CYANOBACTERIA MONITORING AND RESPONSE PLAN

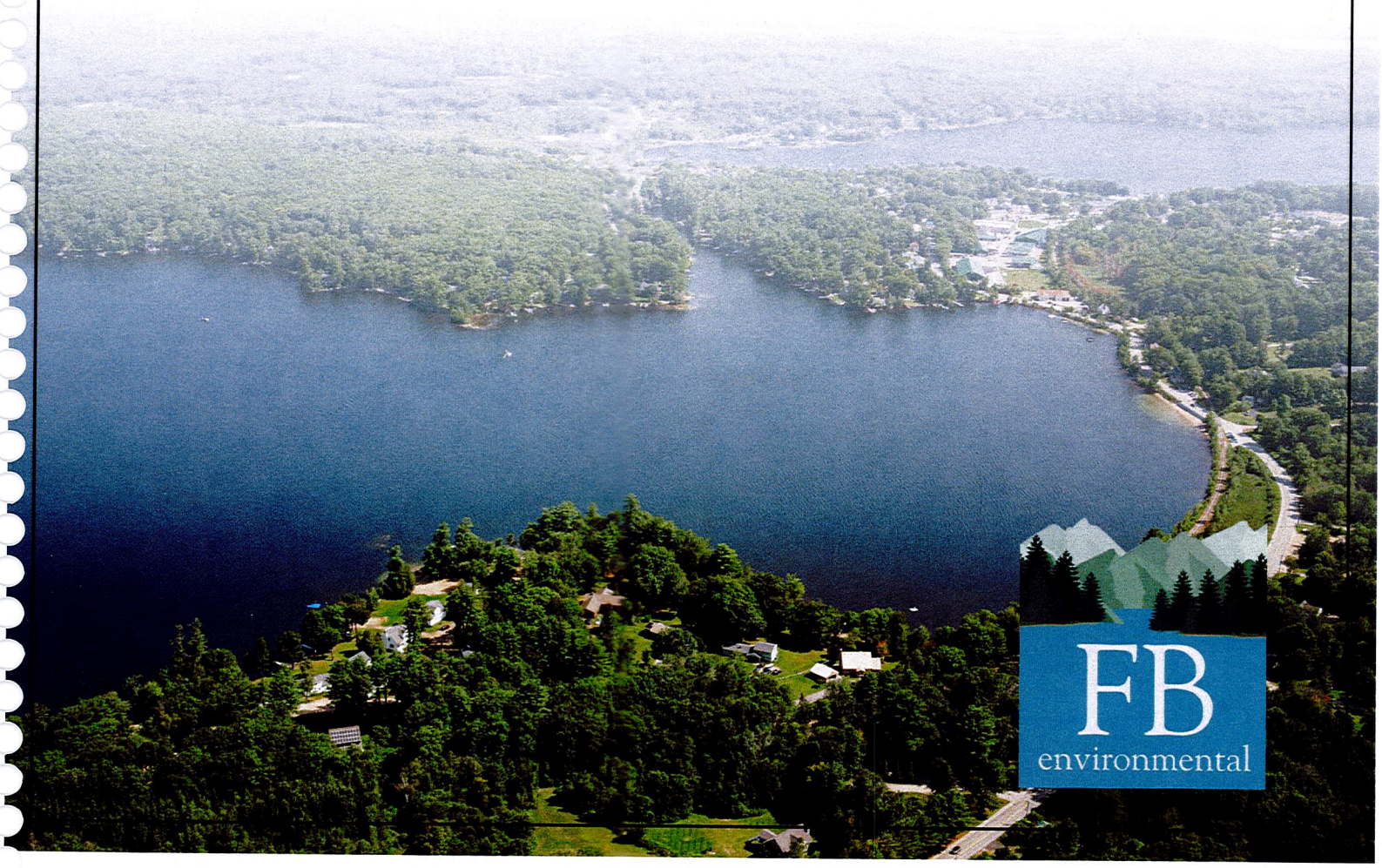
LAKE WAUKEWAN

Meredith, NH

Prepared by FB Environmental Associates

in collaboration with the Lake Winnipesaukee Alliance, University of New Hampshire, Meredith Water Department, Town of Meredith, Waukewan Watershed Advisory Committee, VLAP volunteers, and New Hampshire Department of Environmental Services

June 2025



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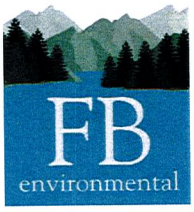

June 2025

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John Slavik
Ray Moritz*
Tim Whiting

** We respectfully acknowledge the contributions of Ray Moritz, whose dedication to monitoring and protecting Lake Waukewan was greatly appreciated and will be deeply missed.*

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For questions, comments, or additional information related to the *Lake Waukewan Cyanobacteria Monitoring and Response Plan*, please contact the Meredith Water Department at water@meredithnh.org.

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INTRODUCTION

Drawing upon a comprehensive literature review of published monitoring guidance, the *Cyanobacteria Monitoring and Response Plan for Lake Waukewan* details sustainable and practical monitoring and response actions to be carried out by the Meredith Water Department (MWD) and volunteers from the Waukewan Watershed Advisory Committee (WWAC) and Volunteer Lake Assessment Program (VLAP), among other key partners. These actions serve to track and respond to cyanobacteria blooms in the lake and ultimately prevent cyanotoxins from entering the public water distribution system. The plan was developed by FB Environmental Associates (FBE) in close collaboration with the New Hampshire Department of Environmental Services (NHDES), MWD, WWAC and VLAP volunteers, the Lake Winnipesaukee Alliance (LWA), the Town of Meredith, and the University of New Hampshire (UNH). An assessment of Lake Waukewan's vulnerability to cyanobacteria blooms and cyanotoxins, as well as thresholds for relevant screening parameters that signal bloom formation, is described in the *2025 Lake Waukewan Source Water Assessment Report* (FBE, 2025).

The *Cyanobacteria Monitoring and Response Plan* is organized as follows:

- **Section 1: Overview of the Drinking Water System** describes Lake Waukewan as a drinking water source and the treatment process at the Meredith Water Treatment Facility.
- **Section 2: Preparation for Source Water Monitoring** provides steps to be taken in preparation for the monitoring season each year.
- **Section 3: Monitoring Source Water for Early Warning Signs** outlines the indicators that will be tracked to identify a potential cyanobacteria bloom in Lake Waukewan.
- **Section 4: Immediate Actions if a Bloom is Suspected** details the steps that will be taken when early warning signs suggest the presence of a cyanobacteria bloom in Lake Waukewan.
- **Section 5: Actions Following Detection of Cyanotoxins in Raw Water** outlines the steps that will be taken following confirmed detection of cyanotoxins in raw water at the treatment facility.
- **Section 6: Actions Following Detection of Cyanotoxins in Finished Water** outlines the steps that will be taken following the confirmed detection of cyanotoxins in finished water at the treatment facility.
- **Appendix A: Monitoring Map** identifies key monitoring locations.
- **Appendix B: SOP for Maintaining the Sonde** details maintenance and deployment of the data sonde each year from April to November.
- **Appendix C: SOP for Maintaining the Weather Station** details maintenance of the weather station year-round.
- **Appendix D: NHDES CyanoHABs Response Protocol for Public Water Supplies** details the response protocol in the event of a suspected bloom.
- **Appendix E: Updated List of Accredited Laboratories for ELISA Analysis using USEPA Method 546** for cyanotoxin testing is modified from Table 3 in Appendix D.
- **Appendix F: Cyanotoxins Public Notice Form template** provides an example of a public notice for cyanotoxins in finished water.

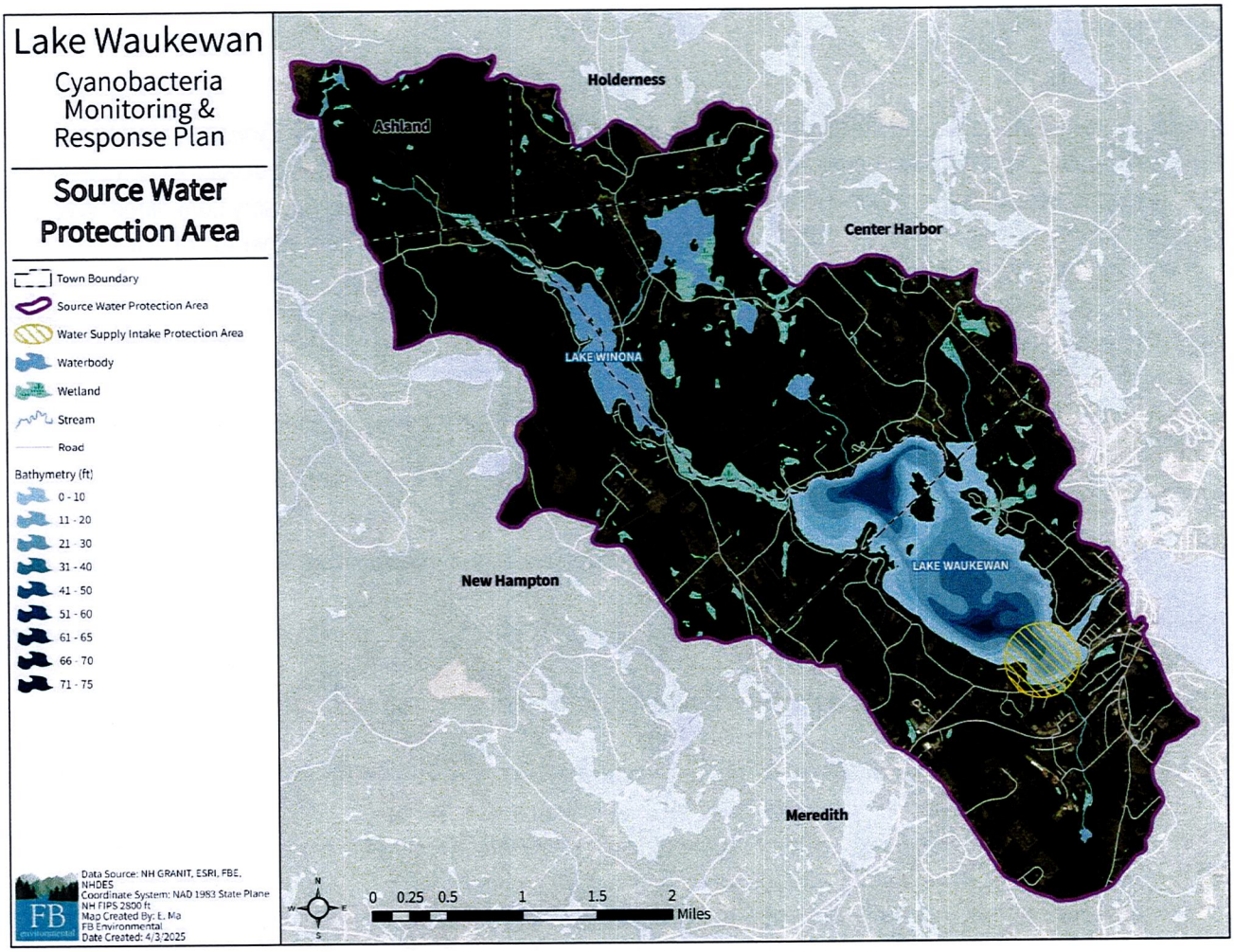

FIGURE 1. Source water protection area for Lake Waukewan as designated by NHDES.

1 OVERVIEW OF THE DRINKING WATER SYSTEM

Lake Waukewan is a 956-acre, 75-ft deep natural lake with a 9,505-acre source water protection area (i.e., watershed) in the towns of Meredith, New Hampton, Center Harbor, Holderness, and Ashland, New Hampshire (Figure 1; NHDES, 1999). Various streams flow into the lake, including the Snake River, which is the lake's major inlet that supplies water from the upstream Lake Winona. The outlet of Lake Waukewan flows from the southeastern portion of the lake into Meredith Bay of Lake Winnipesaukee, the largest lake in New Hampshire and a headwater lake of the Merrimack River. The lake level falls to an elevation of 179.5 m each year during drawdown in early to mid-October and is allowed to refill to 180.0 m in spring. The water quality of Lake Waukewan is considered excellent, though with some concerning trends and historic occurrences of cyanobacteria blooms that threaten the water supply.

LAKE WAUKEWAN CHARACTERISTICS	
Mean Depth	21 ft (6.3 m)
Maximum Depth	75 ft (23 m)
Watershed Area	9,505 acres (38.5 km^2)
Lake Area	956 acres (3.9 km^2)
Lake Volume	24,423,758 m^3
Hypolimnion Volume	1,722,640 m^3
Anoxic Volume	1,722,640 m^3
Flushing Rate	0.6 times per year
Areal Water Load	3.83 m/yr
Winter Elevation	538.5 ft (179.5 m)
Summer Elevation	540.0 ft (180 m)

Lake Waukewan serves as the public drinking water supply for over 3,000 consumers in the Town of Meredith and Meredith Village Business community. Raw water from Lake Waukewan is collected through an intake pipe situated at about 5-6 meters (m) depth in the southern portion of the lake and sent to the Meredith Water Treatment Facility near the southern shoreline on Waukewan Street in Meredith. Operated by MWD, the facility treats 600,000 gallons of raw water daily during peak summer months, with a total capacity of up to one million gallons per day. MWD maintains a 1.5-million-gallon water tower for emergency reserve water that MWD estimates would last a couple days in the event of a water intake shut-off.

1.1 Treatment Process

Raw water inflow from Lake Waukewan enters the Meredith Water Treatment Facility and is injected with aluminum sulfate (Figure 2A, 2F) to bind up particles in the water before the influent headworks splits the inflow into four large filter tanks (Figure 2B). Within each filter tank, water passes through an up-flow clarifier that contains plastic chips (Figure 2C) and then gravity-fed down through a seven-layer media filter to remove particulates from the water. The seven-layer media filter is composed of 18 inches of anthracite coal, 3 inches of garnet sand, 9 inches of silica sand, 3 inches of coarse garnet, 3 inches of 3/16-inch gravel, 5 inches of 3/8-inch stone, and 5.5 inches of 3/4-inch stone (Figure 2D). To clear out the filters and prevent clogging (high head loss), the filter tanks are backwashed with finished water (not air) daily, about every 20 hours. Backwash water is diverted through waste pipes to a 20,000-gallon waste tank located under the building. The wastewater is not recycled but released to the sewer system connected to the Franklin Wastewater Treatment Facility, part of the Winnipesaukee River Basin Program (WRBP). An estimated 8 million gallons of wastewater is generated from the facility and released to the sewer system annually. The backwash process removes some of the top layer of the seven-layer media filter, so anthracite coal is routinely added to replenish this loss and maintain the proper filter level. These filters will be replaced and the filter tanks cleaned out within the next couple years. The entire process from raw water inflow to the facility through the filter tanks takes about 10 minutes.

After passing through the filter tanks, water is treated with calcium hypochlorite for disinfection (Figure 2E). It then flows through outflow pipes (Figure 2G) into a 4-foot-deep, 55,000-gallon clear well located beneath the building. In the clear well, sodium hydroxide (caustic soda to control pH) and phosphate (to reduce corrosion) are added (Figure 2F). There are numerous check points throughout the facility using meters to monitor flow rate, turbidity, chlorine, and pH of the water

as it moves through the system (Figure 2H). The entire process from the filter tanks to the clear well as finished water takes about an hour.

Finished water is pumped from the clear well into a transmission line that flows out of the facility to a 30-foot-high, 1.5-million-gallon storage tank, where it is mixed, stored, and distributed to consumers with the help of three booster pump stations. Mixers were recently added to the storage tank to help de-stratify the water and encourage even mixing throughout the tank. The storage tank is cleaned every four years. About 200,000 (winter) to 400,000 (summer) gallons of water are used each day. The current facility and distribution infrastructure has the capacity to supply about 50% more water (~one million gallons per day). Within recent years, flow meters were added to the pump stations and helped identify major leaks in the system, resulting in about 75,000 gallons of water per day being saved. The facility is currently operated and maintained by Jason Bordeau and three other full-time employees.

The EPA's Summary of Cyanotoxins Treatment in Drinking Water indicates that conventional water treatment methods can effectively remove cyanobacterial cells and low concentrations of cyanotoxins. Coagulation, sedimentation, and flocculation processes are particularly effective for removing cyanobacterial cells and the cyanotoxins they contain. In addition, chlorine is effective at oxidizing microcystins (when pH is below 8), cylindrospermopsin, and saxitoxin, though not anatoxin-a. The EPA guidance also indicates that pre-treatment oxidation can cause cyanobacteria cells to lyse and release cyanotoxins into the water (referred to as extracellular cyanotoxins), which requires additional treatment steps. The Meredith Water Treatment Facility process does not include pre-treatment oxidation, and therefore the need for extracellular cyanotoxin removal is not anticipated. However, further monitoring should be considered as each bloom has a different lysing capacity and each bloom varies in the production of cyanotoxins.

FIGURE 2. Photographs of the Meredith Water Treatment Facility. See text above for details on each step in the treatment process.

2 PREPARATION FOR SOURCE WATER MONITORING

This section focuses on preparing MWD and other partners for the monitoring season, ensuring that all necessary materials and plans are in place to respond immediately and effectively to potential cyanobacteria blooms. It covers essential preparatory actions, such as coordinating with volunteer groups, state agencies, and laboratories to ensure readiness for the monitoring and response efforts described in later sections.

2.1 Pre-Season Coordination

1. **Meet with Partners and Prepare for Monitoring:** Before the growing season, MWD and volunteers through the WWAC and VLAP should review the plan and discuss expectations for the season with community members, state agencies, and the laboratories conducting sample analysis (Table 1). Coordination should begin in February to allow for key equipment/supply purchases and shipments. These actions will allow MWD and partners to be prepared for routine and bloom response monitoring. It will also confirm existing protocols, refresh staff and volunteer roles, and facilitate an open conversation to be continued throughout the season.
    a. Visual assessment monitors will confirm the frequency and locations of visual assessments for the season and how/whom to report possible blooms.
    b. LWA will confirm as-needed availability for immediate bloom sample screening.
    c. VLAP volunteers will confirm expectations for routine VLAP monitoring and bloom reporting for the season with the NHDES VLAP and HAB Program Coordinators.
    d. MWD will confirm expectations for bloom monitoring, reporting, and cyanotoxin testing for the season with the NHDES Source Water Protection Program.
    e. MWD will confirm with the Town of Meredith the primary mode(s) of public notifications (e.g., mail, press releases, noticeboards around the lake) and who will be responsible for sending them by reviewing *Meredith, New Hampshire Public Water System Emergency Plan*, updated July 19, 2023 (MWD, 2023). The NHDES Source Water Protection Program should be kept informed on the issuance of any public notifications related to drinking water quality and have provided template notification language to use in the event of possible cyanotoxin detection in raw or finished water (refer to Appendix F).
    f. MWD will perform pre-season checks on the function and/or calibration of the weather station and continuous data sonde and loggers for deployment.
    g. MWD will confirm acceptable performance of in-facility continuous monitoring of turbidity and pH.
    h. MWD will contact at least three preferred laboratories to confirm services for expedited cyanotoxin testing for the season. For instance, GreenWater Laboratories in Palatka, FL provides sampling and shipping instructions and chain-of-custody forms and offers a turnaround time of 1-3 days with a "rush" surcharge. Ensure that the minimum detection limit is less than health advisory limit, if available.
    i. MWD will obtain a supply of sample bottles and quenching preservatives for the season from NHDES, a preferred laboratory, and/or a reputable supplier. Refer to Appendix D for bottle types.
2. **Coordinate with Dam Operator:** MWD will coordinate with the dam operator to prepare for response actions in the event of a bloom that is determined to impact downstream Lake Winnipesaukee.

TABLE 1. Parties to contact prior to the growing season for Lake Waukewan cyanobacteria monitoring and response.

Contact	Affiliation	Timing	Responsible Party	Rationale
In-Situ, Inc. (for AquaTROLL700® sonde)		After checking equipment and supplies, Refer to Appendix B and C	MWD	Preparation for routine growing season monitoring
AquaRealTime (for AlgaeTracker®)				
LI-COR (for HOBO data loggers)				
Hach Company (for turbidity and pH meters in treatment facility)				
Columbia Weather Systems (for weather station)				
Angela LaBrecque, Town Planner alabrecque@meredithnh.org 603-667-4228 Judie Milner, Town Manager townmanager@meredithnh.gov 603-677-4209	Town of Meredith	Prior to growing season monitoring	MWD	Preparation to alert public or increase public awareness during a bloom
Harvey Pine (interim) Harvey.J.Pine@des.nh.gov Amy Smagula, Director JCLC Amy.P.Smagula@des.nh.gov 603-271-8865	NHDES VLAP		VLAP	Set expectations for routine VLAP sampling
Michele Busi (interim) Michele.E.Busi@des.nh.gov 603-848-1905 Amy Smagula, Director JCLC Amy.P.Smagula@des.nh.gov 603-271-8865	NHDES HAB Program		VLAP	Confirm monitoring approach and when NHDES is expected to be contacted (i.e., when bloom occurs anywhere around the lake, especially outside 0.5 mi of the intake)
Pierce Rigrod, Supervisor Pierce.Rigrod@des.nh.gov 603-271-0688 Liz Pelonzi, Environmentalist IV Ann.E.Pelonzi@des.nh.gov 603-271-3906	NHDES Source Water Protection Program		MWD	Confirm monitoring approach and when NHDES is expected to be contacted (i.e., when bloom is within 0.5 mi of the intake)
Bree Rossiter, Conservation Program Manager brossiter@winnipesaukee.org 603-916-2010 603-619-8703	Lake Winnipesaukee Alliance		MWD or VLAP	Preparation to use LWA for bloom sample screening
Preferred laboratory for cyanotoxin testing	Refer to Appendix D and E		MWD	Confirming services for rapid cyanotoxin testing

2.2 Prepare for Treatment Adjustments

Prior to the growing season, MWD should review the previous year's (seasonal and historical) cyanobacteria activity in Lake Waukewan and assess whether the treatment process effectively addressed cyanotoxins. In 2024, no cyanobacteria blooms were observed on Lake Waukewan, so no treatment adjustments are proposed at this time. If conditions change in the future, refer to US EPA's (2016) Water Treatment Optimization for Cyanotoxins guidance. Conventional treatment is generally effective at addressing cyanotoxins contained within cyanobacteria cells (intracellular cyanotoxins). However, when cells lyse—due to natural processes or otherwise—cyanotoxins may be released into the water (extracellular cyanotoxins). Certain cyanotoxins, such as microcystin and cylindrospermopsin, are more frequently observed in extracellular form than other cyanotoxins (AWWA, 2010). Reviewing the cyanobacteria taxa recorded in Lake Waukewan is therefore essential for identifying the potential or most predominant cyanotoxins and preparing for potential treatment adjustments. If extracellular cyanotoxins become a concern, adjustments could include adding powdered activated carbon (PAC) or granular activated carbon (GAC) early in the treatment process, as well as incorporating adsorption or oxidation steps later in the treatment chain (see Section 3 of US EPA, 2016 and Section 6.2 Treatment Adjustments in this document).

3 MONITORING SOURCE WATER FOR EARLY WARNING SIGNS

3.1 Routine Lake Monitoring

Lake monitoring will include routine, synoptic sampling that aligns with historical sampling alongside additional monitoring efforts retained from 2024 efforts conducted by FBE and VLAP volunteers (Table 2). Existing monitoring efforts will be continued as part of the plan, with the goal of building historical datasets to provide uninterrupted baseline data on lake water quality. Refer to Appendix A for a map of site locations.

Routine monitoring in Lake Waukewan shall consist of the following:

- Monthly (February during safe ice coverage and April through November) routine VLAP sampling of the Mayo (northern) deep spot [WAUMERMD], Winona (southern) deep spot [WAUMERWD], and the three tributary sites [WAUMERI, WAUMERP, WAUMERO]. Consider adding the following parameters: total iron, total nitrogen, nitrate, and ammonium for all three depth layers; total phosphorus at 2-m depth increments from 12 to 20 m in June-October; and zooplankton analyses (phytoplankton analyses already included)[1].
- Deployment of an AquaTROLL700® sonde along with four LI-COR HOBO® temperature pendant loggers at the buoy site within 200 ft (~60 m) of the intake [WAUKBUOYFB]. Remote data checks will be conducted weekly by MWD to ensure proper functioning of the sonde. Alarms are set to alert MWD to parameters surpassing thresholds determined as high risk for cyanobacteria blooms (see Section 3.2). WWAC and VLAP volunteers also have remote access. Refer to Appendix B for more information.
- Deployment of the AlgaeTracker® in the northern section of the lake, toward the Snake River inlet. Remote data checks will be conducted weekly by MWD to ensure proper functioning of the AlgaeTracker®.
- Weekly visual assessments (see Section 3.2.1) will be conducted by MWD and volunteers.
- Year-round deployment and maintenance of the weather station at the Meredith Water Treatment Facility. Remote data checks will be conducted weekly by MWD to ensure proper functioning of the weather station. Alarms may be set to alert MWD to parameters surpassing thresholds determined as high risk for cyanobacteria blooms (see Section 3.2.4.2). WWAC and VLAP volunteers also have remote access. Refer to Appendix C for more information.
- Daily checks of pH and turbidity at the Meredith Water Treatment Facility.

All sample parameters/analytes, frequencies, and responsible parties are identified in Table 2.

[1] Iron, nitrogen, and phosphorus represent essential micro- and macro-nutrients for cyanobacteria growth. Including these parameters in routine monitoring will help track changes in their availability and how those changes influence cyanobacteria prevalence in Lake Waukewan. Collecting additional discrete grab samples for total phosphorus in the hypolimnion in late summer/fall will help track the annual internal phosphorus load over time, which has been identified as a driver of late fall blooms in Lake Waukewan historically. Zooplankton are also a key part of the food web controlling phytoplankton, including cyanobacteria. Including these additional parameters will be contingent on available resources through NHDES, UNH, or other partners.

TABLE 2. Routine sampling details, including parameters, sample locations, frequency, and responsible parties. **indicates recommended add-on to routine sampling.*

Parameter	Location	Frequency	Responsible Party	Lab
Lake & Stream Sampling				
Total Phosphorus	Two lake sites (epi-, meta-, and hypolimnion grab samples), three tributary sites (surface grab samples); additional grabs at 12, 14, 16, 18, and 20 m depths for total phosphorus at the two lake sites, refer to Appendix A for locations	Monthly from April through November, once through the ice in February	WWAC, VLAP	NHDES, NH DHHS PHL
Total Nitrogen*				
Nitrate*				
Ammonium*				
Iron*				
Specific Conductivity				
Chloride				
pH				
Alkalinity				
Color				
Turbidity				
Chlorophyll-a	Two lake sites (integrated core/net)			
Phytoplankton/Zoo*				
Secchi Disk Transparency	Two lake sites			NA
Dissolved oxygen and temperature profiles	Two lake sites			Call technical support for field meter if needed
Continuous Monitoring				
Temperature	AquaTROLL700® at intake site buoy; four LI-COR temperature pendants	Continuously from April through November	MWD (WWAC and VLAP volunteers also have remote access)	Call technical support for AquaTROLL700® if needed, follow maintenance procedures (Appendix B)
Dissolved Oxygen (% saturation and concentration)				
Specific Conductivity				
pH				
Oxidation Reduction Potential				
Turbidity				
Chlorophyll-a				
Phycocyanin				
Temperature	AlgaeTracker® near Snake River Inlet	Continuously from April through November	MWD	Call technical support for AlgaeTracker® if needed, follow maintenance procedures
Turbidity				
Chlorophyll-a				
Phycocyanin				
Weekly Visual Assessments				
Visual assessments for cyanobacteria blooms	Within 0.5 miles of intake	1-2 times per week between April and November	WWAC and VLAP volunteers primary monitors (MWD periodically)	None, but refer to Section 4 for next steps if suspect a bloom
Weather Monitoring				
Air Temperature	Columbia Weather Station installed on MWD building	Continuously, year-round	MWD (WWAC and VLAP volunteers also have remote access)	Call technical support for Columbia Weather Systems if needed, follow maintenance procedures (Appendix C)
Wind Chill				
Heat Index				
Dew Point				
Cloud Cover				
Relative Humidity				
Wind Speed				

Parameter	Location	Frequency	Responsible Party	Lab
Wind Direction				
Wind Gust Speed				
Wind Gust Direction				
Precipitation				
Barometric Pressure				
Solar Radiation				
Raw and Finished Water Monitoring				
Turbidity	Each stage of treatment process in the facility	Continuously, year-round	MWD	No laboratory, call Hach technical support if needed
pH				

3.2 Early Warning Signs

During routine monitoring of Lake Waukewan, early warning signs of a potential cyanobacteria bloom will trigger response actions outlined in Section 4 (Figure 4). Monitors will look for early warning signs as described below. This list will be updated as more blooms occur within Lake Waukewan, providing new data for predicting the onset of blooms and the potential risk of toxicity.

3.2.1 Visual Signs of a Bloom

Visual signs are the most obvious indicator of a cyanobacteria bloom, including scum formation or floating material or debris on the water surface. Such accumulations may wash up on the shoreline and/or cause discoloration of the lake water. Shoreline scums could indicate that conditions are favorable for the formation of larger, whole-lake blooms; however, most cyanobacteria accumulations tend to be vernal or fleeting. Visual assessments will take place during routine monitoring by VLAP volunteers, but to increase the chances of early detection, MWD and/or WWAC and VLAP volunteers will conduct additional visual assessments within 0.5 miles of the intake pipe one to two times per week between April and November (Appendix A). MWD may also work with the Town of Meredith Police Department to complete visual assessments by drone. These assessments will be primarily and preferentially performed by boat. Alternatively, if a boat is unavailable or conditions are not suitable for boating, these assessments can be performed at key land-based locations: boat ramp, public beach, 33 Pollard Shores Rd, and 68 Water Street. A photographic database can be used by visual assessors as a reference for common cyanobacteria taxa (see UNH Center for Freshwater Biology's cyanobacteria reference) to avoid common false alarm cases (e.g., filamentous green algae such as *Spirogyra* or aquatic plants such as *Wolffia* and *Lemna*) (Figure 3). If visual assessments suspect a bloom within 0.5 miles (~805 m) of the intake, then MWD or volunteers will notify the other and proceed to Section 4. If visual assessments suspect a bloom outside of 0.5 miles of the intake, then MWD or volunteers will follow NHDES HAB Program protocols for recreational bloom warnings.

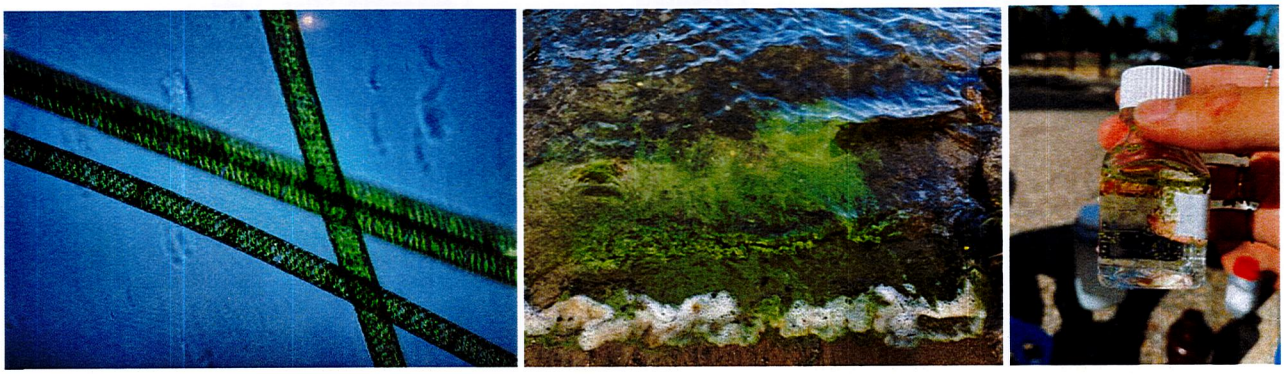

FIGURE 3. *(Left)* The filamentous green algae *Spirogyra* can be easily mistaken for cyanobacteria. *(Middle & Right)* Accumulations of the rooting aquatic plant *Wolffia* can easily appear like a cyanobacterial scum but are more easily identified as plants upon closer inspection. Photos taken by FBE staff.

3.2.3 Phycocyanin Levels

Phycocyanin is a photosynthetic pigment that is associated with freshwater cyanobacteria, making it a good indicator of cyanobacteria concentrations in lakes. Phycocyanin levels may increase as cyanobacteria populations grow, often before other indicators, such as chlorophyll-a or visual surface scums, are evident. Phycocyanin can be measured in the lake in real time by the AquaTROLL700® and AlgaeTracker® or on a per sample basis using the MWD's AmiScience FluoroQuick Dual Channel Fluorometer. This makes it a potentially valuable and practical early-warning tool for increasing trends in pigment abundances that can predict increases in productivity.

No cyanobacteria blooms have been observed in Lake Waukewan since phycocyanin measurements began in 2023. But by recording data over time, a specific phycocyanin threshold for Lake Waukewan could be identified as predictive of an impending cyanobacteria bloom (thresholds may vary among lakes). In 2024, phycocyanin fluorescence values measured by the AquaTROLL700® ranged from 0 to 0.54 RFU and revealed no relationship to cyanobacteria cell counts (FBE, 2025). In other waterbodies, cyanobacteria cell counts of 2,000 and 20,000 cells/mL corresponded to phycocyanin fluorescence values of <1 and 3-4 RFU, respectively (Ma et al., 2022). Based on data collected for the *Arlington Mill Reservoir Cyanotoxin Management Plan* (ERG, 2024), a screening threshold of 1 RFU was suggested for identifying cyanobacteria cell counts of concern, which falls within a reasonable range for RFUs and cyanobacteria cell counts observed in Lake Waukewan. Until more data[2] are collected to establish a specific threshold for Lake Waukewan, >1 RFU measured by the AquaTROLL700® phycocyanin sensor will trigger visual assessments and sampling. MWD has set up an automated alarm for phycocyanin levels > 1 RFU to be emailed to both MWD and volunteers. If an alarm is received, then MWD and volunteers will proceed to Section 4.

[2] "More data" refers to the need for sampling a wider range of bloom conditions with elevated cyanobacteria cell counts so that a statistical analysis can be adequately performed to relate cyanobacteria genera diversity and abundance to phycocyanin fluorescence and ultimately to cyanotoxin levels. The number of bloom conditions sampled as part of the statistical analysis depends on the variability in cyanobacteria composition and its influence on fluorescence and cyanotoxins. Given Lake Waukewan's limited bloom history, collecting enough data for a statistical analysis will likely take a long time to achieve.

3.2.3 Phycocyanin to Chlorophyll-a Ratio

The phycocyanin to chlorophyll-a (PC:Chl-a) ratio has been used as an indicator of the onset of cyanobacteria blooms in several lakes. A PC:Chl-a ratio between 0.5 and 1.5 or a steady increase in the ratio over a few days or weeks will be used as an early warning sign of potentially elevated cyanobacteria concentrations or microcystins based on cyanobacteria taxa (Haggard et al., 2023). MWD may set up an automated alert for that ratio to be emailed to both MWD and volunteers following instructions laid out in Appendix B. Alternatively, MWD or volunteers may discover elevated PC:Chl-a ratios on a per sample basis using the MWD's AmiScience FluoroQuick Dual Channel Fluorometer. If phycocyanin to chlorophyll-a ratios at or near (within 0.5 miles of) the intake buoy site are within this criteria, then MWD or volunteers will notify the other and proceed to Section 4. Note that it is possible that the individual RFUs may be low despite triggering the ratio threshold; best professional judgement will be used (MWD may contact Dr. Amanda McQuaid of UNH Lakes Lay Monitoring Program (LLMP) for follow-up at amanda.mcquaid@unh.edu or 603-862-3887).

3.2.4 Other Indicators

The following indicators serve as secondary early warning signs that should prompt review of the primary early warning signs described above—visual assessments, phycocyanin levels, and phycocyanin to chlorophyll-a ratios—before proceeding to Section 4.

3.2.4.1 Source Water Clarity (Secchi Disk Transparency)

An observed decrease in water clarity during routine monitoring in the lake will be considered a possible indication that a bloom may be forming. Decreased Secchi disk transparency alone will not trigger a response as water clarity is influenced by multiple environmental factors; however, volunteers will alert MWD to the change in water clarity, and MWD and/or volunteers will more closely monitor phycocyanin and chlorophyll-a data and complete visual assessments for signs of increasing cyanobacteria if water clarity decreases. Close inspection of a plankton haul sample may also be helpful in identifying potential cyanobacteria blooms (e.g., dense phytoplankton concentration in the sample). Since these plankton hauls are delivered to NHDES VLAP personnel who will analyze samples at the end of the season, a second plankton haul or grab sample may be collected for more immediate microscopy analysis by LWA or NHDES Source Water Protection Program personnel to confirm cyanobacteria as part of Section 4.

3.2.4.2 Weather and Water Temperature

Blooms are anticipated to occur within the weeks after a heavy rain event followed by or preceding hot, sunny conditions or a period of several warm, calm days during peak thermal stratification or around fall turnover at the end of the season. Cyanobacteria blooms may be unpredictable; however, Lake Waukewan blooms have been mostly observed as *Dolichospermum* in windrows or surface streaks across various locations of the lake. MWD may set up an automated alert to be emailed to both MWD and volunteers for the following weather conditions: more than three consecutive "calm" days (winds <2 mph and precipitation <0.1 inches), particularly warm (air temperature >26.7°C) and sunny (solar radiation >600 W/m^2) days, and after storm events with precipitation >0.5 inches and/or sustained wind speeds >10 mph, particularly for winds coming from the northwest or southeast direction. MWD may also set up an automated alert on the AquaTROLL700® to be emailed to both MWD and volunteers for water temperatures greater than 24.1°C (Recknagel et al., 2017) that are optimal for cyanobacteria growth. If these weather and water temperature conditions are triggered, then visual assessments and remote checks for phycocyanin levels on the AquaTROLL700® will increase to 3-5 times per week for at least one week after the alarm was received. Over time and with proper statistical data analysis, specific thresholds that are precursors to a cyanobacteria bloom may be discovered for weather and temperature data. If so, the automated alerts may be added or updated. Beach observations of cyanobacteria blooms or suspicious surface accumulations should be addressed and NHDES alerted to such observations.

3.2.4.3 Finished Water Turbidity

MWD continuously monitors turbidity in the treatment facility. If an increase in turbidity is recorded, defined as >1 NTU for a single reading (though MWD reacts to >0.3 NTU), then MWD will examine each part of the treatment process to determine the cause. Sediment is a common cause of high turbidity. If the cause is not clear, MWD will communicate with VLAP and WWAC volunteers, and visual assessments for surface accumulations and remote checks for phycocyanin levels on the AquaTROLL700® will increase to 3-5 times per week until conditions are alleviated.

3.2.4.4 Taste and Odor Complaints

Taste and odor compounds (e.g., geosmin) frequently (but not always) co-occur with cyanotoxins and provide a viable early warning indication of cyanobacteria (Graham et al., 2010). MWD currently does not have a formal system to receive taste and order complaints from consumers. If a complaint is received, MWD will record the taste and odor complaint from the water user and will assess the treatment process to determine the cause of taste or odor issues. If the cause is unknown or determined to be cyanobacteria, MWD will communicate with VLAP and WWAC volunteers, and visual assessments and remote checks for phycocyanin levels on the AquaTROLL700® will increase to 3-5 times per week until conditions are alleviated.

If the cause is unknown and there are no indications of a developing cyanobacteria bloom, then monitoring of early warnings signs will continue as normal. However, it is possible for cyanotoxins to be present in the absence of an obvious cyanobacteria bloom, as research on NH lakes by Haney and Ikawa (2001) and Johnson (1999) has shown that extracellular cyanotoxins may be a low-level constant in lakes. If the taste or odor issues persist or worsen, and no other cause is found, then MWD may consider sending samples out for cyanotoxin testing.

3.2.4.5 Other Indicators

Over time, MWD may discover other indicators of impending cyanobacteria in-lake blooms and/or breakthrough into finished water. MWD records several other in-facility parameters, such as pH and filter runtimes, at multiple stages throughout the treatment process. In-lake parameters such as pH and turbidity as measured by the AquaTROLL700® may also be important indicators of bloom-forming conditions, but lake-specific thresholds would need to be determined since other factors can influence these parameters. Once MWD has a dataset of several blooms, they may work with a water quality data scientist to statistically identify which factors best predict an impending bloom, then set up an automated alarm which alerts MWD when those conditions are present and when enhanced monitoring for blooms is warranted.

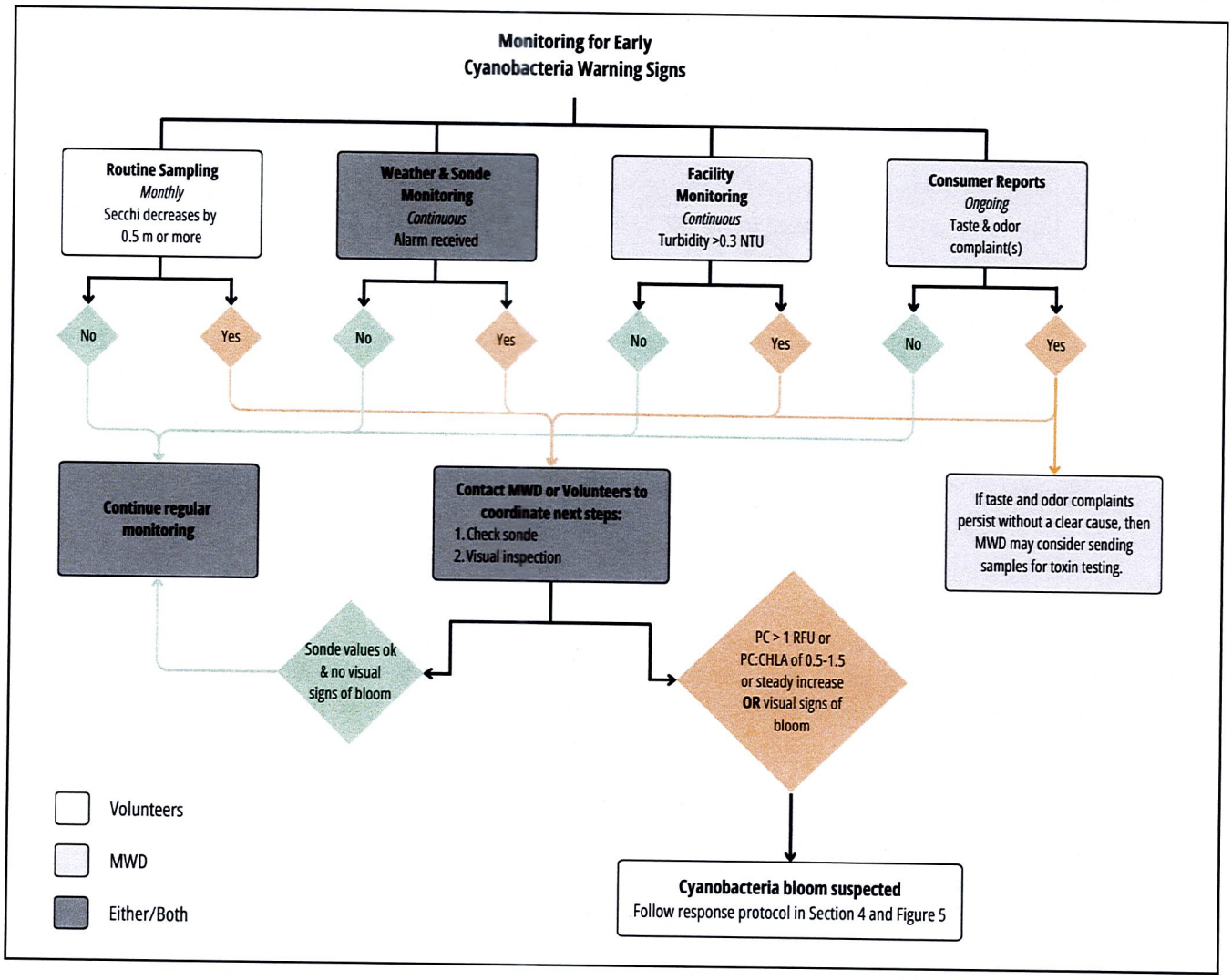

FIGURE 4. Flow diagram of monitoring for early cyanobacteria warning signs and thresholds.

4 IMMEDIATE ACTIONS IF A BLOOM IS SUSPECTED

4.1 Cell Count Confirmation

If a cyanobacteria bloom is suspected within 0.5 miles of the intake based on early warning signs described in Section 3.2, then MWD and WWAC/VLAP volunteers will follow the NHDES CyanoHABs Response Protocol for Public Water Supplies (Appendix D; Figure 5). A summary of key steps is as follows:

1. Send photographs via email and samples of the 1) suspected bloom (plankton net tow or integrated core preferred if open water, otherwise surface grab of shoreline or surface scum), 2) open water near (or within 1,000 feet of) the intake (plankton net tow or integrated core preferred, otherwise surface grab), and 3) raw water tap in the facility via direct delivery to NHDES Source Water Protection Program (Ann.E.Pelonzi@des.nh.gov, 603-271-3906, 29 Hazen Drive, Concord, NH) for confirmation of cyanobacteria presence and cyanobacteria genera identification and enumeration. Alert NHDES HAB Program volunteer point-of-contact, Janan Hays (jhays@northstarnh.com or 603-229-9562).
    a. Alternatively, samples can be diverted to LWA (brossiter@winnipesaukee.org, 603-916-2010 or 603-619-8703), whose headquarters are closest, for immediate sample screening to identify potential false alarms. Samples may also be sent to UNH LLMP (amanda.mcquaid@unh.edu, 603-862-3887). Any samples with the presence or possible presence (if LWA or UNH LLMP is not immediately available for screening) of cyanobacteria regardless of cell count will be sent to NHDES Source Water Protection Program for confirmation.
    b. Additional contacts are provided in Appendix D. If a bloom is suspected outside of weekday working hours, then the New Hampshire Department of Safety can be contacted at 603-223-4381.
    c. Label sample bottles with the waterbody name, location description (coordinates if possible or relevant) and/or location type (bloom, open water intake, raw water tap, finished water tap, other location), date and time, bloom type (shoreline scum, open water surface, whole water column, discrete depth grab if relevant), sample type (surface grab, net with tow depth, or tap), and sample method (depth of sample or tow, net diameter, mesh size).
    d. Keep samples on ice or refrigerated and deliver samples within 12 hours to NHDES.
    e. MWD and WWAC/VLAP volunteers will ensure the other party is copied on all emails and/or informed of other communications regarding the status of bloom response actions.
    f. NHDES HAB Program (HAB@des.nh.gov and interim Michele.E.Busi@des.nh.gov, 603-848-1905 or 603-271-0698) will also be copied on emails and kept informed on bloom status.

If the suspected bloom is not cyanobacteria, then routine sampling and visual assessments can continue as normal. If counts are below the thresholds near the intake area and raw water but the bloom persists within 0.5 miles of the intake, then daily visual assessments and sampling of the bloom, intake area, and raw water will continue until the bloom dissipates. If microscopic assessment by trained MWD, LWA, NHDES, or other qualified personnel confirm the presence of cyanobacteria in samples collected from the intake area or raw water at counts **greater than 5,000 cells/mL for *Microcystis* or greater than 10,000 cells/mL for all cyanobacteria genera**, then proceed to Section 4.2 Cyanotoxin Monitoring and Section 4.3 Communications.

4.2 Cyanotoxin Monitoring

If samples collected from the intake area or raw water have counts greater than 5,000 cells/mL for *Microcystis* or greater than 10,000 cells/mL for all cyanobacteria genera, then MWD will collect raw and finished water tap samples for cyanotoxin analyses following the NHDES CyanoHABs Response Protocol for Public Water Supplies (Appendix D). A summary of key steps is as follows:

1. Coordinate with NHDES Source Water Protection Program (Ann.E.Pelonzi@des.nh.gov, 603-271-3906) to identify the appropriate cyanotoxins for analysis according to the cyanobacteria genera identified in samples. Refer to Table 1 in Appendix D. NHDES can pay for expedited cyanotoxin analyses.
2. Collect sample water from the raw and finished water taps at the Meredith Water Treatment Facility according to method instructions specific to the cyanotoxins selected for analysis. Open the taps and allow the system to flush for 3 to 5 minutes before collecting samples. Add an appropriate quenching preservative (specific by cyanotoxin) to finished water samples. Be sure to not flush out the quenching preservative. Invert the samples multiple times to mix samples with the quenching preservative.
3. Ship samples overnight according to shipping instructions provided by the preferred laboratory conducting ADDA–ELISA and/or LC/MS/MS Toxin Analysis using USEPA Methods 544/545/546. Refer to Table 3 in Appendix D and E for a list of laboratories. **Laboratory cyanotoxin analyses will be performed on the raw water sample first.**
4. MWD will notify NHDES, WWAC/VLAP volunteers, the Town of Meredith, and LWA of the laboratory test results once received.

If cyanotoxin(s) are not detected in the raw water sample, the finished water sample can be discarded and Section 4.1 sampling can be revisited depending on bloom status, otherwise return to Section 3.2 early warning sign monitoring. If cyanotoxin(s) are detected in the raw water sample, then proceed to Section 5.

4.3 Communications

Public notices and postings for exceedances of recreational thresholds (>70,000 cells/mL) will follow NHDES HAB Program procedures. Communications will remain internal to the partners identified in this plan until cyanotoxins are detected in raw water or if raw water have counts greater than 5,000 cells/mL for *Microcystis* or greater than 10,000 cells/mL for all cyanobacteria genera, at which point consumer notifications will be sent out (refer to Section 5.2).

5 ACTIONS FOLLOWING DETECTION OF CYANOTOXINS IN RAW WATER

5.1 Cyanotoxin Monitoring

If cyanotoxins are detected in the raw water, then the next step is to evaluate whether cyanotoxins have passed through the treatment barriers and entered finished water (Figure 5). Under Section 4, a finished water sample would have been sent along with the raw water sample to the preferred laboratory for cyanotoxin analysis. MWD will give permission to the preferred laboratory to conduct cyanotoxin analysis on the finished water sample. MWD will notify NHDES, WWAC/VLAP volunteers, the Town of Meredith, and LWA of the laboratory test results once received.

If laboratory cyanotoxin results show detectable levels in raw water but not finished water, the treatment process is working effectively. Continue to send raw water and finished water samples for expedited cyanotoxin analysis two times per week with a 48-hour interval between samples until cyanotoxins are not detected in the raw water. Once two consecutive results indicate non-detection, MWD will resume monitoring under Section 4 or Section 3, depending on bloom status. If laboratory results indicate cyanotoxins have entered finished water, MWD will proceed to Section 6.

5.2 Communications

Given limitations set by current technology and laboratory turnaround times, there is a significant lag time between the initial possibility and final confirmation of cyanotoxin exposure in drinking water. Therefore, public notifications will be sent out according to the *Meredith, New Hampshire Public Water System Emergency Plan*, updated July 19, 2023 (MWD, 2023) for the following circumstances:

- Cyanotoxins are detected in raw water.
- Raw water counts are greater than 5,000 cells/mL for *Microcystis* or greater than 10,000 cells/mL for all cyanobacteria genera.

Public notifications will inform consumers of possible cyanotoxin exposure so that consumers can make their own choice about whether to drink the water or not depending on their own health circumstances (e.g., immune-compromised, pregnant, children, dialysis patients, etc.). Public notifications will be issued through the Meredith town website (https://www.meredithnh.org/), social media accounts, press releases, email listservs, and the local community television channel but will not include mailing to all consumers at this stage.

The NHDES template for a Cyanotoxins Public Notice Form is included in Appendix F. MWD will edit the template to include specific information about the current advisory (most items requiring edits are in brackets). MWD can also refer to US EPA's Drinking Water Cyanotoxin Risk Communication Toolbox for ready-to-use templates for advisories, advisory lifts, press releases, social media posts, and factsheets.

6 ACTIONS FOLLOWING DETECTION OF CYANOTOXINS IN FINISHED WATER

Detection of cyanotoxins in the finished water indicates the treatment process is not sufficiently treating cyanotoxins. MWD shall take the following steps in response to protect public health (Figure 5).

6.1 Continued Raw and Finished Water Cyanotoxin Monitoring

If cyanotoxins are detected in the finished water, MWD will collect and send another set of raw and finished water samples (as well as a water tower reserve sample) within 24 hours (or as soon as possible) to confirm this initial detection, and MWD will immediately proceed to Sections 6.2 and 6.3. Sampling and cyanotoxin analysis of raw and finished water (as well as the water tower reserve) will be repeated daily until two consecutive non-detects are recorded for finished water (as well as the water tower reserve).

6.2 Treatment Adjustments

If cyanotoxins are detected at a level exceeding health advisories[3] (Table 3), MWD will immediately shut off the lake water intake and switch to their emergency 1.5-million-gallon water tower reserve (pending results), which is expected to supply water for up to two days based on current water demand. MWD, in collaboration with the Town of Meredith, will immediately begin making plans for alternative water sources, including trucking in bottled water for distribution to consumers. Refer to the *Meredith, New Hampshire Public Water System Emergency Plan*, updated July 19, 2023 (MWD, 2023).

MWD will review current US EPA guidance on Water System Optimization for Cyanotoxins and evaluate the effectiveness of its treatment system by comparing results of raw and finished water samples. MWD can make minor treatment adjustments to potentially remove cyanotoxins from the finished water, such as increasing the coagulant dose and reducing flow. MWD will maintain a detailed written log of any treatment adjustments, rationale, and results to facilitate future treatment adjustments.

MWD can revert to using the lake water intake once two consecutive samples with cyanotoxin concentrations below health advisories are recorded for finished water (as well as the water tower reserve).

6.3 Communications

If cyanotoxins are detected in finished water (Table 3), public notifications will be sent out according to the *Meredith, New Hampshire Public Water System Emergency Plan*, updated July 19, 2023 (MWD, 2023):

- Public notice mailed to all water consumers.
- Public notice posted through the Meredith town website (https://www.meredithnh.org/), social media accounts, press releases, and email listservs.
- Public notice posted on the local community television channel.

The NHDES template for a Cyanotoxins Public Notice Form is included in Appendix F. MWD will edit the template to include

[3] Note that EPA health advisories are based on 10-day exposure times in drinking water, so this response is conservative to protect public health.

specific information about the current advisory (most items requiring edits are in brackets). MWD can also refer to US EPA's Drinking Water Cyanotoxin Risk Communication Toolbox for ready-to-use templates for advisories, advisory lifts, press releases, social media posts, and factsheets.

TABLE 3: 10-Day EPA Health Advisory concentrations for microcystin and cylindrospermopsin (USEPA, 2015). Anatoxin-a, saxitoxin, and BMAA do not have established EPA Health Advisory concentrations, so Best Professional Judgement (BPJ) thresholds are tentatively provided.

Cyanotoxin	Bottle-fed Infants and Children Under Six Years Old	Children Six Years and Older and Adults	BPJ Threshold
Microcystin	0.3 µg/L	1.6 µg/L	*NA*
Cylindrospermopsin	0.7 µg/L	3.0 µg/L	*NA*
Anatoxin-a	*NA*	*NA*	TBD
Saxitoxin	*NA*	*NA*	TBD
BMAA	*NA*	*NA*	TBD

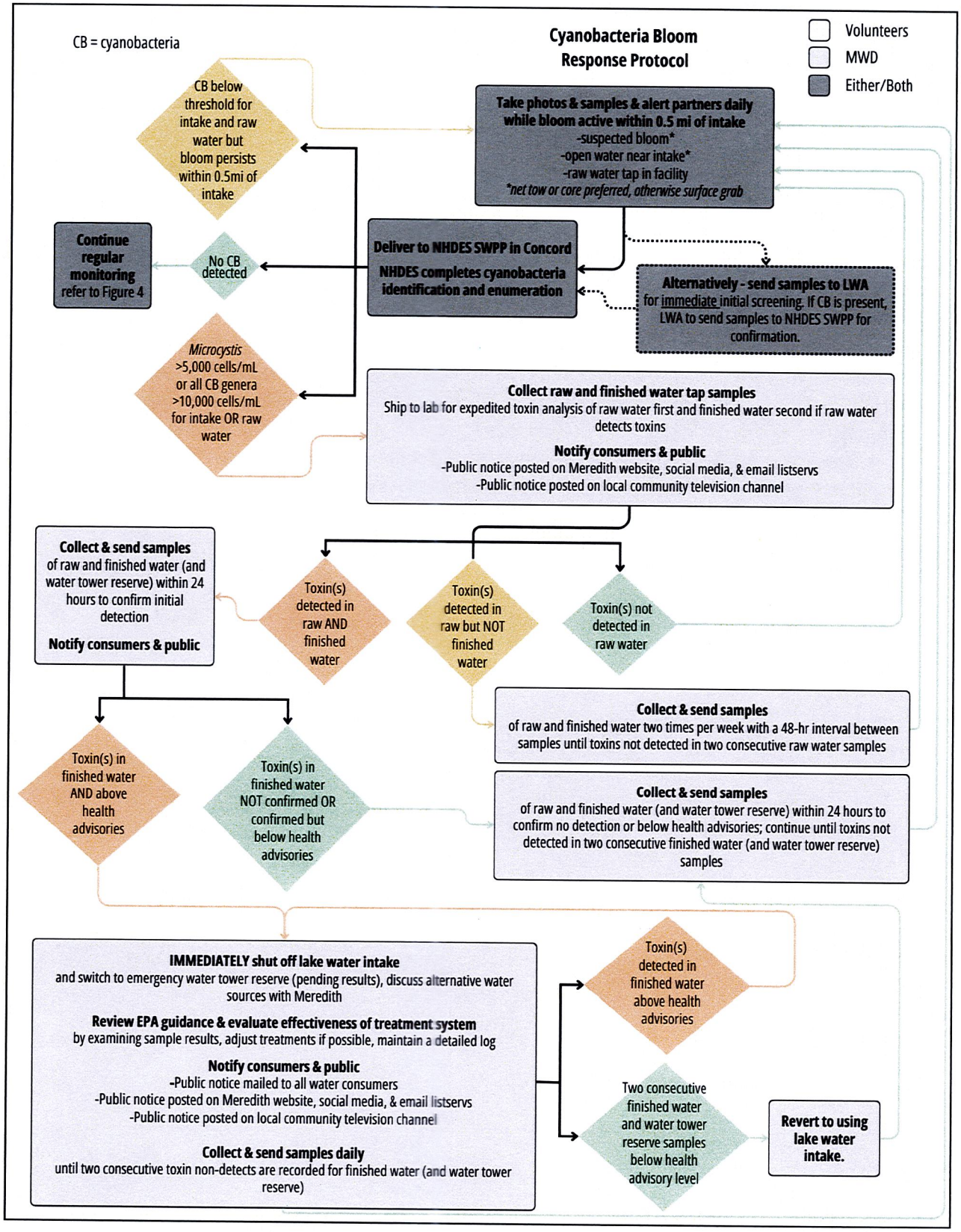

FIGURE 5. Flow diagram of cyanobacteria bloom response protocol.

FUTURE RECOMMENDATIONS

The following recommendations came from discussions with project partners on ways to improve this plan with additional infrastructure or resources:

1. MWD can consider adding text to water bills briefly explaining the risk of cyanotoxin exposure and directing consumers to call MWD if they experience any water issues, particularly taste and odor issues. MWD could also consider directing consumers to the Town's new online permitting portal, which could be used for documenting complaints. MWD can also consider including an email sign-up option on water bills, allowing consumers to receive notifications directly about potential cyanotoxin exposure.
2. LWA owns and maintains an AbraScan® Test Strip Reader to detect the presence of microcystin, cylindrospermopsin, and anatoxin-a in water samples. Though it was determined at this time to not be an efficient use of resources (given how expensive test strips are and how quickly they expire), MWD can consider coordinating with LWA in the future to use the test strips as a rapid screening tool for cyanotoxins while waiting for expedited cyanotoxin testing by a laboratory. The AbraScan® test strips do not provide precise measurements of cyanotoxin concentrations but do signal whether cyanotoxins are present in the sample and provide rapid results (less than an hour) that can be used to inform management decisions until the laboratory test results are received within 24-72 hours. MWD understands that NHDES does not accept test strip results as final measurements, only as an indicator that further testing is needed.

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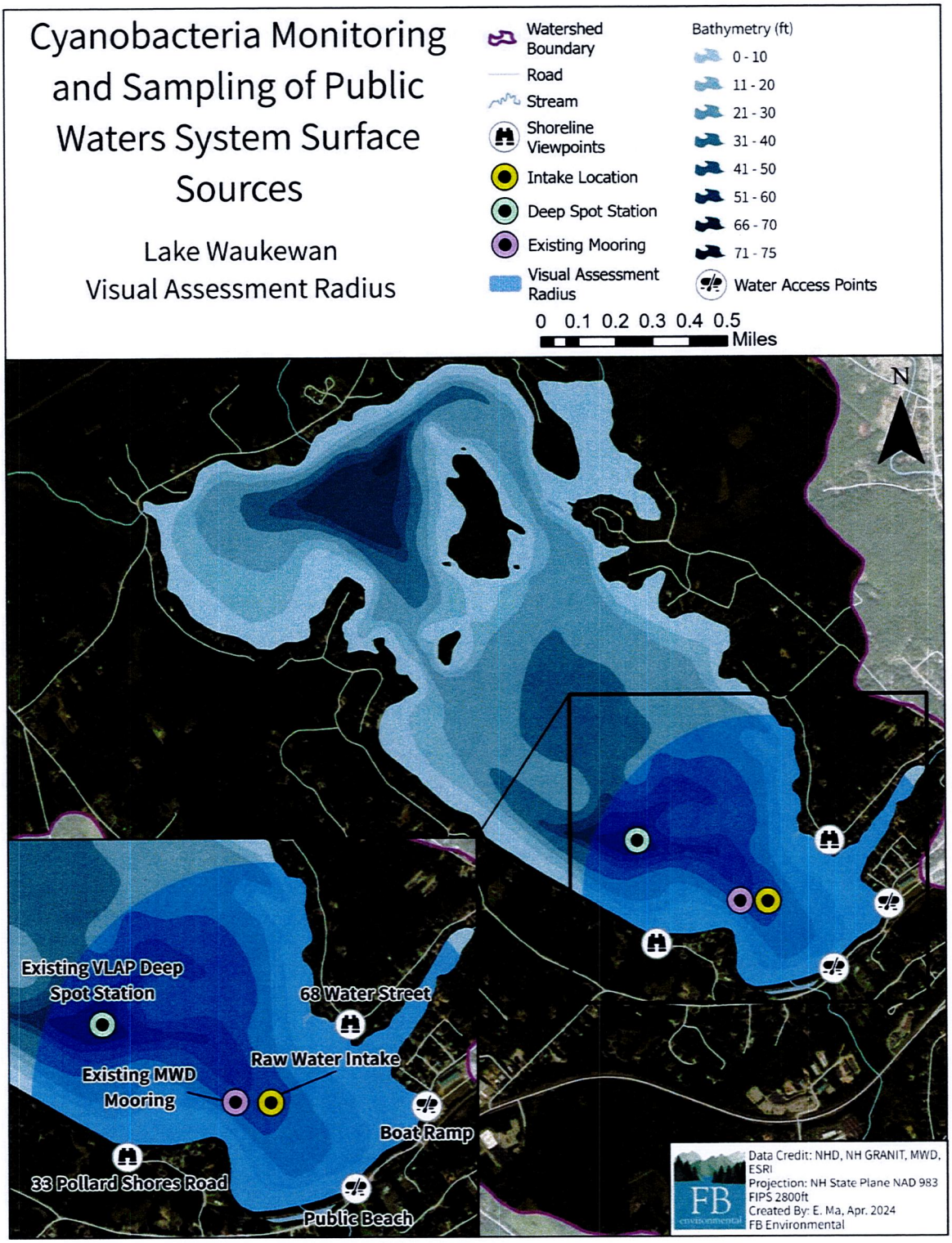
APPENDIX A: MONITORING MAP



APPENDIX B: SOP FOR MAINTAINING THE SONDE

Standard Operating Procedures for

Aqua TROLL® 700 and VuLink®

Standard Operating Procedure

Created 2/29/2024– E. Ma, Reviewed 3/1/2024, L. Diemer (Rev. 3/19/2025 by E. Ma)

Full Manuals:
Aqua TROLL® 700: https://in-situ.com/pub/media/support/documents/aqua-troll-700-manual.pdf
VuLink®: https://in-situ.com/pub/media/support/documents/0094842.pdf

In-Situ Technical Support:
support@in-situ.com
1-970-498-1500 option 2

Purpose of Instrument: Measure temperature, conductivity, dissolved oxygen, pH, turbidity, chlorophyll-*a* fluorescence, and blue-green-algae phycocyanin fluorescence. Sonde is to be deployed attached to an observation buoy or used to record readings separately. Telemetry unit is to transmit data automatically and instantaneously to be accessed remotely. This SOP covers the deployment of technology used within an observation buoy but does not cover the assembly or deployment of the buoy itself, including its anchoring system.

SUPPLIES

- Aqua TROLL® 700 multiparameter sonde with sensors for temperature/conductivity, dissolved oxygen, pH, turbidity, chlorophyll-*a,* and blue-green algae phycocyanin.
- VuLink® telemetry system with VuLink® 4G/LET/2G Cellular Antenna and Rugged Twist-Lock cable
- ShoreScience Basic Observation Buoy
- Dissolved oxygen sensor cap (RDO FAST, Part # 0066800, Expected life 12 months)
- Aqua TROLL® 700 Wiper
- 5-gal bucket, distilled water
- Kim-wipes, toothbrush/bristle, Q-tips (other cleaning supplies as noted in manuals, if needed)
- Sponges
- Six Alkaline D-cell batteries and extras
- 2.5% Rhodamine WT Dye
- 10 NTU formazin turbidity calibration solution
- 147 µS/cm conductivity standard from In-Situ or another conductivity standard
- pH 4, 7, 10 standards
- YSI Pro Solo ODO/CT meter

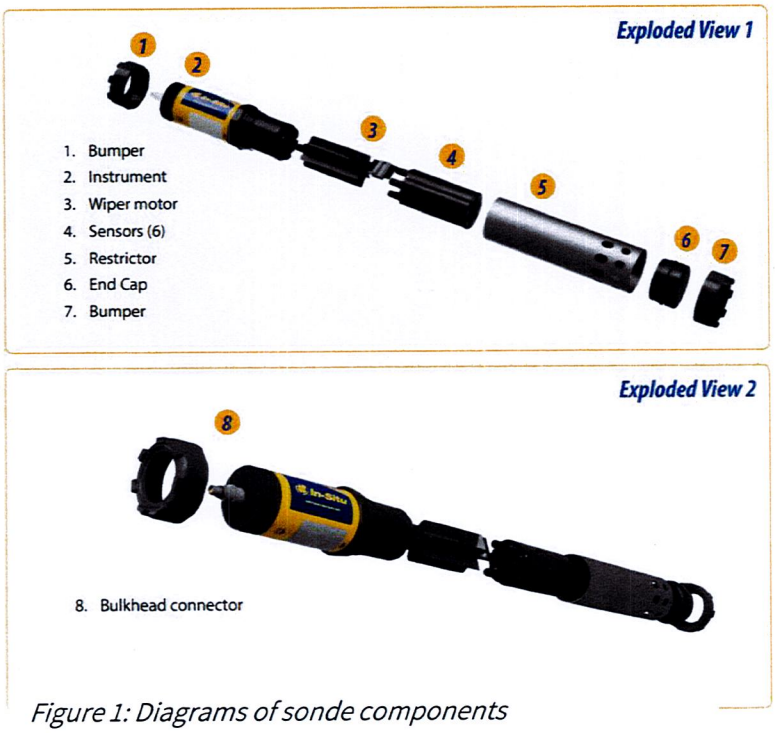


Figure 1: Diagrams of sonde components

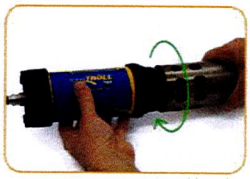
INITIAL/PRE-SEASON ASSEMBLY

1. **Install pH sensor.** The Aqua TROLL® 700 will ship with all sensors installed except for the pH sensor. The pH sensor should be replaced every 1-2 years. Remove the restrictor. Remove

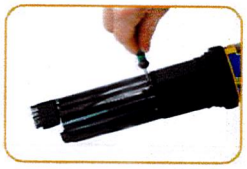
the tape and cap from the pH sensor. Apply a pea-sized drop of lubricant to the O-rings. Insert the sensor into the empty port. Tighten the screw at the base with a hex wrench.

PRIOR TO FIELD SEASON: PREPARATION AND MAINTENANCE

1. **Replace batteries.** The Aqua TROLL® 700 and VuLink® telemetry system use three Alkaline D-cell batteries each to provide internal power for continuous deployment. The battery life is estimated to be around 6 months or greater for continuous deployment with wiping. **NOTE: Due to cellular connectivity while deployed, realistic battery life is likely around ~3 months.**
2. **Replace RDO sensor cap** (lifespan 12 months). Remove the restrictor cage that protects the sensors. Use a hex wrench (included in Aqua TROLL® 700 shipment) to loosen the screw on the RDO sensor. Use the hole at the bottom of the sensor to dislodge and remove the sensor from the sonde. Remove the dust cover from the RDO sensor and install the RDO cap on the sensor. Re-insert the RDO sensor into the port and re-tighten the screw at the base of the sensor with the hex wrench.



Remove the restrictor.



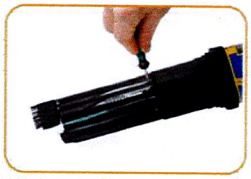
Use included hex wrench to loosen set screw on RDO sensor.

Use the small hole at the bottom of the sensor to lever the sensor out.

Remove the dust cover from the RDO sensor.

Install the RDO cap on the sensor.

Insert RDO sensor in instrument sensor port.



Tighten screw at base of sensor with hex wrench. Do not overtighten.

3. **Connect VuSitu® software to the Aqua TROLL® 700.** Download the VuSitu mobile app and connect to the sonde. An iOS device automatically connects to the closest instrument whereas an Android will need to be connected manually; ensure the app displays the connected instrument screen after the connection is made.
4. **Check LCD Screen for messages.** Turn the sonde upright to activate the LCD screen display, which will show the instrument status. It will show the sonde's connection to telemetry via a cable and the number of sensors that are installed. Check to ensure all six sensors are displayed on the LCD screen and that the "install wiper" message is not present. LCD screen will show if a port is empty or if the RDO sensor cap is at the end of its lifespan.
5. **Pre-deployment calibration.** Before deploying sondes in the field, and in the field in accordance with Table 1, perform the following procedures for each unit. Some sensors will be calibrated on an as-needed basis in the field if FBE field staff finds that meter readings have drifted substantially, significant biofouling has occurred, or readings from the YSI Pro Solo ODO/CT meter are outside of an acceptable margin of error (± 0.5 ppm):

   I. **Turbidity**

      a. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
      b. **Connect the VuSitu app to the Aqua TROLL® 700.** The calibration will be performed through the app. In VuSitu, click calibrations from the Connected Instrument screen and choose the Turbidity sensor.
      c. **Add between 20-40 mL of DI water into the restrictor**. Shake the sonde to rinse the inside of the restrictor and the sensors. Discard the DI water.

d. **Add between 20-40 mL of In-Situ's 10NTU turbidity standard or a formazin calibration solution to the restrictor.** Shake the sonde to rinse the restrictor and the sensors. Perform this twice.
e. **Pour 90 mL of calibration solution into the restrictor and cover with the end cap**. Follow the instructions on VuSitu to calibrate. VuSitu should automatically detect the formazin concentration. If it does not, select Set User Defined to input the calibration value. In-Situ recommends performing the sensor cleaning and maintenance procedure and retrying the auto detect if the sonde does not auto detect the formazin.
f. **Complete calibration in the VuSitu app.**
g. **Rinse the restrictor and sensors with DI water.**

II. Chlorophyll-*a*

Manual: https://in-situ.com/pub/media/support/documents/0038902.pdf

a. **(Optional) Calibrate to reset the zero point.** Calibrating the sensor with DI water will reset the zero point if readings are variable or drifting at the zero point.
    i. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
    ii. **Connect the VuSitu app to the Aqua TROLL® 700.** The calibration will be performed through the app. In VuSitu, click calibrations from the Connected Instrument screen and choose Chlorophyll-*a* from the list of calibrations.
    iii. **Add between 20-40 mL of DI water into the restrictor**. Shake the sonde to rinse the inside of the restrictor and the sensors. Discard the DI water.
    iv. **Pour 180 mL of DI water into the restrictor and place the small black cap on the end of the restrictor**.
    v. **Enter a standard value of 0.0 RFU.**
    vi. **Follow the on-screen calibration instructions to complete the calibration.**
b. **Prepare calibration solution.** Solution should be prepared immediately before use and discard after calibration. The procedure will yield a stock of 100mg/L Rhodamine WT that can be stored in an opaque container for up to six months.
    i. Pipette 1.0mL of 2.5% Rhodamine WT solution into a 250 mL flask or an amber bottle.
    ii. Add 249 mL of DI water (for a total of 250mL) to create a 100mg/L solution of Rhodamine WT.
    iii. Pipette 5 mL of the 100mg/L solution into a 1000mL flask or an amber bottle.
    iv. Add 995 mL of DI water (for a total of 1L) to create a 500 ug/L solution of Rhodamine WT.
    v. Store the 100mg/L solution in an amber bottle for up to six months.
c. **Calibrate using the calibration solution.** Calibration with the Rhodamine WT standard will adjust readings of higher concentrations based on known equivalency.
    i. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
    ii. **Connect the VuSitu app to the Aqua TROLL® 700.** The calibration will be performed through the app. In VuSitu, click calibrations from the Connected Instrument screen and choose Chlorophyll-*a* from the list of calibrations.
    iii. **Add between 20-40 mL of DI water into the restrictor**. Shake the sonde to rinse the inside of the restrictor and the sensors. Discard the DI water.
    iv. **Add between 20-40 mL of 500 ug/L calibration solution to the restrictor.** Shake the sonde to rinse the restrictor and the sensors. Perform this twice.
    v. **Pour 180 mL of 500 ug/L calibration solution into the restrictor and place the small black cap on the end of the restrictor**. The fluorescence-based sensors require extra calibration solution and require a cap to prevent light from interfering with the calibration.
    vi. **Enter a standard value of 2.9 RFU.**
    vii. **Follow the on-screen calibration instructions to complete the calibration.**

III. Blue-Green Algae—Phycocyanin

Manual:https://in-situ.com/us/pub/media/support/documents/Aqua_TROLL_500-600_BGA-PC_Sensor_Instructions.pdf

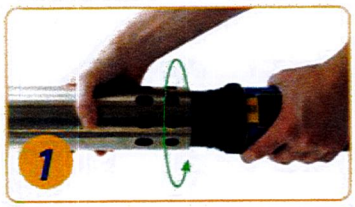
a. **(Optional) Calibrate to reset the zero point.** Calibrating the sensor with DI water will reset the zero point if readings are variable or drifting at the zero point.
   i. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
   ii. **Connect the VuSitu app to the Aqua TROLL® 700.** The calibration will be performed through the app. In VuSitu, click calibrations from the Connected Instrument screen and choose BGA-PC from the list of calibrations.
   iii. **Add between 20-40 mL of DI water into the restrictor**. Shake the sonde to rinse the inside of the restrictor and the sensors. Discard the DI water.
   iv. **Pour 180 mL of DI water into the restrictor and place the small black cap on the end of the restrictor**.
   v. **Enter a standard value of 0.0 RFU.**
   vi. **Follow the on-screen calibration instructions to complete the calibration.**

b. **Prepare calibration solution.** Solution should be prepared immediately before use and discard after calibration. Use the 100mg/L Rhodamine WT stock created in Step II.b.
   i. Pipette 1.0 mL of the 100mg/L solution into a 1000mL flask or an amber bottle.
   ii. Add 999 mL of DI water (for a total of 1L) to create a 100 ug/L solution of Rhodamine WT.

c. **Calibrate using the calibration solution.** Calibration with the Rhodamine WT standard will adjust readings of higher concentrations based on known equivalency.
   i. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
   ii. **Connect the VuSitu app to the Aqua TROLL® 700.** The calibration will be performed through the app. In VuSitu, click calibrations from the Connected Instrument screen and choose Chlorophyll-*a* from the list of calibrations.
   iii. **Add between 20-40 mL of DI water into the restrictor**. Shake the sonde to rinse the inside of the restrictor and the sensors. Discard the DI water.
   iv. **Add between 20-40 mL of 100 ug/L calibration solution to the restrictor.** Shake the sonde to rinse the restrictor and the sensors. Perform this twice.
   v. **Pour 180 mL of 100 ug/L calibration solution into the restrictor and place the calibrator (small black cap) on the end of the restrictor**. The fluorescence-based sensors require extra calibration solution and require a cap to prevent light from interfering with the calibration.
   vi. **Enter a standard value of 8 RFU.**
   vii. **Follow the on-screen calibration instructions to complete the calibration.**

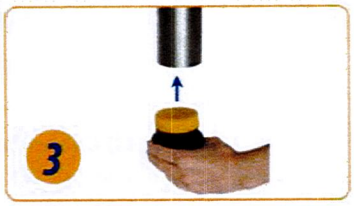
IV. RDO 100% Saturation: Water Saturated Air

a. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
b. **Cut a small piece of sponge about the size of the inside of the restrictor cap (black cap).** Saturate the sponge with water and place it on the inside of the restrictor cap.
c. **Loosely install the end cap, keeping the sensor dry and allowing for air flow.** Twist the cap once only to secure it in place.
d. **Leave the sponge in the restrictor for five minutes.**
e. **Connect the VuSitu app to the Aqua TROLL® 700 and follow the on-screen calibration instructions to complete the calibration.**

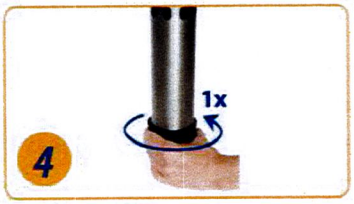


Place the restrictor in calibration mode (holes near center of instrument).

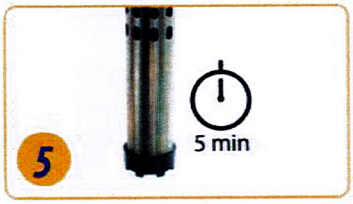
Saturate a small sponge with water.



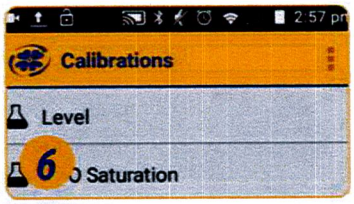
Place the sponge on the restrictor cap.



Loosely install the end cap, keeping the sensor face dry and allowing for air flow.



Leave sponge in restrictor for five minutes.



Follow the instructions in VuSitu to finish calibration.

V. Conductivity

a. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
b. **Connect the VuSitu app to the Aqua TROLL® 700.** The calibration will be performed through the app. In VuSitu, click calibrations from the Connected Instrument screen and choose conductivity from the menu.
c. **Add between 20-40 mL of DI water into the restrictor**. Shake the sonde to rinse the inside of the restrictor and the sensors. Discard the DI water.
d. **Add between 20-40 mL of 147 µS/cm conductivity standard to the restrictor.** Shake the sonde to rinse the restrictor and the sensors. Perform this twice.
e. **Pour 90 mL of 147 µS/cm conductivity standard into the restrictor and place the end cap on the end of the restrictor, making sure the sensors are submerged.**
f. **Accept calibration once the sensors have stabilized.** Review the calibration report.

VI. pH

a. **Place the restrictor (cage that protects the sensors) upside-down on the sonde, so that the holes are near the center of the sonde.**
b. **Connect the VuSitu app to the Aqua TROLL® 700.** The calibration will be performed through the app. In VuSitu, click calibrations from the Connected Instrument screen and choose pH from the menu. Follow the instructions for a three-point calibration on the mobile app.
c. **Add between 20-40 mL of DI water into the restrictor**. Shake the sonde to rinse the inside of the restrictor and the sensors. Discard the DI water.
d. **Add between 20-40 mL of pH 4 standard to the restrictor.** Shake the sonde to rinse the restrictor and the sensors. Perform this twice.
e. **Pour 90 mL of 147 us/cm pH 4 standard into the restrictor and place the end cap on the end of the restrictor making sure the sensors are submerged.**
f. **Accept calibration once stabilized and repeat steps c-e for pH 7 and pH 10 solutions.**
g. **Accept calibration once stabilized.** Review the calibration report.
h. **After calibration, flip the restrictor so that the holes are at the bottom of the cage for deployment.**

Table 1. Calibration frequency protocol for the Aqua Troll® 700 sensors.

Sensor	Recommended User Calibration Frequency	FBE Calibration Frequency Protocol	Recommended Factory Calibration Frequency
Conductivity	Only when required by user protocol	Every 2-3 months	12 months
pH	10 to 12 weeks or as required by user protocol	Every 2-3 months	12 months
DO	12 months or as required by user protocol	Every 2-3 months	12 months
Turbidity	Only when required by user protocol	Once mid-season, if needed	12 months
Chlorophyll-*a*	Only when required by user protocol	Once mid-season, if needed	12 months
BGA-PC	Only when required by user protocol	Once mid-season, if needed	12 months

6. **Set up VuLink® telemetry system.** Steps d-g may be completed in the field at the time of deployment, if desired. Completing them at deployment is recommended by In-Situ.
    a. **Create a HydroVu account at hydrovu.com or via the VuSitu app.**
    b. **Go to the telemetry page on the menu on the left side of the page.** Click "Add a VuLink".
    c. **Claim VuLink by scanning the QR code on the device or inputting the registration code.**
    d. **Attach the antenna.**
    e. **(If first-time deployment) remove the battery cover by twisting counter-clockwise and pulling down.** Remove the yellow tab, which will allow the batteries to power the device. Replace the cover.
    f. **Press the center button on the top of the VuLink®.** The LED lights will turn on. Each color represents device status. Check colors on page 11 of the VuLink® Manual. Connect a mobile device to the telemetry unit via Bluetooth and access it through the mobile app. The telemetry unit should automatically connect to a cellular network and the HydroVu cloud. Allow up to 10 minutes for the telemetry unit to connect to cellular network. If VuLink® has trouble connecting to a 4G network, switch to 2G through the "All Settings" menu option in the VuSitu app. Tap "Cellular Network" and tap "2G" to change. Save. All LED lights should be green when the sonde is connected to the telemetry unit, except for the Bluetooth LED, which should be blue if connected to a mobile device.
    g. **Create alarms in HydroVu.** Alarms may be set to signal low battery or when parameters cross a specific threshold. Alarms can be set by tapping the "All Settings" menu option, tapping "Real-Time Alarms", and creating the custom alarm in the VuSitu mobile app.

DEPLOYMENT METHOD

The Aqua TROLL® 700 sonde may be deployed for continuous monitoring in the ShoreScience Basic Observation Buoy or another buoy setup. The buoy will be deployed in-lake, and the sonde will sub-continuously record data at 30 minute intervals. Data will be wirelessly and automatically transmitted using VuLink® telemetry and will be available instantly on the HydroVu data portal. See video tutorial for additional assistance.

1. **Connect the AquaTROLL® 700 to VuLink® using the Rugged Twist-Lock Cable.** Ensure the restrictor is in deployment mode (holes on the bottom) and the bottom bumper is attached to the sonde.
2. **Once connected to the VuLink, switch devices to the AquaTROLL 700.**
3. **Create a log for the Aqua TROLL® 700 and set the logging frequency to 30 minutes using the "logging" button in the VuSitu mobile app.** Set a scheduled start if setting up the sonde before deployment. Ensure the battery life

is full, and, if not, replace batteries. This log does not upload to the cloud but serves as a backup that can be downloaded through the VuSitu mobile app at each site visit.

4. **Switch the selected device on the VuSitu mobile app to the VuLink® telemetry unit and create a log and reporting schedule using the "logging" button.** Set the logging schedule to 30 minutes. Set a scheduled start if setting up telemetry unit before deployment. When the device reports, it takes unsent readings and sends them to HydroVu. Set the reporting schedule (different from the logging schedule) by changing the upload frequency to 6 hours. More infrequent reporting allows for the VuLink to save battery.
5. **Check the connectivity before deploying buoy by running a test.** The telemetry unit will upload a test report to the cloud which will verify that the instrument and telemetry unit are connected to the cloud.
6. **Open the top of the Shore Science Basic Observation buoy and place the Aqua TROLL® 700 and VuLink® telemetry unit inside.** Secure the VuLink®.
7. **Deploy Shore Science Basic Observation Buoy.**
8. **Meter Readings:** Once the sonde has been in the water for at least 15 minutes, take meter readings using the YSI Pro Solo ODO/CT or another meter for DO, conductivity, and temperature. Record depth reading. Profiles reading may be used to calibrate the Aqua TROLL® 700 or perform quality control checks.

FIELD MAINTENANCE

1. **Pre-Field Checks**
    a. Gather all field equipment.
    b. Calibrate portable field meters according to manufacturer instructions. Record calibration measurements on the calibration log (shown below) or electronic field form.
2. **Condition Checks**
    a. Upon arriving at the field site, pull the buoy onto the boat. Open the top of the buoy be removing the marine-grade light to access the VuLink.
    b. Press the center button on the VuLink and check the status of the telemetry unit. Connect to the VuLink via the VuSitu app. All lights should turn green (except for the Bluetooth light, which should be blue). The "cloud" light is most likely to turn red, indicating that there is an issue connecting to the HydroVu cloud. You can troubleshoot this by sending a test upload or by calling technical support.
        i. It is possible to force-upload all existing data to the cloud if the VuLink is not automatically sending data to HydroVu. Enter the log and select "Upload." For support, please call In-Situ technical support.
    c. Pull up the sonde and check its overall condition. Record a time stamp of when the sonde is out of water; note if the buoy has moved from its last known location or if there is any debris covering the sonde. Check the overall security of the sonde and buoy and their deployment stability.
        i. Always take pictures of any unusual field conditions to help with data interpretation back in the office.
    d. If the battery light is red, or below 40% (assuming one month between field visits) replace the batteries in the VuLink by twisting off the top cover.
    e. On occasion, both the VuLink and the Aqua TROLL 700 will need software updates. These should come up automatically on the screen. Always accept and perform the update immediately. It will take a long time to update.
3. **Calibration Checks**
    a. Place YSI Pro Solo ODO/CT or other meter sensor directly in water next to the buoy at the same depth as the Aqua TROLL® 700. Wait 5 minutes for temperature equilibrium.
    b. Compare meter readings for temperature, DO, and conductivity to Aqua TROLL® 700 readings on the VuSitu mobile app. Record the values, date, and time. Assess if Aqua TROLL® 700 readings are drifting for any given sensor.
    c. Calibrate the Aqua TROLL® 700 sensors, if needed, in accordance with calibration criteria from Wagner (2006) (Appendix A) and this SOP.

d. If Aqua TROLL 700 readings are not drifting, but three months have passed since the last calibration, re-calibrate according to Table 1.

4. **Cleaning and Inspection**
    a. Take the data sonde out of the water and gently wipe the sensor faces with a Q-tip, kim-wipe, or soft toothbrush. Squirt DO sensor cap with DI water.
    b. Check the condition of the DO sensor wiper and assess if it is wiping properly. Reposition wiper, if needed.
    c. Note sensor condition (biofouling) and record time out of water.

TAKING FIELD MEASUREMENTS

1. **If deployed alongside the buoy, retrieve the sonde by reaching into the water or by using a long tool to pull the cord.** Record the time the sonde is pulled out of the water as any measurements taken while the sonde is in motion or changing depths should be excluded from the dataset.
2. **Complete any maintenance required as outlined in this SOP.**
3. **Open the VuSitu app to access live readings from the sonde.**
4. **Allow the readings to stabilize.** Allow temperature to stabilize and wait approximately 25-30 seconds for the DO readings to stabilize. Other parameters that are fluorescence or light-based (turbidity, chlorophyll-*a*, and BGA-PC) may take longer to stabilize or may never fully stabilize.
    a. Take an average value if the reading fluctuates up and down.
    b. If readings slowly drift, make sure the probe is stationary (not moving to deeper depths).
5. **Record data on a paper field form or data collection app.**
6. **Temperature and dissolved oxygen profiles and profiles for other parameters will be taken in accordance with the FBE Lake Sampling Procedures SOP.**

RETRIEVAL & WINTER STORAGE

1. **Retrieve the sonde and VuLink® telemetry system and return to the office.** Do not disconnect the units until it is certain the data is securely on the cloud and is downloadable.
2. **Remove the restrictor and clean sensors with DI water.** Remove any residue from deployment. Dry with a soft lens cloth or kim-wipe. If more rigorous cleaning is needed, soak the individual sensors in either mild dish soap or vinegar in accordance with the Aqua TROLL® 700 user manual. Inspect lenses for scratches.
3. **Store the sonde and sensors for the winter.**
    a. **Remove the pH sensor.** Dampen the sponge inside of the pH sensor storage cap with pH 4 calibration standard. Replace the caps at both ends of the sensor. Seal the cap with electrical tape.
    b. **The RDO sensor, turbidity sensor, and temperature/conductivity sensor may be stored wet or dry on or off the sonde.** Never store the RDO sensor without a sensor cap.
    c. **Thread the restrictor onto the sonde in calibration mode.**

Appendix A

Table 7. Calibration criteria for continuous water-quality monitors.

[±, plus or minus value shown; °C, degree Celsius; µS/cm, microsiemens per centimeter at 25 °C; %, percent; mg/L, milligram per liter; pH unit, standard pH unit; turbidity unit is dependent on the type of meter used]

Measurement	Calibration criteria (variation outside the value shown requires recalibration)
Temperature	±0.2 °C
Specific conductance	±5 µS/cm or ±3 % of the measured value, whichever is greater
Dissolved oxygen	±0.3 mg/L
pH	±0.2 pH unit
Turbidity	±0.5 turbidity unit or ±5% of the measured value, whichever is greater

APPENDIX C: SOP FOR MAINTAINING THE WEATHER STATION

Standard Operating Procedures
for
Columbia Pulsar 700 LX Weather Station, Weather MicroServer, & WeatherMaster Software

Created by: M. Kosalek, FB Environmental (2/6/2025)
Reviewed by: C. Dalton, FB Environmental (4/23/2025)

This SOP is for the operation and maintenance of the Pulsar 700 LX Weather Station, Weather MicroServer, and WeatherMaster Software.

Pulsar Weather Station User Manual: https://columbiaweather.com/resources/manuals-and-brochures/pulsar-docs/pulsar-user-manual.pdf

Weather MicroServer User Manual: https://columbiaweather.com/resources/manuals-and-brochures/ms-docs/weather-microserver-user-manual.pdf

WeatherMaster Software User Manual: https://columbiaweather.com/resources/manuals-and-brochures/weather-master-docs/wm-user-manual.pdf

Contents

What you need to know/the most important information

The WeatherMaster Administrator console username and password are both "admin".

We recommend changing both to unique values. Keep a record in multiple places of the new username and password.

Regular Maintenance

- **DAILY/WEEKLY**
  - **View the data via web browser.**
    - The main desk computer is set up to access the weather station data. The data can be viewed from any other computer at https://ws.columbiaweather.com/Meredith/WeatherStations/Meredith_Pulsar/RT/main or through the Columbia Weather Systems App
      - To connect to the station in the app, click the three lines in the top right corner > Account > Connect Account, then type in "Meredith" for the Account ID.
    - Check that "Measured at" date and time (top left) is current. If the date and time are in the past, incoming weather data stopped at that time.
    - Check that plausible weather readings are coming in. Do temperature, precipitation, and wind seem correct?
- **MONTHLY or AS NEEDED**
  - **Remove leaves and other debris** that accumulate on sensors and check to ensure the system is still firmly mounted.
  - **Clean the sensor transmitter** with a soft, lint free cloth moistened with water (Kim wipes, Q-Tips, or other).
  - Export weather data to a local hard drive. See the Exporting Data section below. This is important because any **power outage can erase data** on the datalogger. Note that data can only be downloaded from the main desk computer.

Alarms

Alarms can be set so that an email is sent if certain parameter levels are measured (e.g., temperature is over X degrees; rain is 0 inches for X number of days; etc.)

1. In the Options menu, select Alarms.
2. To add an alarm, select "Add" under the Alarm Conditions box. Give the alarm a name and click OK.
3. Select the alarm and define upper and/or lower limits.
4. Select Add under the Notifications box to add a type of notification. There are 3 options:
   a. Popup: the computer will sound a tone when alarm conditions are met.
   b. Email:
      i. Enter Description
      ii. Sender Name: name of person using WeatherMaster.
      iii. Sender Email: Email of person using WeatherMaster.
      iv. Subject Line: subject line of email.
      v. Email Address: email of recipient can be the same as the sender email.
      vi. Mail Server: enter name of mail server.

c. Relay Control: An additional USB 4 channel Relay Controller needs to be purchased to enable this feature.

If the WeatherMaster page isn't showing up on the computer, connection is lost, or data seems inaccurate

1. If the page on the main desk computer is gone, type "10.60.0.14" into the browser search bar and hit enter. This should bring the page up.
2. If the data are not showing up or not refreshing (Latest Measurements are outdated), go to the box in the attic to check that all wires are properly connected.
   a. See Connecting the sensors for information on connecting the sensor wires properly
   b. Also check that the ethernet cable (inside box) and all other cables are securely connected. Check that the grounding wire (connected to outside of box) is connected securely to the box and the grounding medium at the other end of the wire. Check that the long ethernet and grounding wires that run through the building are intact (i.e., not chewed by mice). Check that the ethernet cable is properly attached to the modem.
   c. If the station has disappeared from the page on the computer, it may need to be added again. See **WeatherMaster Software** section for steps to add the station.
   d. If these steps do not fix the issue, contact the IT Department to ensure there are no issues with the network. Network details obtained from IT at time of setup:

Firmware Version: MS_3.1.1 B13084 [2023-11-14 13:02:05]
Kernel Version: 5.4.3-imx6ul+g1b88e6a2b5d5
Hardware Model: MARK III (cws-vs6ull)
Serial Number: MS3652
RS485 Available: yes
Current Time: 2024-05-29 16:16:25 EDT
Hardware Time: Wed May 29 16:07:25 2024 0.000000 seconds
MAC address: F8:DC:7A:B3:7F:90
IP address: 10.60.0.14
Subnet mask: 255.255.255.0
Gateway: 10.60.0.1
DNS Server: 10.0.0.134
Data Manager Status: Running
Device Status: up 21 min, 0 users, load average: 0.06, 0.04, 0.00
Device running from: flash
SD card status: ok
User: 0
System: 0
Idle: 100

If connecting the data to a Cloud Server is desired (bypass hardwire connection), send an email to support@columbiaweather.com and they will set up an account for you (this is free).

   e. If the data seem inaccurate, check that the sensor is properly cleaned, and all wires are connected as explained in the previous step (2). If the data still seems inaccurate, contact Columbia Weather

Systems Technical Support [webpage] as the calibration of the system may be off and the sensors may need to be sent in for repair (all sensors are factory calibrated and should be returned to Columbia Weather Systems for calibration and adjustment via factory service).

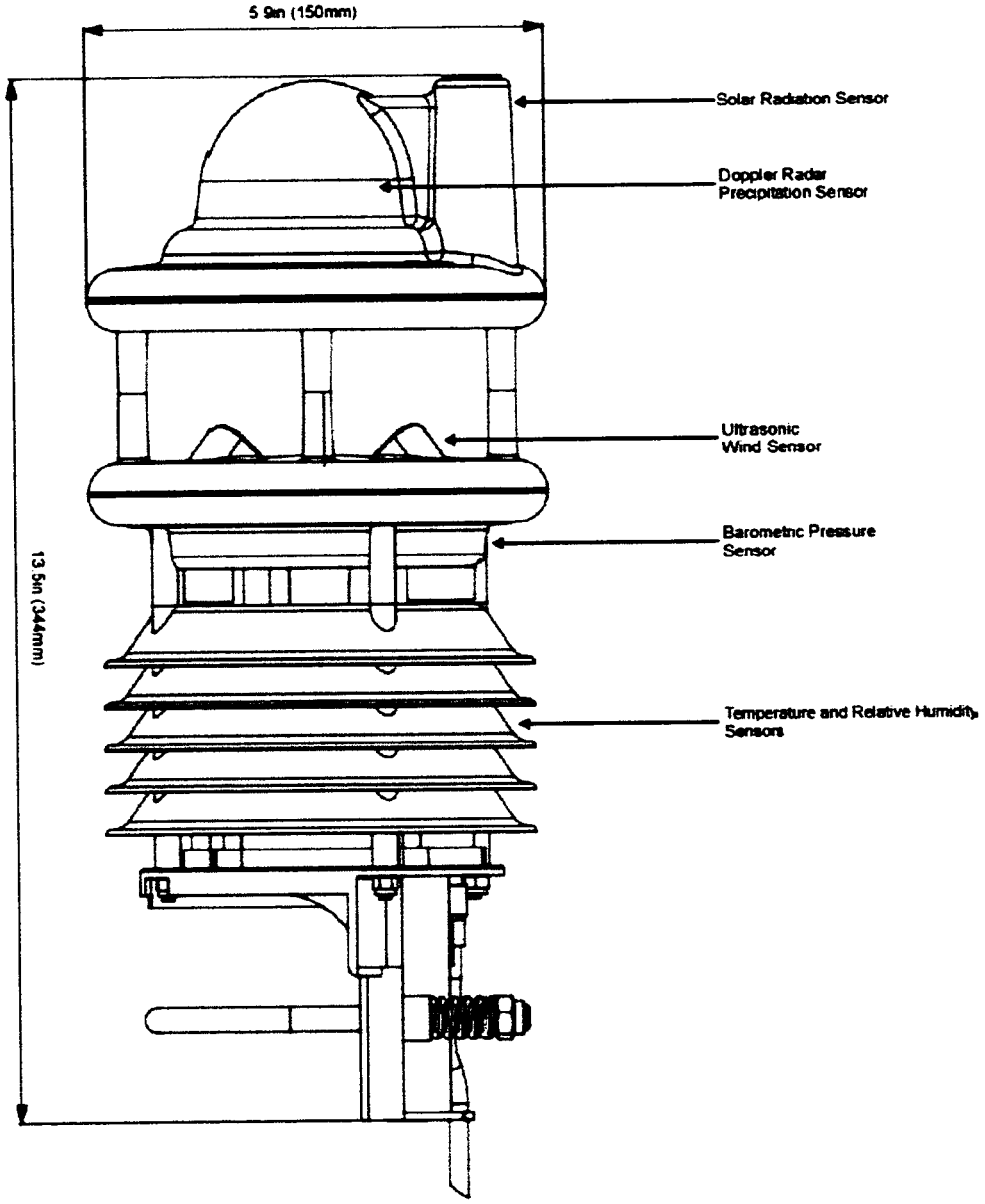
Pulsar 700 LX Weather Station

Safety Notice: Avoid Electrostatic Discharge (ESD) shock by handling ESD sensitive components while the components are properly grounded. If this is not possible, at least touch a conductive part of the equipment chassis (frame) with your hand before touching the boards. Always hold the boards by the edges and avoid touching component contacts.

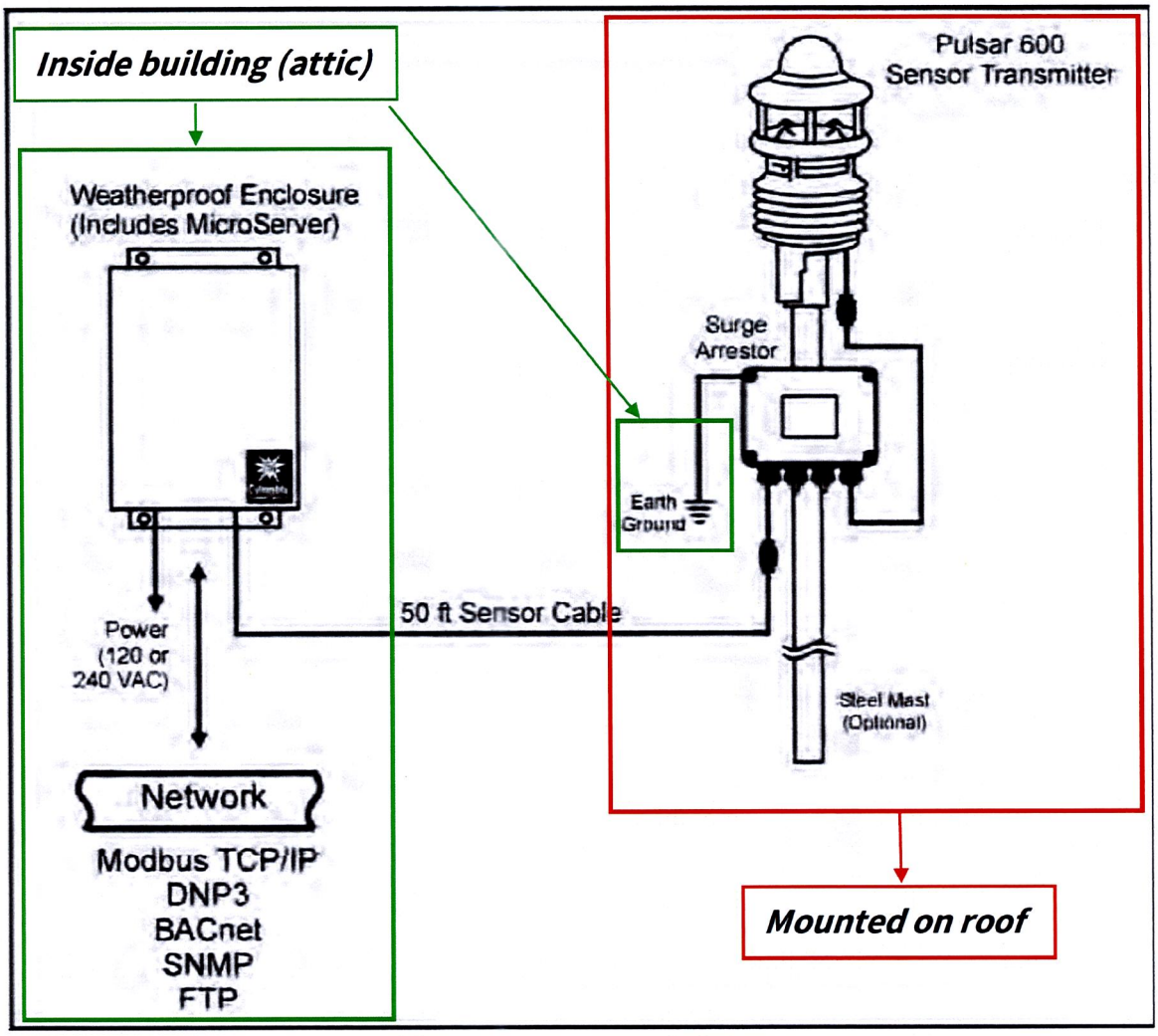
Pulsar Weather Station Sensor Data Specifications.

Sensor	Range	Accuracy	Resolution	Response Threshold	Available Units
Wind Speed	0 to 167 mph (0 to 75 m/s)	±0.67 mph (0.3 m/s) or ±3% 0 to 78 mph and ±5% >78 mph	0.2 mph (0.1 m/s)		Knots, mph, km/hr, m/s
Wind Direction	0 to 360°	< 3° (>1 m/s)	0.1°	0.01 mph (0.3 m/s)	degrees
Relative Humidity	0 to 100%	±2% RH	0.1% RH		%RH
Temperature	-58 to 140°F (-50 to +60°C)	±0.36°F (-4 to 122°F) otherwise ±0.9°F (>-22°F)	0.18°F (-4 to 122°F) otherwise ±0.36°F		°F, °C
Barometric Pressure	8.85 to 35.4 inHg (300 to 1200 hPa)	±0.015 inHg (0.5 hPa) (32 to 104°F)	0.003 inHg (0.1 hPa)		kPa, hPa, mbar, inHg
Precipitation: Doppler Radar (rain or snow)	0.01 to 0.2 in (0.3 to 5 mm) (drop size)		0.0004 in (0.01 mm)	0.002 mm	mm, inches
Precipitation: Tipping Bucket Rain Gauge (rain)		±2%	0.2 mm (0.007 in)		mm, inches
Compass	0 to 359°		1.0° (sample rate = 5 min)		
Solar Radiation	0.0 to 2,000 W/m² (Spectral Range = 300 to 1,100 nm)			Response time (95%) = <1 sec	

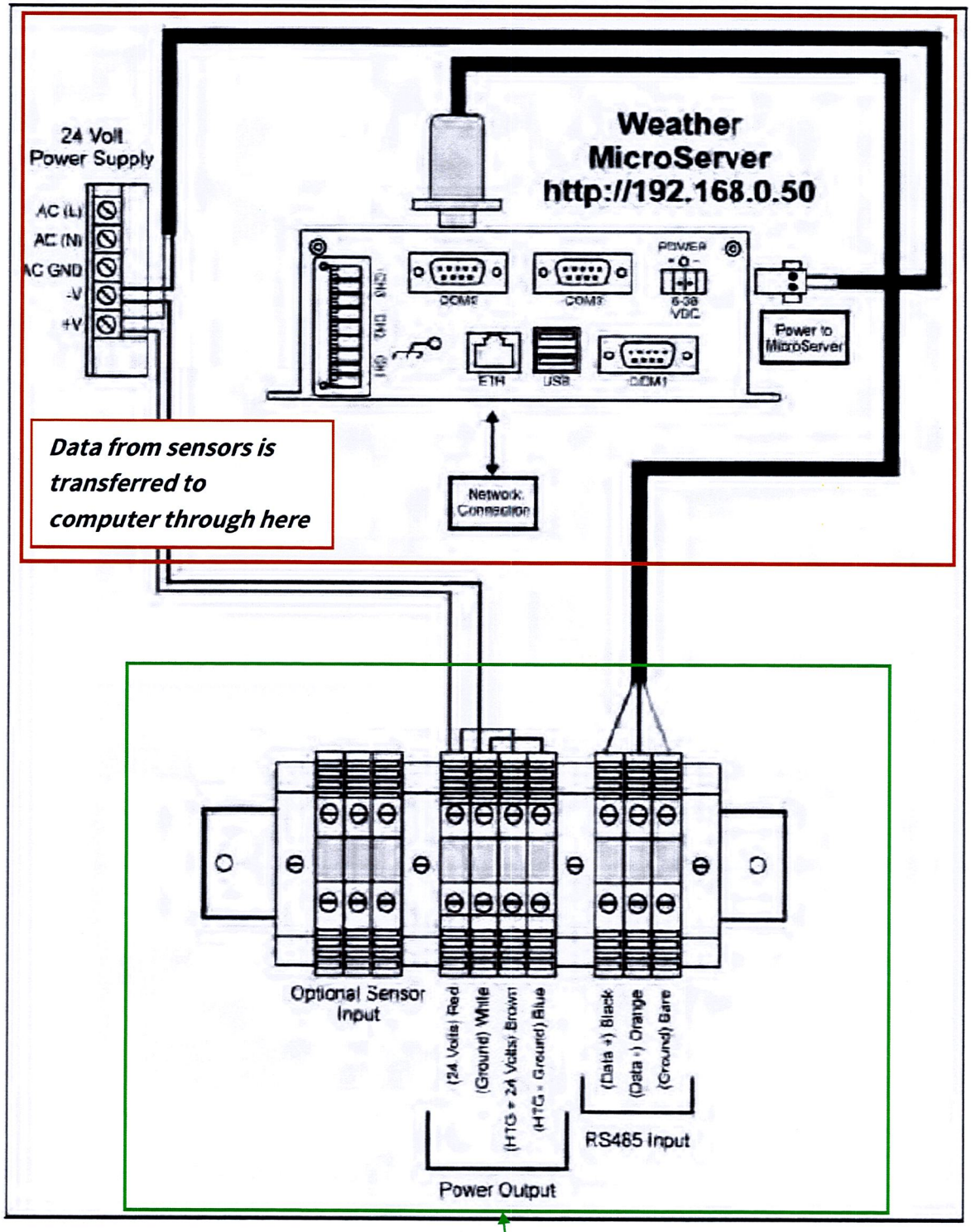
Pulsar 700 Weather Station Configuration.



System configuration with weatherproof enclosure.



Weatherproof enclosure wiring diagram.



System Parts

Base system

- Pulsar Sensor Transmitter [weather station, light bulb-looking piece]
- 50 ft sensor cable [runs from weather station, through attic to box]
- Interface Module with (2) 3-position terminal blocks [inside box, transfers data to MicroServer]
- 24VDC power supply [regular plug to power box]

Weather MicroServer

- MicroServer [inside box, transfers data to computer]
- Power supply [powers system]
- Ethernet cable [connects box to wifi – this is what allows the system to run on the local IP Address]

Surge Arrestor

- Surge Arrestor [mounted to metal pole that Pulsar is on]
- Mounting Hardware

Installation of Pulsar Sensor Transmitter

Site Selection

- Select a site that is free from turbulence caused by nearby objects, such as trees or buildings. It is suggested to install a lightning rod nearby with the tip at least one meter above the sensor transmitter.
- The system should be mounted away from other data cables and at least 25 ft from power lines.

Tripod and Tiedown Kit

- Insert the legs into the main body and secure with retainer pins. Extend mast to desired height and insert another retainer pin. Install guy wires.

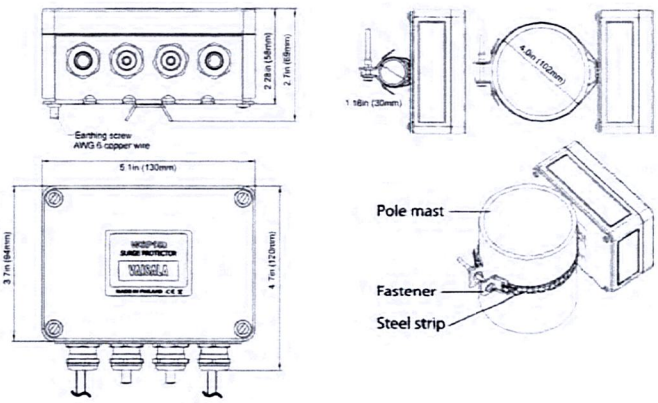
Mounting

- Use plastic tie wraps to secure the cable to the mast, especially at the base. Clip off excess length.
- Route the cable back to the weatherproof enclosure. (see manual for instructions on lengthening the cable, if needed).
- Insert mounting adapter onto the mast and tighten with the provided screws, then fit the U-bolt mounting bracket on the sensor over the adapter and tighten.

These were purchased and Meredith WD has them, but a custom mounting system was made by the employees.

Setup

- Compass – this will automatically correct the wind direction. If True North is desired instead of Magnetic North, the magnetic declination can be entered into the MicroServer. Manually aligning North is optional (see manual if desired). This adjustment is <u>not</u> critical and can be skipped for MWD's use.
- Surge Arrestor [*already installed*]
    1. Attach to the mast close to the weather sensor with clamp.
    2. Slide steel strip beneath the latch on the back of the enclosure.
    3. Wrap the steel strip around the pole mast, shortening if needed.
    4. Loosen the fastener by backing up the screw halfway.
    5. Attach the steel strip ends to the fastener by latching the fastener to a hole on the strip and folding it over.
    6. Tighten the fastener's screw in order to secure the unit to the pole.
    7. If the mast is not grounded, ground the unit using the grounding screw located on the back of the unit with an AWG 6 (16 mm^2) copper wire.

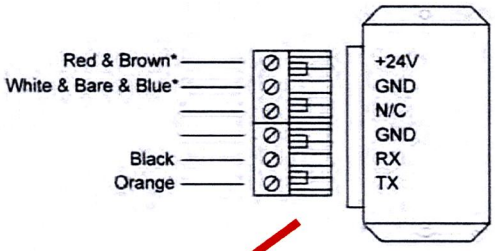


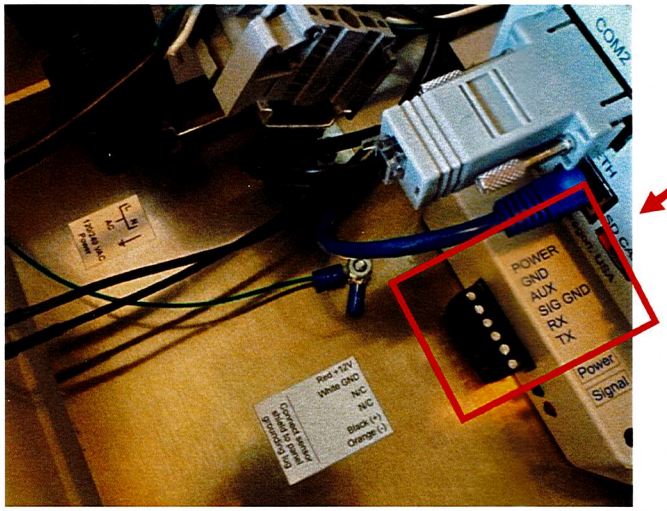
Connecting the sensors

Connect the sensor wires to the interface module terminal blocks (pictured in red box below) using a small straight slot screwdriver as follows:

Terminal Number	Function	Color
1	+24 V	RED & Brown*
2	Ground	White, Bare & Blue*
3	No Connection	
4	No Connection	
5	RX	Black
6	TX	Orange

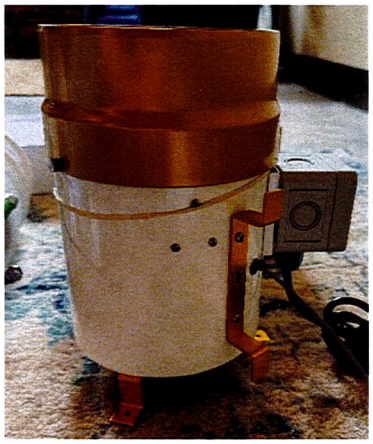
*The Meredith weather station does not have brown and blue wires





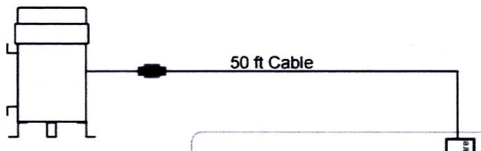
If you look in the box, you will see the sensor wires hooked up here. If there seems to be a connection issue, check that the wires are connected properly.

Wire connection: the wires are clamped into the screw terminals by tightening the screws (need a tiny flathead to tighten). If the screw is stripped, you can replace the terminal with one from the MicroServer on top (to the right out of frame in the photo; the little blocks pop in and out and you can swap them around). If the wires are disconnected at any time, reconnect them and go back through the setup instructions to ensure the settings are correct in the user interface (on the computer).

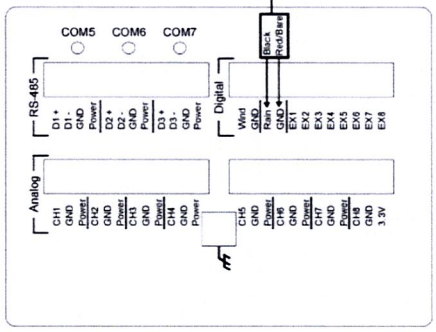


The Meredith weather station also has an additional Tipping Bucket Rain Gauge. This sensor has 3 wires that are connected to the MicroServer (to the right out of frame in the above photo) as shown below.

Rain Gauge



Description	Function	Color
CH#	Signal	Black
GND	Ground	Bare
Power	+5V (standard)	Red



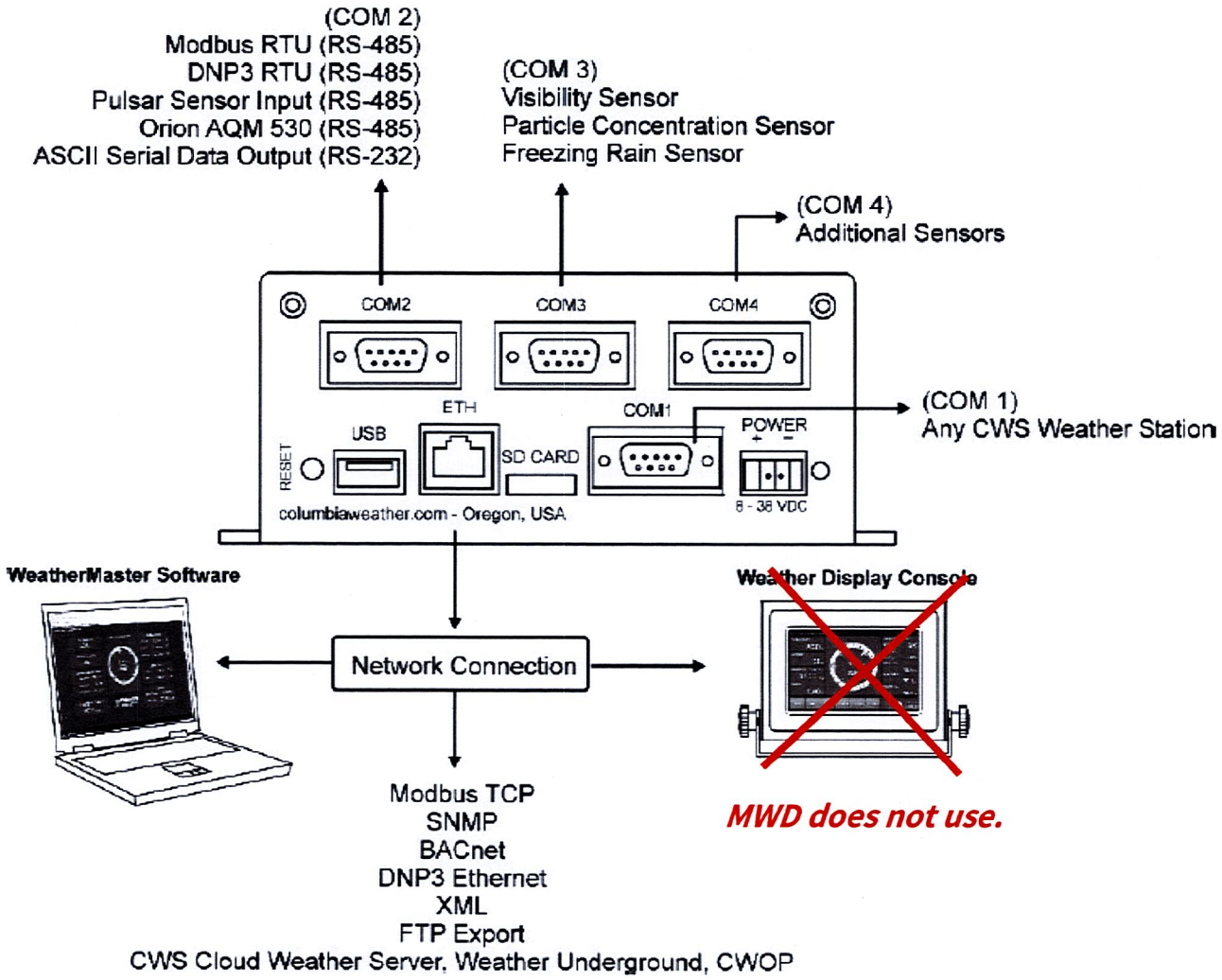
Weather MicroServer

The Weather MicroServer transmits data real-time from the sensors to the WeatherMaster software on the connected computer. The Weather MicroServer includes automatic data output to Weather Underground, the CWS cloud-based Weather Server and the Citizen Weather Observer Program (CWOP).

System Configuration [already done for Meredith weather station]

- Connect the Pulsar Sensor to COM2 on the MicroServer through the Interface Module using an RJ-11 cable provided with the station. In Sensor Inputs the Serial Port selection should be COM6-485. See image below.
- If True North is desired for compass readings (and impacted directional sensor readings), set the magnetic declination in the Pulsar Sensor Firmware. The magnetic declination is already set in the factory based on shipping location, so see manual if a reset is desired.

Configuration of Weather MicroServer



Installation [already done for Meredith weather station]

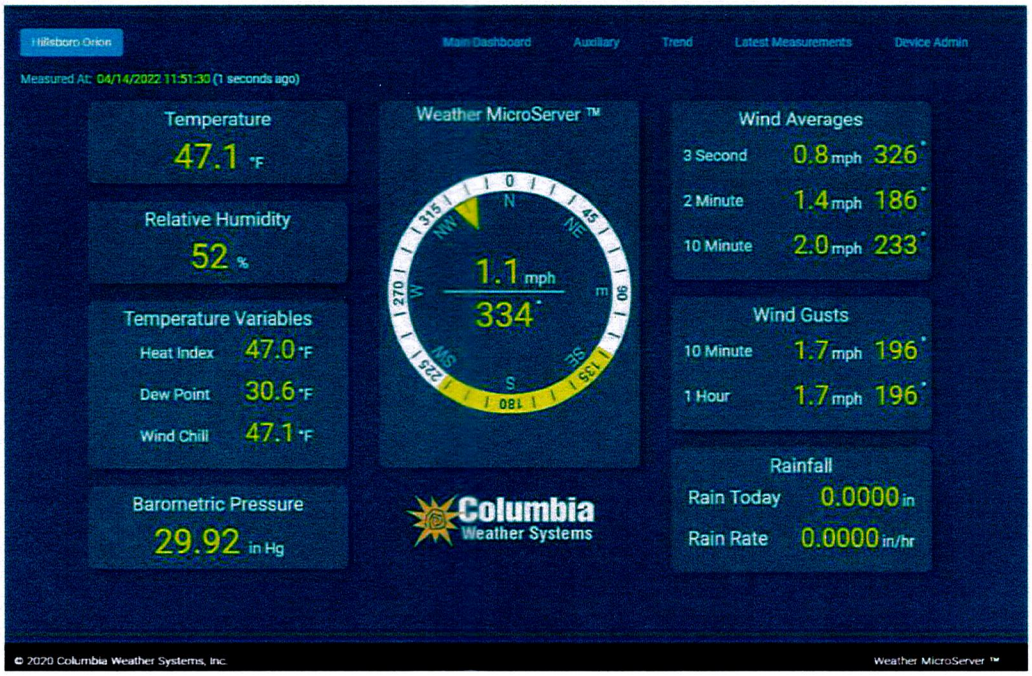
- Install MicroServer in clean, dry location in the weatherproof housing along with the interface module.
- Ensure the lug on the outside of the weatherproof enclosure is installed to ground the unit. A 14 to 16 AWG copper wire is recommended for proper grounding.
- Connect an Ethernet cable from the Ethernet port of the MicroServer to a network device such as router, hub or switch. A 12VDC Power Supply is included to power the MicroServer.

Setup [already done for Meredith weather station]

- The Weather MicroServer User Interface IP address can be changed to the local network configuration in admin settings:
    - Connect MicroServer to a laptop via ethernet cable and change the computer IP Address to 192.168.0.49. The Subnet Mask should be 255.255.255.0.
    - Browse to the MicroServer at 192.168.0.50.
    - In the MicroServer User Interface, click on Network Setup and change the settings to match your network. Click on Apply Changes.
    - Disconnect the MicroServer from the stand-alone computer and connect it to the network using a standard Ethernet cable.
    - Browse to the MicroServer at the new IP address from the network to verify that the changes are successful.
    - Change the computer (laptop) network settings back to default settings.

This has been done for the Meredith WD weather station, and the system runs on IP Address 10.60.0.14. If connecting the data to a Cloud Server is desired, send an email to support@columbiaweather.com and they will set up an account for you (this is free).

- Main Dashboard: this page must be used with Chrome or Firefox. If the weather station has lost power, is no longer functioning or has a connection problem, "Measured At" will show the date & time of the last measurement received, with the seconds since data was last received.



- The default **username** and **password** for the admin page are both "admin". The Data Manager software begins automatically upon power up. Click the Shutdown button to stop the Data Manager. The station name, date, time, etc. can also be changed in admin. See manual for more information on making these changes.
- The MicroServer is provided preconfigured from the factory to communicate with the purchased weather station. See the manual for configuration if it is lost.
- To connect and upload data to Columbia Systems' Cloud Weather Server, Weather Underground, Anything Weather, or the Citizen Weather Observer Program, see the manual.
- Parameter Settings: configure parameter settings based on how the station is set up (i.e., height of sensors)
- The Data Log stores up to a year of data, after which the oldest file is deleted and the newest one is stored. It is recommended to back up the Data Log files through the Data Export feature periodically to avoid loss of data due to power failure.

WeatherMaster Software

Installation

[this has already been set up for the Meredith weather station and the program is run on the main desk computer]

1. Your computer must meet the following requirements for the software:
    a. Windows 7 or 10 operating system
    b. Intel Core i3 or equivalent
    c. 4MB Memory
    d. 500MB Hard Drive
    e. Serial port or USB to Serial Converter

Configuration

[this has already been set up for the Meredith weather station, but if connection to the system is ever lost, go through these steps to reconnect]

1. In the configuration window, select Weather Stations. Select "Add" to add a new station.
    a. Station ID: serial number of the MicroServer.
    b. Description: description of station (location).
    c. Station Type: MicroServer. Enter the IP address into the Server box.
    d. Click OK.
2. The measurements list can be changed at any time by editing the "Measurements" tab.
3. Display units can be changed under Options > Units.
4. Configure Export under Configuration > Auto Setup.
    a. Choose CSV Data Export tab. Check Enable Automatic Export and specify details.

Email Report

WeatherMaster can send periodic reports via email or text. To set this up, go to Options > Email Reports.

Weather Underground

Automatic upload of data to Weather Underground can be configured under Options > Weather Underground.

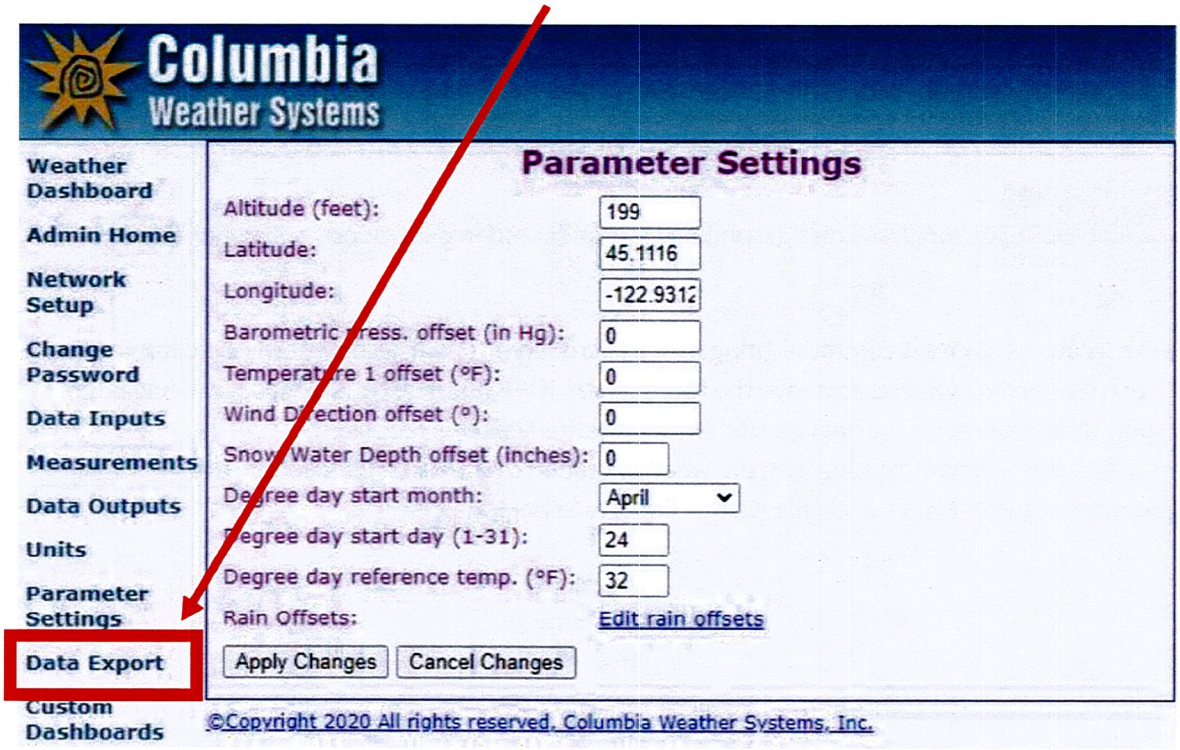
Data

- If WeatherMaster software is communicating with a MicroServer, it will automatically synchronize the database with the data log files stored in the MicroServer. If WeatherMaster is closed it will begin the synchronization process (in the background) when WeatherMaster is reopened.
- If WeatherMaster is communicating with the weather station over a serial connection, the sensor data can be captured and saved as a CSV file (Data > Capture Serial Data).

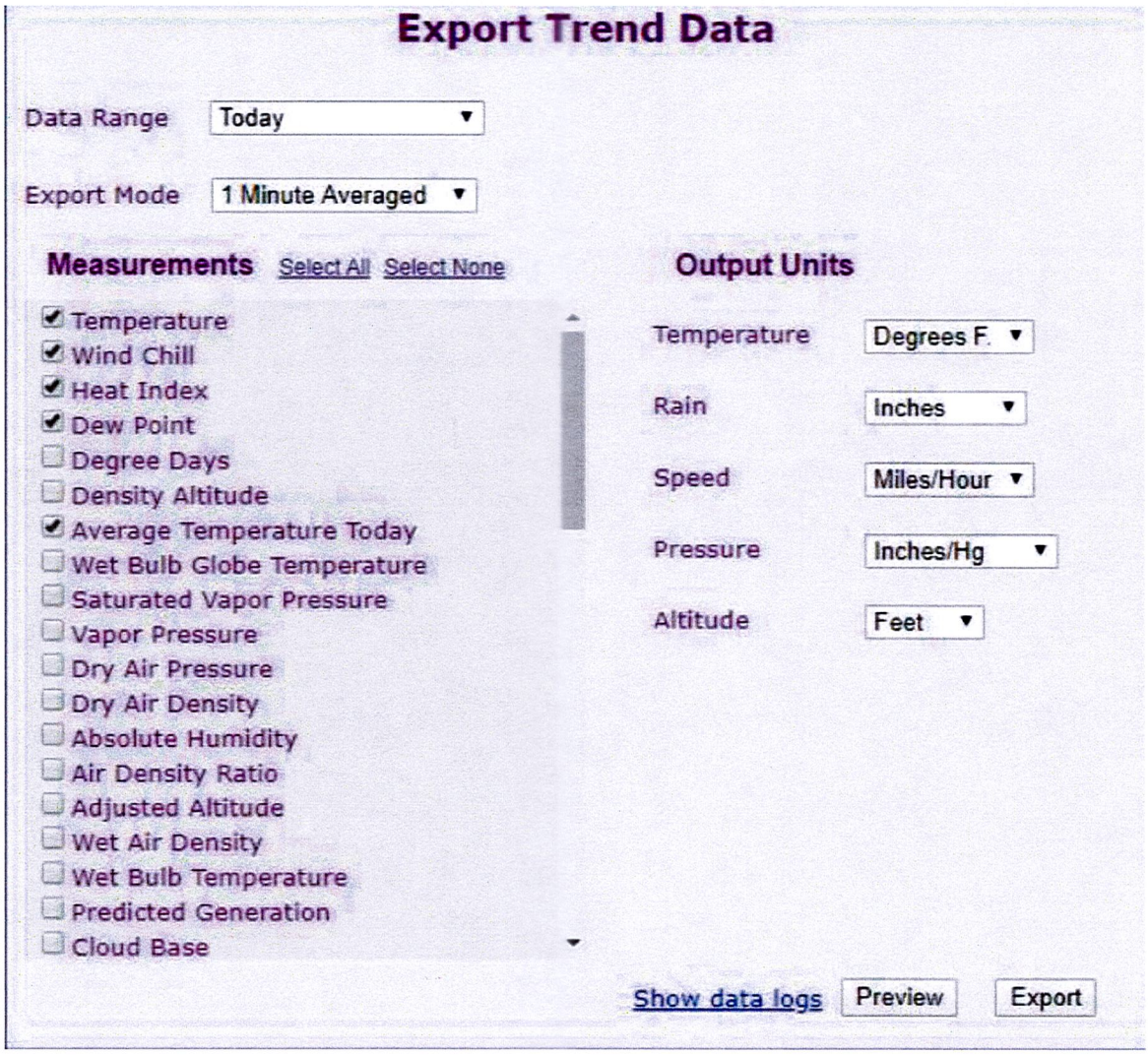
Exporting Data

1. In the user interface, sign into "Device Admin" (username and password: "admin")

2. In the admin interface menu, select "Data Export"



3. Select export parameters, then click export
    a. Data Range: select the range you wish to download
    b. Export Mode: 1 Hour Averaged
    c. Measurements: Select All
    d. Output Units: select desired units



APPENDIX D: NHDES CYANOHABS RESPONSE PROTOCOL FOR PUBLIC WATER SUPPLIES

CyanoHABs Response Protocol for Public Water Supplies

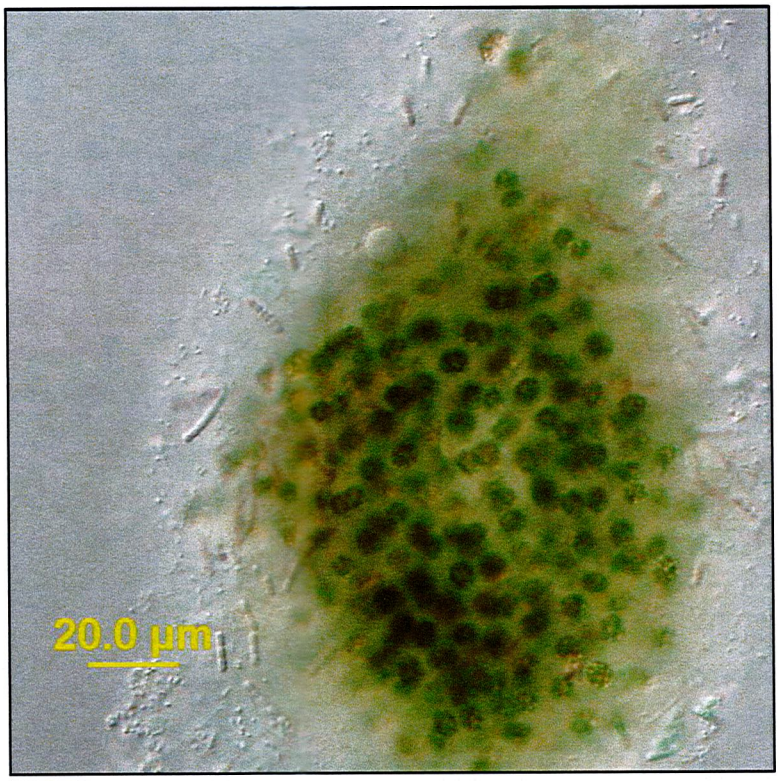


Figure 1 Microcystis aeruginosa

New Hampshire Department of Environmental Services
Drinking Water and Groundwater Bureau
29 Hazen Drive
Concord, NH 03302

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

TABLE OF CONTENTS

INTRODUCTION

The following describes the New Hampshire Department of Environmental Services (NHDES) protocol for responding to suspected cyanobacteria harmful algal blooms (cyanoHABs) in public water supply sources. An overview of the protocol is provided in the attached flow chart. This protocol uses a tiered approach, with screening and monitoring steps, leading to actions including optimizing treatment and notifying the public if test results indicate that cyanotoxins are or may be present at levels of concern.

This describes the approach for water systems that are not already implementing a customized protocol developed in consultation with NHDES.

Contacting NHDES

Call in the following order in case of a suspected bloom.

Drinking Water and Groundwater Bureau (DWGB)

- (603) 271-3906 (Liz Pelonzi) - Primary contact for source water cyanobacteria issues.
- (603) 271-0688 (Pierce Rigrod) – Supervisor, Source Water Protection Program.
- (603) 271–2513 (DWGB Main Number) (8:00 AM – 4:00 PM weekdays except holidays).

Jody Connor Limnology Center (JCLC):

- (603) 271–0698 (Beach Coordinator office).
- (603) 271–8865 (JCLC Director office).

New Hampshire Department of Safety.

- (603) 223–4381 (New Hampshire State Police – **outside NHDES business hours**).

Key terms used in the protocol:

- NHDES – New Hampshire Department of Environmental Services.
- cyanoHABs – cyanobacteria harmful algal blooms.
- JCLC — Jody Connor Limnology Center at NHDES.
- DWGB – NHDES Drinking Water and Groundwater Bureau.
- PWS – public water system.
- USEPA – United State Environmental Protection Agency.
- bloom – source water where the suspected bloom appears to be at its worst.
- open water – an area of the lake or reservoir between the visible BLOOM and the intake.
- raw – raw water entering the treatment plant.
- finished – finished water entering the distribution system.
- ELISA – enzyme–linked immunosorbent assay (Quantiplate) test for total Microcystins (ADDA) (modified USEPA method 546).
- LC/MS – Liquid Chromatography/Mass Spectrometry for analysis of specific Microcystins, Nodularin, Anatoxin–a, and Cylindrospermopsin (EPA Methods 544 and 545).
- BMAA – beta–Methylamino–L–alanine.
- DABA – 2,4–diaminobutyric acid dihydrochloride.
- Microcystins – (MC).
- Nodularins – (NOD).
- CMC – Cyanobacteria Monitoring Collaborative.
- HDPE – high density polyethylene.
- mL – milliliter.
- PTFE – polytetrafluoroethylene.

MONITORING

1. **All public water systems (PWSs) using surface sources are advised to conduct** at a minimum, **daily visual surveillance** of their source water(s).
2. NHDES recommends that PWSs using sources with a history of suspected cyanobacterial blooms implement monitoring programs that incorporate continuous or frequent monitoring of source water or raw water for:
    a. Phycocyanin.
    b. chlorophyll–a.
    c. pH.
    d. Temperature.
    e. Turbidity.
    f. Daily observation of weather conditions.
3. To facilitate easy monitoring NHDES recommends:
    a. Have sample bottles on hand. PWSs are responsible to purchase sampling supplies. NHDES can supply only a limited amount of supplies.
    b. Have samples bottles on hand prepared by another lab following their specific protocol.
4. **When there are visual signs of a bloom** or water quality parameters (e.g., pH, turbidity, taste/odor) indicating a suspected cyanoHABs, the PWS should contact DWGB or JCLC and JCLC will notify DWGB of the confirmed bloom.
5. **Take samples of the bloom, open water away from bloom, raw water tap in brown, 250 – 500 mL HDPE bottles. Finished water should be collected in at least a 250 mL amber glass bottle with quenching agent(s).** Refer to "Sample Collection, Preservation, Shipment, and Storage" beginning on page 10.
6. **DWGB or JCLC will visually identify the genera and determine the density of cyanobacteria in the samples.** Based on the genus and cyanobacterial cell counts, DWGB will determine whether toxin analyses should be done right away (or batched for later) and whether additional sampling should be done, either by the PWS or by NHDES.
7. If immediate action, such as treatment adjustments is required, DWGB will contact the PWS.
8. If toxin producing cyanobacteria are identified and in concentrations at or above 5,000 cells/mL near the intake, DWGB will make the appropriate decision as to which of the available toxin testing option(s) seem(s) appropriate (See Tables 1 and 2 for cyanobacteria and associated toxins). If a decision is made to use LC/MS methods, DWGB will consult with the PWS to run such tests and in what frequency.

    Toxin analyses will be conducted at an EPA approved lab that performs ELISA or LC/MS/MS toxin testing. Depending on the results, DWGB may ask the PWS to continue to sample water, will work with the PWS to optimize treatment, and will consider asking the PWS to **issue an advisory**. *Public notification templates are available.*
9. The PWS will notify DWGB once the required action(s) have been completed.

For more information on cyanobacteria and what they might look like, refer to Cyanos.org.

CyanoHABs Monitoring and Response Flowchart.

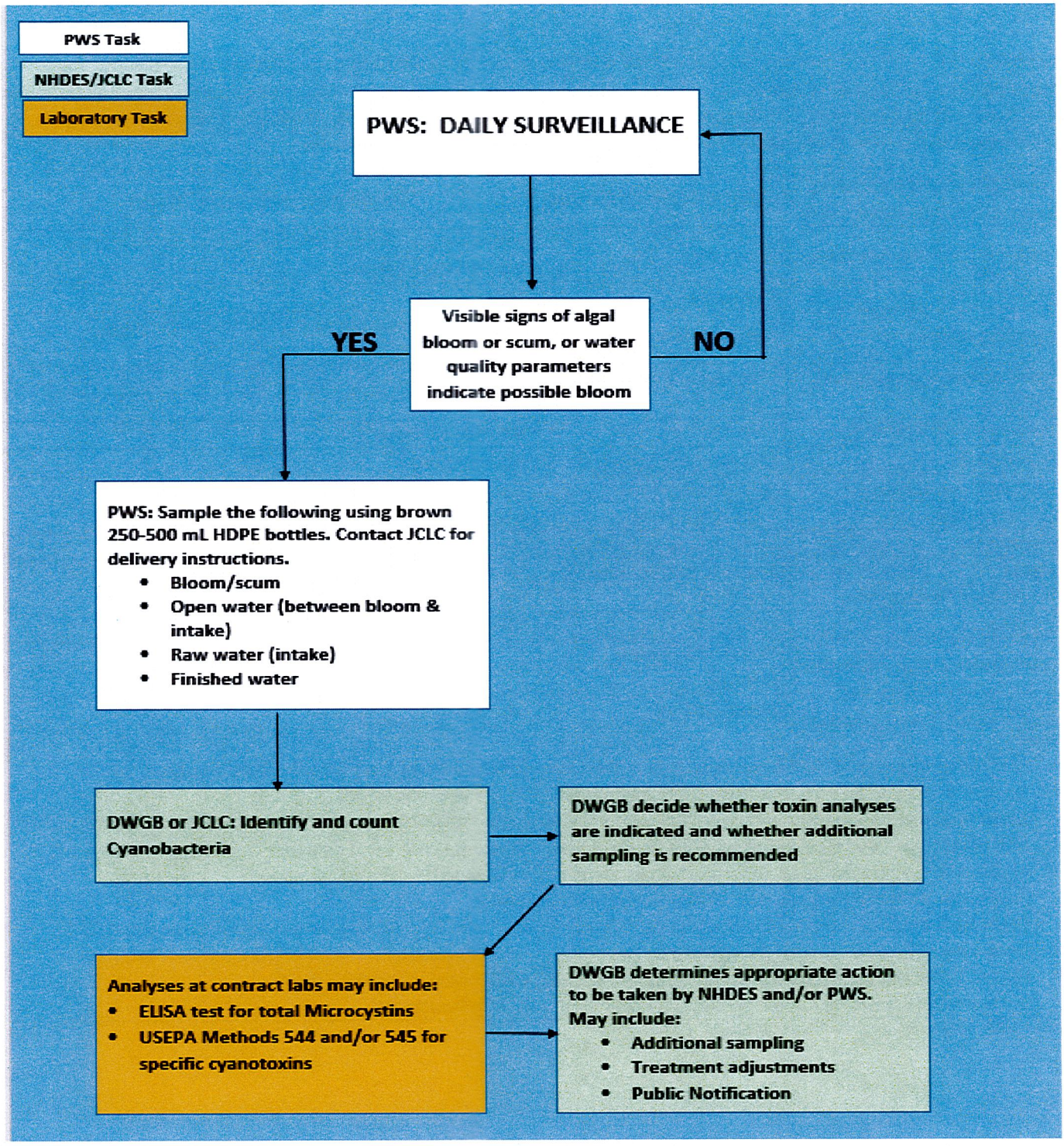


Table 1: Common New Hampshire Cyanobacteria and Associated or Known Toxins.

The toxin test that NHDES may advise is first based on the presence of potentially toxic cyanobacteria, then on the concentration of cells (at or above 5,000 cells/mL near the intake), and the type of toxin they may produce. Labs listed in Table 3 can test by ELISA or LC/MS methods to determine 7 variants of Microcystins, Nodularins, Anatoxin–a, and Cylindrospermopsin. This is not a complete list of the cyanobacteria or the cyanotoxins.

Common Cyanobacteria Genera of New Hampshire	Typical Form Observed	Associated or Known Toxins
Anabaena/Dolichospermum	Filaments	Microcystins, Anatoxin–a, Anatoxin–a (S), Saxitoxins, Cylindrospermopsin
Anabaenopsis	Filaments	Microcystins
Aphanizomenon	Rafts of Filaments	Anatoxin–a, Anatoxin–a (S), Saxitoxins, Possibly Microcystins
Aphanocapsa/Aphanothece	Colonies or Single Cells	Microcystins
Coelosphaerium	Colonies	Microcystins
Chroococcus/Gloeocapsa	Colonies	Possibly Microcystins
Gloeotrichia	Macroscopic Colonies	Microcystins
Lyngbya/Phormidium	Benthic Filaments	Microcystins, Lyngbyatoxins, Anatoxin–a
Merismopedia	Rafts of Colonies	Microcystins
Microcystis	Variations of Colonies	Microcystins, Anatoxin–a
Nostoc	Macroscopic Colonies	Microcystins, Nodularins
Oscillatoria/Planktothrix	Filaments	Microcystins, Cylindrospermopsin
Spirulina	Filaments	Microcystins
Synechococcus/Synechocystis	Single Cells, Rarely Colonial	Microcystins and Saxitoxins
Woronichinia	Dense Colonies	Microcystins

Note:

- Some genera grouped here have variations in their taxonomic name or are similar in morphology.
- Species may vary significantly. This is not a complete list of the cyanobacteria.
- More than one type of cyanobacteria and toxin may exist in a typical bloom.
- Microcystins are the most common cyanotoxin in New Hampshire and New England.
- Associated toxins are typical and may change as research evolves.
- Production of some toxins is "turned on" by genetic regulation.
- Toxin tests are also available for Nodularins, commonly produced by marine/brackish cyanobacterium called *Nodularia* (uncommon to New England).
- BMAA, DABA toxins (neurotoxins) have been associated with nearly all cyanobacteria.
- Dermal–toxins, causing rashes on skin can occur with most cyanobacteria.

Table 1 Table created by Amanda Murby McQuaid

Table 2: Cyanotoxins and Common Modes of Action.

(modified from *Handbook of Cyanobacteria Monitoring and Cyanotoxin Analysis, First Ed. 2017*).

Cyanotoxin	Mode of action and/or symptoms
Microcystins (nearly 100 variants)	Hepatotoxic, targets the liver and digestive organs, tumor promoting, inhibition of protein phosphatases. Acute gastroenteritis, chronic tumor promotion.
Nodularins (similar in structure to Microcystins)	Similar to Microcystins, but not as toxic and common in brackish or marine systems.
Anatoxin–a	Neurotoxic, inhibits acetylcholine receptors (neurotransmitter). Fast–acting and may cause seizures or death (i.e., common for dogs or other animals to ingest and die).
Anatoxin–a (S)	Neurotoxic, similar to anatoxin–a
Saxitoxins	Neurotoxic, blocking voltage gate of sodium ion channels. More common to marine organisms.
Cylindrospermopsins	Toxic to multiple organs, neurotoxic and genotoxic, affecting neurons and genes.
Lyngbyatoxins	Tumor promotion
BMAA/DABA	Neurotoxic, chronic exposure may be linked to neurodegenerative diseases such as ALS. (Though individuals may have a genetic precursor).

Note:

- Dermal–toxins, causing rashes on skin, and can occur with most cyanobacteria. Usually depends on the individual in contact.
- Synergistic effects of the cyanotoxins may also occur.
- Many of the cyanotoxins cause gastroenteritis–like symptoms, while others may cause seizure–like or possibly neurodegenerative symptoms.
- Exposure can occur through drinking, food, dietary supplements, inhalation, and/or by dermal contact, and has occurred by hemodialysis (with contaminated water).

Table 2 Table created by Amanda Murby McQuaid

LABORATORY METHODS

USEPA Methods for Cyanobacteria Toxin Analysis.

USEPA Method 544: Determination of Microcystins and Nodularin in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS).

Analytical method to determine six microcystins (including MC-LR) and nodularin in finished drinking water.

USEPA Method 545: Determination of Cylindrospermopsin and Anatoxin–a in Drinking Water by Liquid Chromatography Electrospray Ionization Tandem Mass Spectrometry (LC/ESI—MS/MS).

Analytical method to determine cylindrospermopsin and anatoxin-a, in finished drinking water.

USEPA Method 546: Determination of Total Microcystins and Nodularins in Drinking Water and Ambient Water by ADDA–Enzyme–Linked Immunosorbent Assay (ADDA—ELISA).

Analytical method to determine "total" microcystins (MC) and nodularins (NOD) in finished drinking water and ambient water.

Table 3: Labs Conducting ADDA–ELISA and LC/MS/MS Toxin Analysis using USEPA Methods 544/545/546

Other labs listed by USEPA are available for similar services. Consult USEPA's list of Laboratories that Analyze for Cyanobacteria and Cyanotoxins.

Table 3 Labs Conducting ADDA–ELISA and LC/MS/MS Toxin Analysis using USEPA Methods 544/545/546

GREENWATER LABORATORIES*	(386) 328–0882 Greenwaterlab.com	205 Zeagler Dr. Palatka, FL 32177	**Sample Protocol:** Amber glass bottles** Keep cold **Shipping Protocol:** Ship on Ice
ALLOWAY LABORATORY*	(800) 873-2835 Allowaylab.com	1776 Marion-Waldo Road Marion, OH 43302	**Sample Protocol:** Amber glass bottles** Keep cold **Shipping Protocol:** Ship on Ice
EnviroScience In., Toxicity Lab*	(330) 688-0111 www.enviroscienceinc.com	5070 Stow Road Stow, OH 44224	**Sample Protocol:** Amber glass or polyethylene terephthalate glycol (PETG) container. Keep cold **Shipping Protocol:** Ship on Ice
New Jersey Center for Water Science and Technology*	(973) 655-7117 wum@montclair.edu	Dr. Meiyin Wu Montclair State University; NJ Center for Water Science and Technology; Center for Environmental and Life Sciences 100; Montclair, NJ 07043	**Sample Protocol:** Amber glass bottles** Keep cold **Shipping Protocol:** Ship on Ice **48 hour hold time between sample collection and lab's receipt**
RHODE ISLAND STATE HEALTH LABORATORIES*	Evan K. Philo Principal Lab Scientist/Food Testing Coordinator (401) 222–5553 Evan.Philo@health.ri.gov	RI State Health Laboratories RI Dept. of Health 50 Orms Street Providence, RI 02904	**Sample Protocol:** Amber glass bottles** Keep cold. **Shipping Protocol:** Ship on ice

SAMPLING

This sampling protocol outlines how to collect cyanobacteria and cyanotoxin samples at PWS source waters, finished waters, and other sampling locations. This protocol does not address sample collection for site specific monitoring plans. Consult with DWGB on recommendations for a routine cyanobacteria monitoring plan or refer to USEPA Cyanobacteria Monitoring Collaborative (CMC) at cyanos.org.

Safety Precautions

- Wear protective gear such as gloves if handling a suspected harmful cyanobacteria bloom.
- Precautions should be taken to avoid mouth and eye contact.
- Wear eye protection and a mask to further prevent exposure.
- Chest waders should be worn if collecting a cyanotoxin sample when wading off the shore to protect skin from contact with cyanotoxins.
- Always wash your hands and rinse thoroughly after handling.

Recommended Safety Supplies

For cyanobacteria and cyanotoxin sampling at public water systems, the recommended safety supplies include:

- Disposable gloves or reusable arm-length gloves.
- Goggles.
- Mask.
- Chest Waders.

General Sampling Supplies

Cooler with packed ice for sample storage under 12 hours and/or refrigerate if up to 24 hours until delivery. (Do not allow bottles to float in warm water or melted ice water).

High density polyethylene (HDPE) brown bottles of at least 250 mL capacity.

Analytical Method Specific Supplies

Cyanobacteria screening for Microcystins/Nodularins at NHDES:

- HDPE brown bottles of at least 250 mL capacity.
  - PWSs are responsible to purchase the HDPE bottles and all other cyanobacteria sampling supplies. NHDES can supply only a minimal amount.
  - Call Liz Pelonzi at (603) 271-3906 to request supplies.

For cyanobacteria toxin sampling for lab analysis using USEPA Methods 544/545/546:

- 250-500–mL amber glass bottles (1–2) fitted with polytetrafluoroethylene (PTFE)–lined screw caps **and;**
- USEPA Method specific preservatives.
  - Sodium Thiosulfate (0.1g/L) - **Method 546.**
  - Ascorbic Acid (0.1g/L) and Sodium bisulfate (1g/L)- **Method 545.**
  - Trizma (7.75 g/L); 2-Chloroacetamide (2 g/L); Ascorbic acid (100 mg/L); Ethylenediaminetetraacetic acid trisodium salt (0.35 g/L)-**Method 544.**
  - **Confirm with lab for specific protocols.**
- **PWS's are responsible for obtaining the required sampling bottles and preservatives**. The amber glass bottles and preservatives can be supplied, if necessary, upon request by DWGB , contact:
  - Liz Pelonzi, Source Protection Specialist at (603) 271–3906 or liz.pelonzi@des.nh.gov.
  - Pierce Rigrod, Supervisor, Source Water Protection Program at (603) 271–0688 or pierce.rigrod@des.nh.gov.

Sample Collection, Preservation, Shipment and Storage.

Sample Collection Procedure for Grab Samples and Surface Skim Samples.

- **Grab samples:** samples that are collected from a sample tap or by submerging a bottle in water at an attainable location by hand. Wearing gloves, sample by submerging bottle slowly through the water and swing arm in a u–shaped orientation. Recommended for:
  - Water surface
  - Beach or shoreline at knee depth (or about 1 meter)
  - Raw or finished water (from a sample tap)
- **Surface skim:** using a collection bottle to skim the surface of the water. Recommended for:
  - Dense surface bloom or shoreline accumulation

Sample Collection Procedure for EPA Methods 544 and 545

- Open the cold water tap and allow the system to flush until the water temperature has stabilized (approximately 3 to 5 minutes). Collect samples from the flowing system. Fill sample bottles, taking care not to flush out the sample preservation reagents.
- After collecting the sample, cap the bottle and agitate by hand until preservative is dissolved. Note that 2–chloroacetamide is slow to dissolve, especially in cold water. Samples must be chilled during shipment but should not be frozen.
- Shipping instructions are provided in Table 3.

Sample Collection Procedure for EPA Method 546.

- Open the tap and allow the system to flush for approximately 5 minutes. Fill each bottle, taking care not to flush out the sodium thiosulfate. Invert bottle(s) several times to mix the sample with the reducing agent. Sample must be chilled during shipment but should not be frozen.
- Shipping instructions are provided in Table 3.

NHDES Sample Submittal Procedure

Samples will be analyzed free of charge. At NHDES samples will be analyzed for:

- Cyanobacteria ID and cell count

1. Take a photo(s) of the bloom and submit it to Liz Pelonzi at liz.pelonzi@des.nh.gov.
2. Collect a sample(s) from the options listed below, using a 250 mL brown HDPE bottle(s).
    a. Grab sample.
    b. Surface skim.

    **Avoid collecting samples from areas where the bottom sediment has been disturbed.*
3. Label and store water samples properly.
    a. Label 250 mL brown HDPE bottle(s) and 250 mL amber glass bottle with quenching aqent(s) to include:
        i. Waterbody and location (coordinates if possible).
            1. Bloom.
            2. Open water (away from bloom).
            3. Intake, Raw water.
            4. Finished water.
            5. Or other location within source.
        ii. Date and time.
        iii. Type of sample (indicate if this was a surface bloom or other).
        iv. How sample was stored (e.g., on ice or refrigerated) **DO NOT FREEZE.**
4. Place in packed ice in cooler or refrigerate (deliver within 12 hours of event).
    a. Bring samples to Liz Pelonzi, DWGB or JCLC, 29 Hazen Dr., Concord, NH during business hours (8:00 a.m.–4:00 p.m.) or by prior arrangement.
5. If dropping off the sample(s) to JCLC staff, fill out a requisition form at the JCLC for confirmation of sample delivery and details of bloom event with appropriate contacts.
    a. Your name, contact and concern.
    b. Location – waterbody, beach or specific bloom area or depth.
    c. Date, time and weather.
    d. Details or description of bloom– surface scum or throughout water column, surface area, magnitude of area, color and odors, etc.
    e. Submit photos, if possible, to Liz Pelonzi at liz.pelonzi@des.nh.gov.
    f. How sample was collected and stored prior to delivery.

If additional toxin analysis for Microcystins, Nodularin, Cylindrospermopsin and Anatoxin–a using USEPA Methods 544, 545, or 546 is required, DWGB will request the system take additional samples. Laboratories that conduct these methods are listed in Table 3 above.

If using USEPA Methods, follow USEPA sampling procedure instructions.

REVISION HISTORY

Revision No.	Date	Initials	Summary of Revision
0	07/18/2022		Initial version
1	04/15/2025		Edits to procedural changes.

NH Department of Environmental Services
Drinking Water and Groundwater Bureau
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APPENDIX E: UPDATED LIST OF EPA-ACCREDITED LABORATORIES FOR ELISA ANALYSIS USING USEPA METHOD 546

For the full up-to-date list, see EPA's Laboratories that Analyze for Cyanobacteria and Cyanotoxins. This Appendix has been adapted from NHDES' CyanoHABs Response Protocol for Public Water Supplies, which also contains sampling protocols details. All laboratories should be called prior to shipping to confirm they can expedite samples.

Laboratory Name	Address	Contact	Estimated Cost	Sample Protocol
GreenWater Laboratories	205 Zeagler Drive, Palatka, FL 32177	(386) 328–0882 Greenwaterlab.com	$200/sample	Amber glass bottles; Keep cold; Ship on ice.
Alloway Laboratory	1776 Marion-Waldo Road, Marion, OH 43302	(800) 873-2835 Allowaylab.com	**Ohio EPA DES 701.0 (ELISA) Method** $110.00/sample – Regular turn-around time (7 days) $220.00/sample – Expedited turn-around time (48 hours)	Amber glass bottles; Keep cold; Ship on ice.
EnviroScience Inc., Toxicity Lab	5070 Stow Road, Stow, OH 44224	(330) 688-0111 enviroscienceinc.com	**Ohio EPA DES 701.0 (ELISA) Method** $125.00/sample – Regular turn-around time (3-4 business days) Cost TBD – Expedited turn-around time (1-2 business days)	Amber glass bottles or polyethylene terephthalate glycol (PETG) container; Keep cold; Ship on ice.
New Jersey Center for Water Science and Technology	Dr. Meiyin Wu Montclair State University; NJ Center for Water Science and Technology; Center for Environmental and Life Sciences 100; Montclair, NJ 07043	(973) 655-7117 wum@montclair.edu	$190.00/sample – Regular turn-around time (10 day). Can do 2-3 days if requested. Can possibly do weekend analyses.	Amber glass bottles; Keep cold; Ship on ice. 48 hour hold time between sample collection and lab's receipt
EcoAnalysts, Inc.	4729 NE View Drive PO Box 216 Port Gamble, WA 98364	(360) 297-6040 Ecoanalysts.com	$115.00–$200.00/sample	See detailed packaging and shipping guide here.

APPENDIX F: CYANOTOXINS PUBLIC NOTICE FORM

The following pages contain a NHDES template for MWD to use should cyanotoxins surpass EPA safety levels as described in Section 6. The form, and instructions for mailing and completing the form, are available from https://onlineforms.nh.gov/app/#/formversion/76e39835-7c13-4480-9dbd-13c17811b310?formtag=nhdes-w-03-253

DRINKING WATER WARNING

This water system is contaminated with cyanotoxins. Do Not Drink

[TEMPLATE] PUBLIC HEALTH ADVISORY:

CYANOTOXINS AND DRINKING WATER

Public Water System Name:_____ PWS ID: _____

Date Sampled_____ Location in distribution system/source(s)_____

[PUBLIC WATER SYSTEM/LOCAL AUTHORITY] issues a DO NOT DRINK Advisory due to the presence of [CYANOTOXIN]

(A) Vulnerable Populations Specific Language: [INSERT CYANOTOXIN], a toxin produced by cyanobacteria was detected today in the treated drinking water supplied from the **[NAME OF SOURCE]** at a level of **[0.XXX__µg/L].** This exceeds the U.S. Environmental Protection Agency's National Health Advisory levels of [**INSERT TOXIN CONCENTRATION**] for [**INSERT CYANOTOXIN**] [**for the most vulnerable population, infants and children under 6 years of age.**]

OR

(B) Language Applying to All Customers: [INSERT CYANOTOXIN], a toxin produced by cyanobacteria was detected today in the treated drinking water supplied from the **[NAME OF SOURCE**] at a level of **[0.XXXXX__µg/L].** This exceeds one of the U.S. Environmental Protection Agency's National Health Advisory levels of **[INSERT TOXIN CONCENTRATION]** for **[INSERT CYANOTOXIN**].

What does this mean? *Individuals who drink water containing **[TOXIN NAME]** at levels above the National Drinking Water Health Advisories are at risk of various adverse health effects. Possible adverse health effects include upset stomach, vomiting and diarrhea as well as liver and kidney damage. If you have recently experienced similar symptoms and have concerns, contact your primary health professional.*

NOTE: This advisory is NOT related to COVID-19.

The World Health Organization has stated that the "presence of the COVID-19 virus has not been detected in drinking-water supplies and based on current evidence the risk to water supplies is low." For additional information on COVID-19 and drinking water, you can refer to EPA's website: https://www.epa.gov/coronavirus/coronavirus-and-drinking-water-and-wastewater

What should I do? Customers, including pets, of the [PUBLIC WATER SYSTEM NAME] SHOULD NOT DRINK THE WATER. NHDES recommends customers use bottled water for drinking, making infant formula, making ice and preparing food and beverages and to use precautions against accidental ingestion of tap water until further notice. Do not boil the tap water, as boiling water does not remove cyanotoxins and may increase toxin levels.

Everyone may use tap water for showering, bathing, washing hands, washing dishes, flushing toilets, cleaning and doing laundry. However, infants and young children under the age of six should be supervised while bathing and during other tap water-related activities to prevent accidental ingestion of tap water.

For more information about the USA Health Advisories visit, EPA Drinking Water Health Advisories for Cyanotoxins.

Steps being taken to correct the situation: [PUBLIC WATER SYSTEM] staff are working closely with the New Hampshire Department of Environmental Services to address and resolve the situation. **[PUBLIC WATER SYSTEM]** staff are reducing cyanotoxin levels in tap water by taking the following actions:

The **[PUBLIC WATER SYSTEM]** is switching the supply sources exclusively to groundwater wells and ceasing the supply from the surface water source containing elevated cyanotoxins.

OR

The **[PUBLIC WATER SYSTEM]** will temporarily stop using **[NAME OF SOURCE]** and establish a temporary interconnection with the **[PUBLIC WATER SYSTEM]** while optimizing treatment to remove cyanotoxins from finished drinking water.

Contact Name: _____ **Company:** _____

Address: _____ **Telephone Number:** _____

You will be notified when the water quality problem is corrected. Until that time, the water SHOULD NOT BE CONSUMED as described above.

Please share this information with all of the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

Water use restrictions will be needed to meet water system demands during this time; therefore, no irrigation will be allowed until the order is lifted.