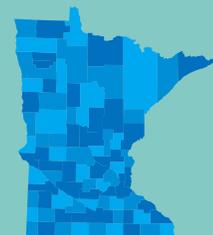


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Standard Operating Procedures

Intensive Watershed Monitoring - Lake Water Quality Sampling



Authors

Pam Anderson
Lindsay Egge
Lee Engel
Kalley Guerdet
Kelly O'Hara

Editing and graphic design

Paul Andre

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

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Foreword

This document is specific to lake monitoring within the Intensive Watershed Monitoring approach conducted by MPCA staff and adapted for local partners contracted through the Surface Water Assessment Grant program. Procedures outlined cover basic agency condition monitoring on all lakes in Minnesota.

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Executive summary

Scope and application

This standard operating procedure (SOP) is applicable to field observations and the collection of water quality samples from lakes, shallow lakes, and reservoirs. It is applicable to samples taken from the surface and at any depth along a vertical column between the surface and bottom. It is limited to samples collected for physical and conventional chemical analysis. This SOP details the steps necessary to prepare for lake monitoring, make proper field observations, collect, and process water quality samples, and complete the proper documentation for sample delivery and analysis from a State certified lab.

Personnel qualifications and responsibilities

The Minnesota Pollution Control Agency (MPCA) and local partner's monitoring staff must be familiar with proper sampling techniques, sample handling, safety procedures, and record keeping. New staff and seasonal staff must be trained and accompanied in the field by experienced staff until competence is assured. Seasonal staff shall be provided written SOPs/instructions and one on one training at the start of their employment.

Summary of method

No single procedure will be applicable to all sampling situations; therefore, no single procedure is recommended. Water samples from surface waters are generally collected in one of the following ways:

- **Hand-collected sample:** bottle in hand for collection of a sample just below the surface on shallow lakes
- **Integrated sampler:** composite sample collected through the top 2 meters of the water column
- **Depth sample:** sample collected at a depth below 2 meters (using a Kemmerer or Van Dorn sampler)

Cautions and interferences

Contamination of the sample can occur if the sampling device is not properly rinsed prior to sample collection. For standard sampling equipment (i.e., integrated samplers) the sample device should be rinsed three times from the opposite side of the boat from where the sample will be collected. For depth samplers, the lowering of the device through the water column provides the necessary rinsing.

Sample contamination can also occur if the bottom sediments are disturbed during sample collection or the release of the anchor in shallow lakes. In the event where bottom sediment is present within the sample, the sampling device should be emptied, rinsed, and sample collection should be attempted again at a different location of the boat. For lakes less than two meters, a lesser depth to avoid the disturbed sediment may be required. In addition, depth samples need to be taken from a different location on the boat to avoid disturbed bottom sediments from anchoring.

Also, avoid touching the inner surfaces of the lid, bottle, and sampling equipment to reduce chance of contamination. This includes when adding preservatives to the corresponding samples.

Samples should be collected between sunrise and sunset only. Inaccurate Secchi depth measurements may be recorded when readings are taken at dusk or dawn.

Lake monitoring feasibility

All lakes designated for monitoring are susceptible to changing conditions that may affect access and/or navigation. Minnesota lakes commonly experience fluctuating lake levels or extensive vegetation affecting the ability to launch/retrieve or navigate boats. Additionally, access to lakes is not always guaranteed; ramps or lakes may be closed to use due to construction or lake management activities. If these conditions or situations arise, the feasibility of sampling and assessing must be considered.

Document the conditions affecting lake access with notes and pictures and contact the MPCA Project Manager to determine whether monitoring efforts shall continue or if the lake will be removed from the work plan. Local partners shall maintain and submit documentation of lake conditions and determinations within the interim and final progress reports.

Procedures

This section details the steps necessary to collect, process, and prepare samples for delivery to a State certified lab. Contractors must use laboratories listed within the [MPCA's Master Lab Services Contract](#) or an approved University lab within Minnesota. Under MPCA guidance, contractors are expected to work directly with the lab for specific instructions on bottle rinsing, sample preservation, bottle labeling, and submission instructions. It is expected that all contractors will coordinate with the MPCA Project Manager to ensure these details have been established prior to the sampling season. It is also the contractor's responsibility to keep a physical, signed copy of a current Minnesota DNR General Permit to Transport Water for Water Quality Sampling, as provided by the MPCA Project Manager. This permit is required to be carried for all water quality monitoring events.

Pre-sampling requirements

Sonde/field meter calibration

Calibration is required for pH, conductivity, depth, and dissolved oxygen (DO). A detailed calibration record is necessary for quality assurance/quality control (QA/QC). **Calibration for DO shall occur each day of monitoring at the first sampling location.** Additional parameters shall be calibrated per manufacturer's recommendations but not to exceed 30 days during monitoring season.

Local partners may use the Field Meter Calibration Records Form located on the [Surface Water Assessment Grant \(SWAG\) guidance webpage](#) and submit with the progress reports. Alternative forms of documentation are acceptable and shall be discussed with the MPCA Project Manager.

Sensor calibration records support the accuracy of the data collected using these instruments. Contractors are expected to report all calibration logs recorded throughout the monitoring season. For any calibration record keeping method used, the following information must be provided: For each parameter calibrated, a measurement must be taken using the standard solution prior to calibration and recorded in the 'pre-calibration' field. The value obtained from the sonde after the calibration will be entered in the 'post-calibration' field. If applicable, the expiration date of the calibration standard must also be recorded in the 'Expiration Date' field. Error readings or complications with the meter will be recorded in the appropriate field. Technicians calibrating the sonde/field meter will sign off to indicate a calibration has been completed.

The frequency of recorded calibration logs is also determined by the amount of time observed for a sensor to drift beyond an acceptable difference from the factory-defined limits or, in the case of DO, the expected concentration at 100% saturation. It is up to user discretion to understand and to report sensor drift based on factory defined limits established for each sonde/field meter. Contractors are expected to coordinate with the MPCA Project Manager when sensors have drifted beyond an acceptable difference from the factory-defined limits, and therefore sensor efficacy, has been identified. It is expected that the user shall, in coordination with the MPCA Project Manager, take the steps necessary to troubleshoot the sonde/field meter according to manufacturer's specifications.

Further issues for faulty sondes/field meters shall be discussed with the MPCA Project Manager and documented within the progress report. A record of maintenance for each sonde/field meter should also be kept and shared. The expectation in sharing sonde/field meter information is to increase the longevity of the equipment and ensure the accuracy of readings.

Equipment preparation

Equipment necessary to complete each monitoring trip should be gathered prior to departure. Confirm that the number of bottles and preservative necessary to complete all regular and duplicate sampling are packed. The required analyses and observations for the required parameters are listed in the **Appendix A**. A trip-specific checklist of equipment and supplies is recommended when preparing for all monitoring trips, see **Equipment and supply checklist** below.

The use of additional equipment and decontamination materials may be necessary when monitoring lakes designated with an invasive species infestation. Samples collected in infested waters shall be labeled “AIS” in accordance with subcontracted lab requirements to ensure proper disposal. Additionally, documentation shall be provided within the Chain of Custody (COC) form. See the MPCA procedures for monitoring in infested waters on the [Water Monitoring Resources](#) webpage, under Aquatic Invasive Species

Equipment and supply checklist

A variety of sampling equipment is necessary for surface water sample collection depending on conditions. The following checklist is a guide for sampling needs. 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.

Field survival/personal protective equipment (PPE)

- First aid kit
- Insect repellent and sunscreen (wash hands thoroughly after applying to avoid sample contamination)
- Rain gear/rain boots/waders
- Personal floatation device (PFD)
- Cell phone
- Replacement batteries
- Toolbox with basic tools

Boat/canoe

- Drain plug
- Canoe straps and pads
- Anchor
- Adequate anchor line
- Paddles
- GPS unit (optional)
- Full gas tank for motorized boats

Field equipment/documentation

- Physical copy of signed, valid DNR Permit: *Transport Water for Water Quality Sampling*
- Electronic field capture of field datasheets/Chain of Custody, and photos
- Physical copy of field datasheet(s) and Chain of Custody
- Secchi disk
- Calibrated multiparameter sonde with pH, conductivity, temperature, and dissolved oxygen probes

- Waterproof pens, markers and/or pencils
- Sample bottles and preservative
- Integrated sampler
- Kemmerer depth water sampler
- Coolers and ice
- Items to complete QA/QC protocols
- Sample shipping supplies (if applicable)

Equipment decontamination

- Distilled water
- Low pressure sprayer
- High pressure, high-heat sprayer (if applicable)

Document preparation

Prior to any field monitoring preparations, all local partners, in coordination with the MPCA, shall obtain guidance from their designated laboratory regarding appropriate bottle labelling and completion of the COC. Local partners may complete COC's prior to sampling trips for trip planning guidance. In this instance, local partners may submit to the MPCA Project Manager for prior review. Indicate the correct EQuIS Project (PRJ) code, contact information, site information, and designated analyses and bottles details for each specific monitoring location. When relevant, include field replicates for quality control. Label bottles prior to filling and provide identifying information in accordance with instructions provided by the analytical laboratory.

Prepare lake monitoring field datasheets with the specific site and date information relevant to the sampling event. Note that information recorded on the lake monitoring field datasheet will be transcribed to EQuIS at a later date. It is imperative that accurate documentation occurs at this step to prevent future errors.

Boat/canoe preparation

The boat or canoe, outboard motor, and trailer shall be thoroughly inspected prior to use. The following checks shall be completed before all monitoring trips:

- Sufficient tire pressure and bearing grease for the trailer.
- Ensure trailer lights are functional prior to departure and repair inoperable lights.
- Gunnel and winch straps should be in good working order (no frays).
- Adequate fuel levels maintained in proportion to anticipated travel time on lakes.
- Sufficient oil levels for the outboard motor.
- Adequate boat battery charge.
- Sufficient PFDs, paddles, drain plugs, anchors, and anchor lines are stowed.
- Canoe straps and pads are secured. Inspect periodically when traveling and re-secure as necessary.
- Ensure that no vegetation is on the trailer or boat and that the drain plugs are removed, and motor and bilge are drained.

On-site procedures

Boat launch

Travel to the boat launch or point of entry with the assistance of a GPS unit or map. Ensure that all sampling staff observe proper boat landing etiquette. Park the vehicle and boat trailer in a location that does not obstruct access to the boat launch. The following preparations shall be completed before launching:

- Label bottles as designated.
- Prepare field datasheets.
- Calibrate multiparameter sonde for DO where necessary.
- Stow water quality collection equipment (integrated sampler, Secchi disk, etc.) into the watercraft.
- Remove tie down straps but do not yet remove the bow safety chain or winch line.
- Check functionality of GPS and verify sampling destination.

Once preparations are complete, follow these steps for launching the boat:

1. Raise the outboard motor, remove the support device, and double check the drain plug.
2. Disconnect the trailer wiring when not equipped with LED taillights.
3. Make any equipment adjustments necessary.
4. Connect the fuel tank when applicable.
5. Drive to the ramp and back the boat and trailer down the ramp, keeping the tow vehicle's wheels out of the water whenever possible.
6. Set the emergency brake and shift into park.
7. Have assisting staff board the boat, lower the motor, look for water entering the boat, ensure water is flowing through cooling indicator line.
8. Make sure you have attached a bowline to the boat, release the winch and disconnect the winch line, and remove the bow safety chain.
9. Launch the boat with a slight shove or by backing the boat off the trailer under power.
10. Return the towing vehicle to the parking lot as soon as the boat is launched to allow other boaters to proceed.
11. Move the boat to an area away from the ramp to load additional equipment and passengers.

Travel to sampling location

From the dock/shore, travel to the predetermined sample location(s) via GPS. Stop the boat and lower the anchor, ensuring the boat is not drifting. When possible, verify depth of sampling location during each visit to determine the correct location is being sampled. If high wind conditions are present, a second anchor may be necessary to hold the boat in place. Upon completion of lake monitoring tasks pull anchor and travel back to boat launch.

Sonde measurements for a water column profile (where applicable)

Temperature, conductivity, dissolved oxygen (DO), depth and pH measurements shall be recorded with a multiparameter sonde. Use a reliable sonde with documented calibration records maintained per

contractual work plans. Follow the operation instructions supplied by the manufacturer of your specific sonde.

1. Remove the protective travel/storage cover from the sonde and replace it with the weighted sonde guard. Turn on the display unit.
2. Lower sonde until the probes are just in the water (the seam between the weighted cover and the body of the sonde should be at the water interface). Allow the numbers to stabilize.
3. On the sonde/field meter display unit ensure correct site is selected and log sample on device when applicable or record values on lake profile datasheet.
4. Lower the sonde and record readings every 1.0 meter through the water column and repeat steps 3 through 5 until the bottom has been reached; after all readings have stabilized below the thermocline (temperature change of 1° C for every incremental depth of 1 meter of water) readings may be taken every 2.0 meters.
5. Do not take a final depth reading once the probe reaches the bottom of the lake. When the probe is touching or immersed in sediment the reading will not be accurate. Raise the sonde approximately ½ meter from the lake bottom for the final reading.

Field datasheet completion

1. Visually assess the condition at the sampling site, appearance rating and recreational suitability rating at the sampling site, referring to Appendix B for ratings, abbreviations, and observation codes.
2. On the field datasheet, determine the appearance and suitability of recreation of the sampling site using the 1-5 scale provided.
3. Assess other uses occurring on the lake at the time of sampling i.e., fishing, swimming, etc. Note these on the sheet.
4. Note vegetation growth that may be limiting lake use (curly leaf pondweed, Eurasian milfoil, etc.) on the sheet.
5. Add additional observations that may aid in assessment decisions.

Surface sample – for lakes two meters or deeper

1. Remove stoppers from the integrated sampler.
2. Lower sampler vertically into the water, insert stopper on the upper end of sampler, remove from water and release stopper. Repeat this process two more times to complete rinsing.
3. On the opposite side of the boat, lower the un-stoppered integrated sampler into the water column until the top is at the water surface. Be sure that sampling personnel keep hands on the outside of the tube and stopper only to avoid contamination.
4. Place the stopper in the tube.
5. Slowly raise the tube so the lower opening is just below the water surface.
6. As the tube breaks the surface, either quickly cap, or allow contents to pour into a clean, sample collection container (often a 2-liter (L) plastic sample bottle). Again, ensure that sampling personnel do not touch the inside of the bottle or cap.
7. Caution shall be administered to ensure that sediment is not collected during sample collection. As specified in the **Caution and Interferences** section, in the event where bottom sediment is present

within the sample, the sampling device and collection container/sample bottle should be emptied, rinsed, and sample collection should be attempted again at a different location of the boat.

8. Cap and invert the sample collection container. Pour contents of the sample collection container into applicable sample bottle(s).
9. Preserve any samples as recommended per lab specifications.
10. Repeat steps 4 through 7 to collect a second sample for chlorophyll-*a* and algae analysis; move to a new location along the boat for the integrated sample collection. Pour second integrated sample into 2 L bottle.
11. Place all properly labeled bottles in a cooler with an adequate amount of ice.

Depth sample – when applicable

12. Open depth sampler or Kemmerer and lower into the water column to desired sample depth (0.5 meters above bottom).
13. Send messengers to close the sampling apparatus and collect the sample at the desired depth. Be sure the cord connecting to the sampling device remains straight when sending messengers.
14. Reel in the cord and depth sampling device and use spigot to fill applicable sample bottle(s).
15. Caution shall be administered to ensure that sediment is not collected during sample collection. As specified in the **Caution and Interferences** section, in the event where bottom sediment is present within the sample, the sampling device and collection container/sample bottle should be emptied, rinsed, and sample collection should be attempted again at a different location of the boat to avoid disturbed bottom sediments.
16. Place all properly labeled bottles in a cooler with an adequate amount of ice.

Surface sample – for lakes less than two meters deep

1. Uncap the 2-L bottle.
2. Tip the bottle upside down and lower it into the water column until the sampling personnel's elbow is at the water surface. Be sure the inside of the bottle and cap are not touched by sampling personnel.
3. Invert the bottle and allow it to fill.
4. Bring the bottle to the surface, taking care to avoid any surface scum/material.
5. Cap and invert the bottle, thoroughly rinsing the bottle, and dump the contents in a new location along the boat.
6. Repeat steps 1-5 two more times to rinse the sample collection container (often 2-L bottle) for a total of three times.
7. On the fourth collection, cap and invert the sample collection container, then pour contents of the sample collection container into applicable sample bottle(s).
8. Preserve any samples as recommended per lab specifications.
9. Repeat steps 1 through 4 to collect a second sample for chlorophyll-*a* and algae analysis, moving to a different location along to boat to collect the sample.
10. Place all properly labeled bottles in a cooler with an adequate amount of ice. Note: the depth label for this sample should be "Grab" or 0.5 meters.

Quality assurance/quality control

Field replicates shall be collected in July of the first monitoring season at each monitoring location for all scheduled parameters. Contact your laboratory to verify the QA/QC labeling they have designated for use. Guidelines for collecting a field replicate:

1. Label bottles as directed by the lab, ensuring that you identify the sample as a field replicate. If time is used, record as 1-5 minutes after the original sample is collected.
2. Collect the sample using one of the methods previously described.
3. Add preservative, if needed, and place sample bottles in coolers with an adequate amount of ice.
4. Be sure to note the appropriate sample type on the COC for a field duplicate.

Secchi transparency

1. Remove sunglasses or polarized eyeglasses and move to the shaded side of the boat. The sun should be behind sampling personnel.
2. Lower the Secchi disk into the lake until the disk just disappears completely from view. When it does, stop lowering the disk.
3. While continuing to look down into the water, slowly raise the disk until it reappears. Lower and raise the disk until you have found the midpoint between disappearance and reappearance of the disk – then note this depth.
4. Round the reading to the nearest 0.1 meter to obtain the transparency reading and record this value on the field sheet.

Lake photo

1. Photos shall only be taken for unusual or unique circumstances when current conditions may aid in assessment decisions.
2. When applicable, take a photograph of a sample bottle or field sheet to assist with photo identification, then take photos of the unusual or unique circumstances.
3. Unusual and unique circumstances include, but are not exclusive to:
 - a. Nuisance blue-green algae blooms
 - b. A large population of dead wildlife or fish kills
 - c. Recreation occurring in nuisance blue-green algae blooms
 - d. Drawdown or flooding conditions
 - e. Nuisance vegetation or new AIS identification
4. Photos taken for unusual or unique circumstances shall be submitted to the MPCA Project Manager utilizing the Sharebase application, as directed.

Boat retrieval

All personnel must always display proper boat landing etiquette during boat retrieval.

1. Avoid crowding the approach to the dock and the dock area in the event of high traffic.
2. Approach dock and allow one staff to exit boat and retrieve vehicle and trailer.

3. Back the trailer into the water, again keeping the tires of the tow vehicle at water's edge, not in the water if possible.
4. Raise outboard, maneuver the boat carefully onto the submerged trailer, attach a bowline and shut off the engine prior to raising it.
5. Winch the boat onto the trailer and secure the safety chain.
6. Drive the trailer and boat out of the ramp and out of the way of other ramp users.
7. Carry out **Post Sampling Best Management Practices** as outlined in the **IWM AIS SOP**, see the **Aquatic Invasive Species Decontamination** section below.
 - a. Remove the drain plug to allow water to drain from the bilge. Keep drain plugs out and water-draining devices open while transiting watercraft.
 - b. Inspect boat hull, outboard, and trailer for vegetation. Remove all visible aquatic vegetation by hand or portable sprayer.
 - c. Inspect gear and sampling equipment for vegetation. Remove all visible aquatic vegetation by hand or portable sprayer.
 - d. The outboard motor should be fully lowered to allow all cooling water to completely drain. Once draining has finished return the outboard motor to the raised position and secure for travel.
8. If the lake is listed with the presence of aquatic invasive species, ensure any additional measures to decontaminate the boat and field equipment is followed. See the **Aquatic Invasive Species Decontamination** section below for more information.
9. Remove equipment from boat.
10. Secure all straps and prepare for road travel.

Post-sampling bottle organization

1. Ensure preservative is added to appropriate sample bottle(s).
2. Organize sample bottles by lake and double check bottle labeling. Ensure that all identification is correct and easily readable.
3. Place in cooler with adequate ice to account for shipment or delivery time. Ensure all bottle caps are tightly sealed and that all bottles are packed within the cooler securely to avoid breakage.

Post-trip requirements

Aquatic invasive species decontamination

If a lake is listed with the presence of aquatic invasive species, necessary measures shall be taken to decontaminate field equipment. Decontamination procedures listed within the [MPCA AIS SOP](#) must be followed before any sampling equipment, including boats, can proceed to further lakes. **All bottles from Aquatic Invasive Species (AIS) lakes must be labeled appropriately in accordance with your labs COC documentation procedures.**

Chain of custody preparation

Prior to any field monitoring preparations, all local partners shall obtain guidance from their designated laboratory regarding appropriate labelling and (COC) documentation. Local partners may complete COCs prior to sampling trips for use as a guidance for trip planning. In this instance, local partners may submit

to the MPCA Project Manager for review. Local partners contracted to perform multiple MPCA water quality monitoring projects must coordinate documentation with MPCA project managers prior to monitoring.

1. Prior to packing, ensure bottle labels exactly match information provided within the COC.
2. Ensure the correct EQUIS Project ID has been added to the form. Only one COC can be used per EQUIS Project ID (i.e., PRJ07081, PRJ07082).
3. Include the correct lake ID, site ID, date, and time.
4. All bottles from Aquatic Invasive Species (AIS) lakes must be labeled appropriately and identified on the COC, in accordance with the designated lab's COC documentation procedures.
5. Depth recorded for surface should be 0-2 m for the use of an integrated sampler or 0.5 m if a subsurface grab sample was taken.
6. Duplicate/replicate samples must be recorded in their own sample row.
7. Document preservative use.
8. Sign and date COC when possession of samples have been transferred.

Post sampling equipment management

All equipment used for the collection of lake samples and for boating and anchoring shall be properly cleaned and prepared for its next use. This includes a visual inspection for damage or excessive wear.

- Remove all sampling equipment from the vehicle and boat and visually inspect and remove any aquatic vegetation or sediment.
- Wash equipment and allow adequate time for drying.
- Unused, clean bottles should be returned to the appropriate clean bottle storage.
- Coolers should be rinsed, drained, and allowed to dry.
- If used, inspect and clean waders.
- Inspect anchor and anchor line, wash, and allow to dry.
- Inspect Kemmerer and Secchi line, wash, and allow to dry.
- Properly clean, dry, and store sonde and handheld. If profile data was collected electronically, download all files for submittal. Follow manufacturer's instructions for downloads.
- If the last body of water visited is listed with the presence of aquatic invasive species, ensure any additional measures to decontaminate the boat and field equipment are followed. See the **Aquatic Invasive Species Decontamination** section for more information

Data management

Data collected through the SWAG program is characterized by two categories: field observations and recordings and analytical laboratory data. Separate procedure and management practices are required for the collection, storage, and submittal of data collected through your agreement.

Field observations

All observations documented in the field shall be transferred from the Lake Secchi Datasheet or Lake Profile Datasheet to the EQUIS Excel Template. Local partners are not required to submit the datasheets

but must retain a record for future references. The following information must be included within the template.

- a. Correct Lake ID.
- b. If completing lake profiles, all information must be included per each row of the profile.
- c. The designated Project ID.
- d. Include the field name, sample ID, date, and time.
- e. Ensure the correct unit of measurement (feet or meters) is used for Secchi disk values entered.

Laboratory results

All laboratories contracted under the SWAG program are required to submit analytical results to the MPCA electronically. Laboratories shall submit the results as an electronic data deliverable utilizing the LAB_MN feature of EQuIS. Local partners shall coordinate and monitor electronic data deliverable (EDD) submittal with their contracted laboratory and retain the hard copies of the results. These documents shall be used at the end of the monitoring season for QA/QC data review. Local partners are not required to transcribe the lab results to the EQuIS Template.

Health and safety

Weather and lake conditions

Prior to sampling preparation and boat launching, all staff shall assess lake conditions. The following steps must be considered to safely launch the boat, travel to the sampling location, remain safely anchored, and retrieve the boat.

- Lake monitoring shall not occur when lightning is present. Return to the vehicle and wait a minimum of 20 minutes from the last visible lighting flash before returning to the water.
- Determine if wind conditions are creating gusts/waves greater than the capability of the boat.
- If gusts/waves create conditions where stationary anchorage is not possible, sampling must not occur.

Personal flotation device

All local partners are required to wear a United States Coast Guard certified personal flotation devices (PFDs) while conducting lake water quality monitoring under the SWAG program. The motor kill switch should be attached to the boat operator (clip to PFD) to prevent loss of control should the operator fall out of the boat. By law, personal flotation devices (PFDs) must be easily accessible (not in storage) when the boat is in operation and/or occupied, including throwable (Type IV) PFDs.

Chemical safety

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

1. When handling sample preservatives, always use extreme care; splash-proof goggles and non-contaminating gloves are recommended.
2. Avoid contact between preservatives and the skin, eyes, nose, and mouth.
3. Sulfuric and other acids will eat through clothing. Immediately wash shoes and clothes that are exposed to acid.
4. Leave ample room at the top of the sample bottle for the addition of preservatives and room for mixing.
5. 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 SDS.
6. When using pre-measured preservative vials from a lab, place empty vials in a sealed plastic bag and dispose of properly.

Harmful algal blooms

Harmful algal blooms (HAB) toxins include compounds affecting skin, internal organs, and the nervous system. Cases of human illness related to HAB exposure are very rare. Prevent toxin exposure by minimizing contact during sample collection by using protective clothing (gloves and waders). Symptoms can be immediate or arise several days after exposure; they include:

- Liver toxicity – may take hours or days for symptoms to appear in animals and humans; they include abdominal pain, diarrhea, and vomiting.
- Kidney toxicity – acute, severe gastroenteritis (including diarrhea and vomiting).
- Neurotoxicity – often appear within 15 to 20 minutes of exposure; animals may experience increased salivation, weakness, staggering, convulsions, difficulty breathing, and in severe cases, death. Humans may experience numb lips, tingling fingers and toes, or dizziness.
- Respiratory problems – runny eyes and nose, sore throat, and asthma-like symptoms.
- Skin irritation – visible rash, hives, or blisters, especially under clothing, swimsuits, or wetsuits.

Treatment typically involves removal from exposure, rinsing the contact area and continued symptom monitoring. Symptoms often resolve within a few hours or days without medical attention. In cases of prolonged or severe symptoms, seek medical attention or call the Poison Control Hotline at 800-222-1222. Report human and animal illnesses that may be due to harmful algae blooms to the MDH [Foodborne and Waterborne Illness Hotline](#) by calling 1-877-366-3455.

General sampling safety

The safety of monitoring staff is of utmost importance and staff shall not put themselves at risk when sampling lakes. Water quality samples are to be collected only if conditions allow. If samples cannot be collected safely using approved methods, monitoring shall not occur. Monitoring staff are encouraged to develop a safety plan prior to departure that includes the following:

- Determine the location and telephone number of the nearest medical centers within your defined sampling area.
- 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.

- 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.
- Consider the potential for lake conditions to alter within a given day. Collecting samples from a small lake with little impact from the wind may be different from a large lake with a large fetch resulting in higher waves. In the first instance, minimal effort may be required to safely launch and travel to the designated sampling location. While in the second instance, lake monitoring may need to be postponed completely.

Appendix A – Preservation and holding times

Information in this table is based off the Minnesota Department of Health (MDH) Environmental Health Laboratory standard practices. Alternative laboratories may have different standard procedures per parameter preservation, container type, and holding time. **Contractors are expected to consult with contracted labs to specify standard procedures for preservatives, container type, and holding times for the analytical methods selected and approved by MPCA QA/QC staff.**

Parameter	Sample collection method	Container type	Preservation	Holding time
Dissolved Oxygen	1.	Field Measurement	None	Instantaneous
pH	1.	Field Measurement	None	Instantaneous
Specific Conductance	1.	Field Measurement	None	Instantaneous
Temperature	1.	Field Measurement	None	Instantaneous
Total Phosphorus	2., 3., 4.	1 250-mL nutrient	10% H ₂ SO ₄ & 4°C	28 days
Chloride	2., 3., 4.	1 1000-mL general chem.	4°C	28 days
Sulfate	2., 3.	1 1000-mL general chem.	4°C	28 days
Chlorophyll-a	2., 3.	45-micron glass fiber filter and Petri dish or 2 L	4°C	48 hours
Pheophytin	2., 3.	45-micron glass fiber filter and Petri dish	4°C	48 hours
Calcium	2., 3.	500 mL metal	20% HNO ₃	6 months
Magnesium	2., 3.	500 mL metal	20% HNO ₃	6 months
Hardness	2., 3.	500 mL metal	20% HNO ₃	6 months

1. Sonde/field meter measurements: parameters are collected via sensor readings from a multiparameter sonde or field meter.
2. Direct bottle grab: sample is collected from surface water by taking an open collection container or sample bottle and immersing said bottle into the water to a specific depth to collect a sample by hand.
3. Integrated/composite: A 2-meter PVC tube is used to collect a composite water sample from the upper two meters of surface water.
4. Depth: sample is collected using a Kemmerer water sampler. The Kemmerer is lowered to desired depth and closed to capture the sample.

Appendix B – Metadata coding for field observations in EQUIS

Additional instructions/information

Metadata forms and Data Process Information located [online](#).

Physical condition

Please use the **one** number each day that you sample that best describes the physical condition of the lake water **at your sampling site**.

- 1 = Crystal clear water
- 2 = Not quite crystal clear - a little algae present/visible
- 3 = Definite algae, green, yellow, or brown color apparent
- 4 = High algae levels with limited clarity and/or mild odor apparent
- 5 = Severely high algae levels with one or more of the following:
 - massive floating scums on the lake or washed up on shore
 - strong, foul odor
 - fish kill (please note the number and types of fish)

Recreational suitability

Please use the **one** number each day that you sample that best describes your opinion of how suitable the lake water is for recreation and aesthetic enjoyment **at your sampling site**.

- 1 = Beautiful, could **not** be better
- 2 = Very minor aesthetic problems; excellent for swimming, boating
- 3 = Swimming and aesthetic enjoyment slightly impaired because of algae levels
- 4 = Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels (i.e. would not swim but boating is okay)
- 5 = Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels

Appendix C – Field filtering chlorophyll-*a* sample

Overview

The following procedures are applicable to MPCA staff in the Water Quality Monitoring Unit. Water collected for chlorophyll-*a* analysis must be filtered as soon as possible, as these samples have a 24-hour holding time. If overnight trips are required, a field filtration kit should accompany field crew. The following steps should be completed before returning to the office to satisfy holding time requirements. Light and heat degrade chlorophyll, therefore it is imperative to minimize exposure to heat, sunlight, and artificial light. Do not process samples in direct light and keep cooler lids closed tightly. Field filter sample(s) can remain on wet ice until delivery to lab. The amount of water filtered must be provided in the field datasheet and on the COC in mL.

Equipment and supplies

Filter kit:

- 0.30-micron glass fiber filter (4.7 diameter)
- Filtration apparatus and base
- Stainless steel filter funnel
- Plastic or glass Erlenmeyer flask (1000mL)
- Graduated cylinder (250mL)
- Filtration pump with vacuum tubing
- Sterile tweezers or forceps
- Rinse water

Storing and preserving:

- Cooler with ice
- Aluminum foil
- Petri dish
- Fine-tip permanent marker
- Zip-lock bags

Filtering procedure

The procedure for processing the chlorophyll-*a* sample is presented below. Whenever possible, sample processing should be done in subdued light, out of direct sunlight.

1. Assemble the filtration equipment. Attach the base of the filtration apparatus to the Erlenmeyer flask. The vacuum tubing shall attach to the Erlenmeyer flask and filtration pump.
2. Place glass fiber filter on the filtration apparatus with the grid side down. Do not handle the filter with bare hands; use clean tweezers or forceps. Once filter is in place, attach the filter funnel to the filtration apparatus.
3. Gently invert the 2-L chlorophyll-*a* sample bottle to homogenize the sample. Rinse filtering equipment with sampling medium.

4. Place glass fiber filter on the filtration apparatus with the grid side down. Do not handle the filter with bare hands; use clean tweezers or forceps.
5. Gently invert the 2-L sample again, measure a volume of sample water into the graduated cylinder. Due to the differing trophic levels among lakes, the volume of water filtered varies. In general, start with 250 mL in turbid water, 500 mL in clearer water.
6. Pour the volume of sample water from the graduated cylinder into the filter funnel attached to the filtration apparatus and pump the sample through the filtration apparatus. Pressure shall not exceed 7 inches of Hg (approximately 3.4 psi) in the vacuum gauge on the filtration pump. This prevents cells from rupturing, as well as prevents the filter from overloading.
7. If 250 mL of sample water will not pass through the filter, the filter should be discarded, and the process shall be repeated using a new filter and a smaller amount of sample water. **NOTE: if the lake water observed is green or turbid, use a smaller volume to start.**
8. Observe the filter for visible color. If no visible color is present, repeat step 3 until color is visible on the filter, or until a maximum of 2,000 mL have been filtered.
9. Once visible color is observed record the actual sample volume filtered into the field datasheet and COC.
10. Disconnect the filter funnel from the filtration apparatus. Carefully fold the filter in half with colored side folded in on itself using a clean pair of tweezers or forceps. Caution shall be used to avoid touching the colored portion of the filter, it is recommended that sterile gloves be worn for this portion of the procedure.
11. Using the tweezers or forceps place the folded filter into a sterile petri dish and replace the cap. Using a fine tip marker, label the petri dish with the Lake ID and volume of water filtered, as well as if this is an AIS designation for the waterbody sampled.
12. Wrap the petri dish in aluminum foil and place the sample in a refrigerator or on ice. If placing the sample on ice place the aluminum wrapped petri dish in a sealed Zip-lock bag to prevent water from infiltrating into the sample.
13. Disassemble the filtration equipment. Pour off water from the Erlenmeyer flask. All equipment shall be rinsed with tap or distilled water.
14. Any water left over in the 2-L sample bottle can be disposed of or saved until post-trip requirements.