

**RECOMMENDED STANDARD PROCEDURES
FOR PHYTOPLANKTON COLLECTION TO
DETECT HARMFUL ALGAL BLOOMS**

State of Utah
Department of Environmental Quality
Division of Water Quality

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Utah Division of Water Quality (DWQ) methods are adapted from published methods, or developed by in-house technical experts. The primary purpose of this document is for DWQ use and cooperating agency partners. This method is not intended to replace any official published methods.

Any reference within this document to specific equipment, manufacturers, or supplies is only for descriptive purposes and does not constitute an endorsement of a particular product or service by the author or by DWQ.

Although DWQ and its partners will follow this method in most instances, there may be instances in which collectors will use an alternative methodology, procedure, or process. Our goal would be to document the specific methods used during those instances.

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1. SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for collecting phytoplankton samples during harmful algal blooms (HAB). HABs can occur when certain cyanobacteria, a type of phytoplankton, become abundant enough to change the visual and physical nature of the waterbody. Although technically inaccurate, the terms "algae" and "algal" are commonly used to refer to both algae and cyanobacteria. Most water protection agencies have adopted the term "harmful algal bloom" to describe these events, and for consistency, DWQ will use the same terminology.

This SOP applies to any DWQ monitor and is recommended as the procedure for the non-DWQ cooperator or local health department (LHD) official performing algal bloom sampling in lakes, reservoirs, rivers, or streams. Any deviations from this procedure should be documented on the sample tracking (Appendix 1) and bloom report (Appendix 2) forms prior to sample submission to the lab. The goal of HAB sampling is to provide results that may be used: 1) to provide LHDs with information to evaluate potential recreational health risks, 2) provide public water systems with information to evaluate potential risks to drinking water supplies, and 3) for DWQ to record bloom conditions for use in evaluating lake water quality.

Prior to any sample collection, contact the DWQ HAB Coordinator, Ben Holcomb (bholcomb@utah.gov, 801.536.4373) or Jodi Gardberg (jgardberg@utah.gov, 801.536.4372) . DWQ will coordinate efforts to identify sample types, quantity, and locations appropriate to HABs on a case by case basis.

Prior to any sample collection, DWQ will coordinate with the receiving lab to ensure:

1. the lab is prepared for an additional workload,
2. the appropriate samples to be collected,
3. the level of analysis to be conducted,
4. the expected/anticipated reporting time

Prior to any sample collection, coordination with DWQ is recommended for the following reasons:

1. Determine and characterize the algal bloom—Is this a potential HAB?
2. Determine the stage of the bloom—Has a cyanobacteria surface scum developed on the waterbody?
3. Determine the spatial extent of the bloom—Is the bloom widespread throughout the waterbody or limited to certain areas?
4. Determine the drinking water and recreational uses of the waterbody.
5. Determine if adequate funding is available to cover phytoplankton sampling costs until completion of the bloom. Cooperators and partners should not assume that DWQ will pay for phytoplankton sampling without prior notice and coordination.

2. SUMMARY OF METHOD

The primary purpose of the sampling is to characterize the nature of the bloom in the context of plausible exposure pathways, especially blooms with potential to harm people and pets. Therefore, samples should target areas where there is the highest likelihood or risk of human-cyanotoxin interaction and exposure. This may require some planning to determine common use areas such as beaches, piers, shoreline access areas, drinking water intakes, etc. and wind direction, as blooms may be blown to the downwind side of the lake. This information will inform partner agencies whether to take further actions according to their respective response plans.

Phytoplankton samples can be collected from the water column or from the surface depending on the type or phase of the bloom. Cyanobacteria blooms often exhibit extensive temporal and spatial variation. As a result, it may be necessary to take multiple types of samples from various places around the water body to most effectively estimate the threat of the bloom to humans, pets or livestock.

There are several factors that should be considered when selecting sample locations and technique. Samples should be collected in areas of the lake where there is evidence of a potential bloom at the time of sample collection. Within the area of the bloom, samples should be collected where potential exposure is greatest. In many cases, this means samples should be collected near the shorelines where cyanobacteria cells accumulate, especially in areas that are frequented by recreationists.

In addition to targeting potential recreational exposure areas, additional samples should be collected across the extent of the bloom so that the spatial extent of the bloom can be characterized, especially if the waterbody is a drinking water supply. The drinking water intake is typically located in areas where public access is limited and may require a watercraft collection if the bloom is inaccessible from the shore. Visual estimates, documented by taking photographs and GPS coordinates, can also be used to determine the extent of the bloom. Samples are kept in the dark and on ice until they can be refrigerated.

3. ACRONYMS

HAB	Harmful algal bloom
LHD	Local Health Department
m	meter(s)
mL	milliliter(s)
l	Liter
UDEQ	Utah Department of Environmental Quality
MLID	Monitoring Location ID
DWQ	Division of Water Quality

4. HEALTH AND SAFETY WARNINGS

Algal blooms may contain toxin-producing cyanobacteria. Samplers should wear elbow/shoulder length gloves, eye protection (such as goggles), and waders/boots during sampling. Do not ingest water or allow the water to come into contact with exposed skin. Avoid inhaling spray caused by boats, wind or other water surface disturbances. If these conditions are present, wear a mask to avoid inhalation of water spray. Hands should be washed thoroughly after sampling before eating or drinking. Waders/boots should be rinsed of algal material using fresh water (not lake water) before storage.

It is important that monitors also watch for and report any symptoms of exposure to cyanotoxins, which can occur immediately to several days following exposure. Potential symptoms 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 wetsuit.

If any of these symptoms occur, monitors should seek medical treatment immediately.

Field personnel should take appropriate precautions when operating watercraft and working on, in, or around water. All boats should be equipped with safety equipment such as personal flotation devices (PFDs), oars, air horn, etc. Utah's Boating Laws and Rules shall be followed by all field personnel.

Field personnel should be aware that hazardous conditions potentially exist at every waterbody. If unfavorable conditions are present at the time of sampling, the sample visit is recommended to be rescheduled. If hazardous weather conditions arise during sampling, such as lightning or high winds, personnel should cease sampling and move to a safe location.

5. SAMPLE CAUTIONS AND INTERFERENCES

Care should be taken not to include the lake bottom materials that may be disturbed and suspended if wading.

Anything that makes phytoplankton more difficult to visualize in the laboratory can cause interference with results. Try to minimize duckweed, sediment, etc. in the sample.

High turbidity or dense aquatic vegetation may also interfere with sample collection.

Samples should not be frozen nor exposed to hot temperatures during storage (i.e., do not store in a hot vehicle outside of a cooler).

6. PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

Field staff collecting phytoplankton samples must read this SOP annually and acknowledge they have done so via a signature page (see **Appendix 3**). New field personnel must also demonstrate successful performance of the method. The signature page will be signed by both trainee and trainer to confirm that training was successfully completed and that the new monitor is competent in carrying out this SOP. The signature page will be kept on-file at DWQ along with the official hard copy of this SOP.

7. EQUIPMENT AND SUPPLIES

- ___ Copy of this SOP
- ___ Protective equipment: extended gloves, safety goggles, mask, chest/hip waders, and PFD
- ___ Several clean, plastic 1L sample bottles The State Lab provides these bottles. Alternatively, a new, unused jug of deionized/distilled/RO water could be used for sample collection. Open the bottle, pour out the contents, and rinse the bottle with native water before using.
- ___ Clean 1 gallon or greater bucket for compositing samples
- ___ 1 clean stirring rod
- ___ Digital camera
- ___ GPS
- ___ Pencils and sharpies
- ___ Sample labels
- ___ Phytoplankton sample labels (**Figure 1**)
- ___ Sample tracking forms (**Appendix 1**)
- ___ Bloom Report Form (**Appendix 2**)
- ___ Field notebook or field form
- ___ Cooler and wet ice or ice packs

Figure 1. Sample label (U:\PERMITS\MONITORS\Labels\HAB-PHYTO-CYANO(5163or5523).doc)

<u>Harmful Algal Bloom Phytoplankton Sample</u>	
Waterbody Name:	_____
Site Description (near-shore/open water):	_____ _____
Sample Type (1 or 2):	_____
MLID: _____	Visible Bloom Observed? _____
Samplers: _____	Date: _____ Time: _____

8. PROCEDURE

Due to the varied nature of HABs, a visual assessment of the bloom should be conducted prior to contacting the DWQ and sample collection. A visual assessment includes documenting the color and physical nature of the bloom (e.g., floating scum/mats) using a digital camera (**please take photos both close-up and of the extent of the bloom**). Also, note the locations and extent of the bloom, especially if it is present near any public access. Your observations should be recorded on the Algal Bloom Report Form (Appendix 2) and emailed to DWQ's HAB coordinator.

As stated above, the primary purpose of HAB sampling is to characterize the nature of the bloom in the context of plausible exposure pathways, especially those with potential to harm people and pets. Therefore, samples should target areas where there is the highest likelihood or risk of human-cyanotoxin interaction and exposure. Beaches, piers, shoreline access areas, drinking water intakes, etc. will inform collection strategies. Depending on the characteristics of the bloom at the targeted sampling site, samples can be collected by either of the methods described below.

On sample label indicate near-shore or open water for all samples collected using these collection methods:

Type 1: Surface grab: bottle immersion. Select this method if the bloom forms a concentrated algal mat or scum on the surface of the water.

Type 2: Composite: mixed site bottle immersion. Select this method if the bloom forms a thin or diffuse film on the surface of the water.

Preliminary analysis of samples collected with these methods will be conducted qualitatively. These methods will be sufficient for the examination of a sample for the presence or absence of cyanobacteria, the dominance of cyanobacteria, the identification of dominant cyanobacteria genera, and their relative abundance in the sample. From these results, toxicity testing and or further taxonomic analysis may be recommended.

If taxonomic analysis is conducted to the resolution of genera or cells/mL, the results will be quantitative, but for the contents of the sample volume alone. These methods will not quantify the composition of cyanobacteria in the waterbody, the water surrounding the bloom, or even the entirety of the bloom itself. For more intensive studies of cyanobacteria, protocols for quantitative phytoplankton collection methods are available and can be referred to if comprehensive quantified information is needed.

Preparing for Sample Collection

Prior to any sample collection, follow these initial steps:

1. Upon arrival at the waterbody, check the GPS coordinates to locate the predetermined area. Please note that this coordinate point is a recommendation and should not supersede the current, ground-based information. Use your judgement to identify the area(s) where the public has access such as beaches, piers, docks, etc., and where the bloom is concentrated. Take note of wind direction and whether the bloom has blown across the lake to another public access point. If so, collect the sample from that location. If no coordinates are given, or if the sample location changes, ensure that GPS coordinates are collected from the shoreline at the first sampling point and record them. If the sample is collected by watercraft, collect GPS coordinates from the sample location.
2. Use appropriate personal protective gear such as gloves, eye protection, mask, waders/ boots, etc. that will minimize exposures to contaminated water.
3. Label the sample bottle with the sampling location, sample type, date and time of collection (Figure 1).

Surface Grab Sample Procedures (Type 1)

If the bloom contains a concentrated algal mat or scum on the surface of the water, perform a simple, surface grab sample from the center of the bloom with a 1 liter bottle. This entails tilting the bottle parallel to the water surface with the goal of capturing only the top 1-2 inches of the surrounding surface water/scum. For thick mats, you may need to help push the material into the bottle. Several of these samples may be collected around the near-shore and within the lake by boat to target bloom/interaction risks. The precise locations of these samples may be determined by the bloom extent and water uses for that particular waterbody.

Composite Surface Sample Procedures (Type 2)

If the bloom forms a thin or diffuse film on the surface of the water, a composite sample may be needed. This procedure requires the collection of three grab samples from elbow-depth to the surface in 1 liter bottles. These triplicate samples will be composited into a bucket, mixed, and a volume of 1 L returned to a 1 L sample bottle. This sample type may be collected near-shore and in open water by watercraft by following this procedure:

1. For the Type 2 sample, carefully wade into the waterbody until knee deep.
2. Remove the lid of the sample bottle and carefully dip the inverted bottle beneath the surface of the water to elbow depth and revert the bottle and bring to the surface, evenly sampling as much of the water column as possible. Replace the lid and move to the next sample point.
3. Walk 10 feet in one direction (paralleling the shoreline) to grab the second replicate; then walk another 10 feet further to grab the third replicate sample. Take extra care when paralleling the shoreline to minimize disturbance of the bottom sediments (i.e. do not sample the kicked up sediment plume). In some cases, this may require walking back to the shore before pacing the 10 steps and then back out to knee depth.
4. Return to shore and composite the three samples in a bucket, mix the samples using a clean stirring rod, and return 1 L to a 1 L sample bottle leaving a small headspace.

Sample Storage and Reporting

Upon the completion of any sample collection, follow these procedures:

1. Store the samples in a cooler on wet ice or ice packs.
2. For each sample, fill out a bloom report form (**Appendix 2**) accurately and completely.
3. If samples are to be delivered to the lab (Section 9), fill out a Chain of Custody form (**Appendix 1**). Samples must be kept in the cooler on wet ice, or otherwise refrigerated in dark conditions until delivery to the lab for analysis.

9. LABORATORY ANALYTICAL METHODS

Phytoplankton samples will be analyzed as determined by the nature of the bloom and as negotiated with the laboratory. Samples will be analyzed qualitatively/quantitatively for community composition depending upon the level of analysis necessary.

The analysis involves the direct observation and enumeration of the phytoplankton and any cyanobacteria present in the water column sampled. Depending upon the level of analysis, phytoplankton are identified to the lowest possible taxonomic category (generally species) and counted. Cell densities for all identified cyanobacteria *sp.* will be calculated. The methodology and quality assurance and quality control procedures for this analysis and analyzing laboratory can be obtained from:

Sarah Rushforth, MS
Rushforth Phycology, LLC
470 24th Street or 4123 Bona Villa Drive
Ogden, UT
(801) 376-3516
sarah@rushforthphycology.com
<http://rushforthphycology.com/201.html>

10. DATA AND RECORDS MANAGEMENT

Fill out the bloom report form accurately and completely. Make sure information on the field sheet is consistent with the information on the sample container label.

11. REFERENCES

Boyer, G. 2008. MERHAB 2002: Tier-based monitoring for toxic cyanobacteria in the Lower Great Lakes. Available at: <http://www2.coastalscience.noaa.gov/publications/>

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Graham, J.L., Loftin, K.A., Ziegler, A.C., and M.T. Meyer. 2008. Cyanobacteria in lakes and reservoirs: Toxin and taste-and-odor sampling guidelines. In: National Field Manual for the Collection of Water-Quality Data. Available at: <http://pubs.water.usgs.gov/twri9A7/>

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Ohio DOH, EPA, and DNR. 2015. State of Ohio Harmful Algal Bloom Response Strategy for Recreational Waters. Available at: <http://epa.ohio.gov/portals/35/hab/HABResponseStrategy.pdf>

Oregon Health Authority. Oregon Harmful Algae Bloom Surveillance (HABS) Program. Public Health Advisory Guidelines. Available at: www.healthoregon.org/hab

Proceedings of the interagency, International Symposium on Cyanobacterial Harmful Algal Blooms (ISOC-HAB): State of the Science and Research Needs. Available at:
www.cdph.ca.gov/HealthInfo/environhealth/water/Documents/BGA/ISOCHABdocument.pdf

APPENDICES

Appendix 1 – Chain Of Custody form for phytoplankton samples analyzed by Rushforth Phycology

UTAH DIVISION OF WATER QUALITY					Harmful Algal Bloom - CYANO CHAIN OF CUSTODY RECORD (Rushforth Phycology, LLC)			
PROJECT:					Sample Collection Method: Surface Grab Composite Grab		Preservation: Refrigerated	
Sample Date Range:							Analysis Requested: Cyanobacteria Composition	
Sample Number	Sample Type*	Date Collected	Time Collected	MLID or Lat/Long	Site Name		Collector Initials	Notes
Relinquished By:		Date:			Time:		REMARKS:	
Received By:		Date:			Time:			

Appendix 2 – Bloom Report Form

UT DWQ Algal Bloom Report Form

Please provide information about the potential blue-green algae bloom observed.

Please remember to include digital photographs as additional documentation (close-up, and landscape showing extent and location of bloom). Also, if you don't have ability to collect GPS coordinates, please include an image from an online mapping application such as Google, Bing or Yahoo Maps, with a marker at the bloom location.

Bloom Location:

Waterbody:	Date bloom observed: / /
County (optional):	Drinking Water Source? Yes No Unknown
Publicly Owned Lake? Yes No Uncertain	Attached map with bloom location noted (e.g. Google Map image)? Yes No Digital photos attached? Yes No

Report Completed By:

Name:	Organization:	
Title:	Phone: ()	Email:

Bloom Description and Sampling Information:

Please describe the location of the bloom in the water body (e.g. center of lake, at the boat dock, at the beach):

Do you notice any colors in the water column? Yes No
Please check any colors you see, or describe the color(s) below:
Green Blue Red Rust Brown Milky White Purple Black
Other:

Please estimate the size (sq. feet) or the extent of bloom (e.g., percent of lake):

Can you see a surface scum (an accumulation at the surface) or algae floating near the water surface?
Algae floating at the surface can look like grass clippings, green cottage cheese curds, or spilled paint.
Yes No Uncertain

Is the bloom near a public beach? If yes, please specify the beach name or location:
Yes No Uncertain

Is the bloom near a drinking water intake? (Specify water system name if known):
Yes No Uncertain

Were samples taken? Yes No
If yes, what type of samples? *
Type 1 Type 2 Type 3 Type 4
When and where were they collected; and where were they sent for analysis?

Do you know if other water quality information is available? (Specify what data is available and where): Yes
No

Please provide additional observations if available e.g., smells, dead fish/birds, public witness accounts and contact info:

