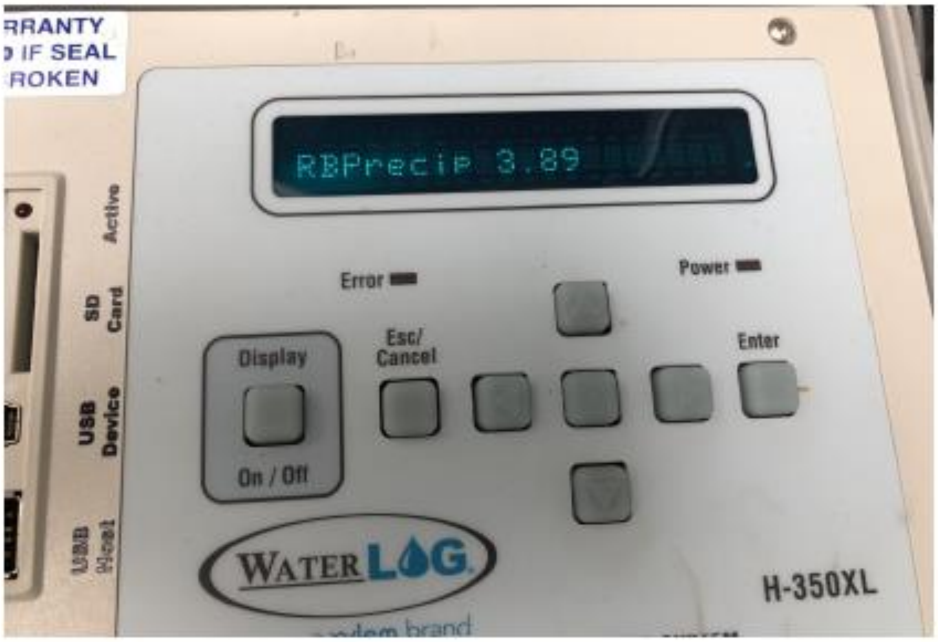
**Make the logger scan several times to see if it’s stable. (+/- 0.01ft from scan to scan) Note the range if it’s not stable in your comments.*

Logger Inspection 3

DEPARTMENT OF NATURAL RESOURCES

Hit the down arrow again to get to RBPrecip (if the site has a rain bucket).

Hit the down arrow again to see the battery voltage.



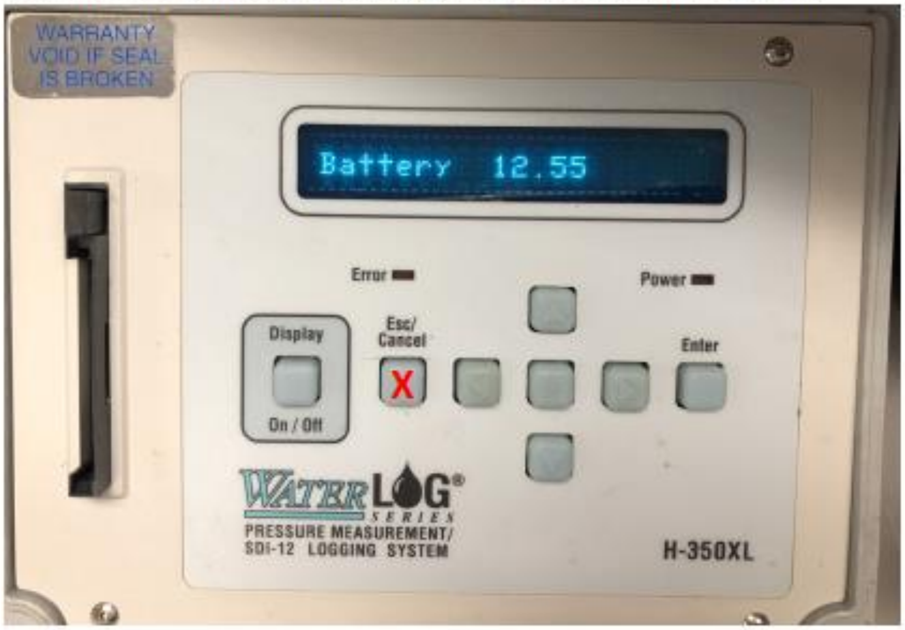
This is the total for the year. It will reset to zero on January 1st.

Local Partners let your MN DNR contact know if the voltage is less than 12 volts.

Logger Inspection 4

DEPARTMENT OF NATURAL RESOURCES

Hit the Esc/Cancel button to go back to date/time screen.



**Note: if you hit the down arrow again and the logger reads "Sensor Input Setup" that's ok just use the up arrow to go back to go back up in the menu one step i.e. Battery or hit the Esc/Cancel button.*

Hit the Display On/Off to shut off the logger.

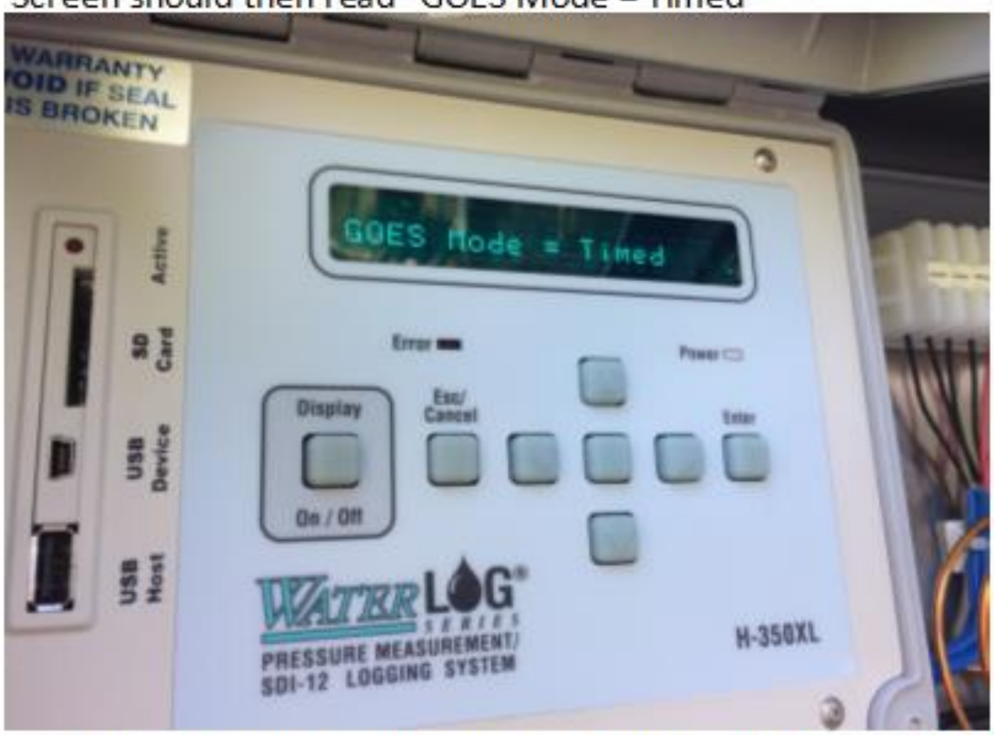
**Logger will timeout and shut off on it's own if you forget this step.*

Logger Inspection 5

DEPARTMENT OF NATURAL RESOURCES

Screen should read "Scanning Is On"

Screen should then read "GOES Mode = Timed"



**It will only say "Timed" if the site is telemetered; otherwise, it will read "GOES Not Installed".*

Closed the lid on the logger and secure the 2 clips on the bottom corners.

Logger Inspection 6

DEPARTMENT OF NATURAL RESOURCES

Logger Header Definitions

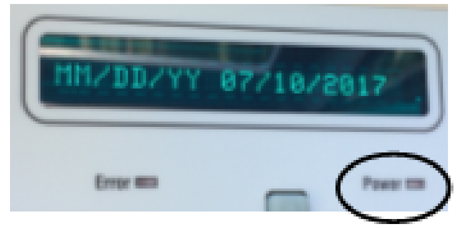
Standardized Header	Description	Notes
RBPrecip	Precipitation	
Level	Level	
Level2	Level from secondary sensor	parameter or time series?
Velocity	Velocity	
IndexVel	Index Velocity	
XS_Area	Cross Sectional Area	
Battery	Logger Battery Voltage	
RH%	Relative Humidity (%)	
STemp6	Soil Temperature at 6in - Vegetated C	
STemp12	Soil Temperature at 12in - Vegetated C	new parameter
WTempC	Water Temperature C	
WTempF	Water Temperature F	
MaxDTemp	Maximum Daily Air Temperature	
MinDTemp	Minimum Daily Air Temperature	
AirTempF	Air Temperature F	
AirTempC	Air Temperature C	
WindDir	Wind Direction - Average	
WindSpd	Wind Speed - Average	
WindSMax	Wind Speed - Max	
BaroPres	Atmospheric Pressure	This is labeled "BaroPres" in the climate station data files
SolarRad	Solar Radiation Intensity	
TurbFNU	Turbidity (FNU)	Standard header for **median**

Logger Inspection 7

DEPARTMENT OF NATURAL RESOURCES

Logger Trouble Shooting

1. Logger won't turn on.
    - Is the power light (located to the lower right of the display) flashing indicating power to the logger?
        - Not flashing.
            - Check the power plug (located on the right end of the wiring block on the bottom of the logger) is seated completely and wires are not loose.
            - If the station normally has a solar panel, is it still there?
            - If you have a volt meter you could check the battery to see if it's dead.
            - If the station has a fuse hooked up to the battery, it may have blown.



2. Level reads 99.99 ft.
    - Indicates power loss, force logger to scan for new level reading.
3. Display is frozen.
    - Logger is scanning, wait for it to finish then continue through the menu.
        - Typical scans are at :00, :15, :30, and :45.
        - Mesonet station freeze for a portion of every minute.
4. Data on website is flat lined.
    - Bubbler—check orifice line to see if it's out of water or the line in the bank has been damage by excavating, might be a temporary line or could be a permanent one, work with DNR contact to know what your stations have. If under the water should see a bubble every second provided the water is calm and not turbulent or fast flow.
    - Radar—make sure it's pointed down at the water and the wire is still connected to the Radar unit. Flat line likely only would occur with ice under the radar or a problem with the Radar and/or logger.
5. Data on website is very erratic or spiky.
    - Orifice line
        - Might be frozen.
        - Might be buried in sediment.
        - Bubbler not repressurizing properly.
    - Radar
        - Occurs during windy conditions.
        - Internal error if it's large spikes to a similar number.
6. Bubbler compressor sounds.
    - Daily purge occurs at noon CST or 1pm CDT.
        - Wait for it to make a small burp sound before attempting to check the level on the logger.
7. RB Precip total lower than last visit or dropped to zero on the website.
    - Automatically resets to zero on January 1st.
    - Power loss and counter not reset to previous value.
8. Gaps in data on website.
    - Power loss or transmission problems.