ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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# Cyanobacteria and Drinking Water: Guidance for Public Water Systems

**What are cyanobacteria?**

Cyanobacteria are microscopic organisms found naturally in lakes, streams and ponds. Once known as blue-green algae, they are actually photosynthetic bacteria. Cyanobacteria may occur in all of New Hampshire's waterways. When present at low density they do not cause recreational or aesthetic problems; however, when conditions are optimal for their growth, high concentrations of cyanobacterial cells may form "blooms." There is no official definition of a bloom in terms of cell density, but a key aspect is dominance of a single type of cyanobacteria. Blooms sometimes appear as green or blue-green flecks scattered in the water, scums that float on the surface, or mats that rest on the bottom, but they can occur anywhere in the water column. When blooms produce dangerous concentrations of cyanotoxins they are known as harmful algae blooms (HABs), cyanoHABs, or harmful cyanobacteria blooms (HCBs).

**Why are they of concern with respect to drinking water?**

There are about 3,000 known species of cyanobacteria, about 50 of which produce toxins (collectively referred to as "cyanotoxins" or "algal toxins") that are harmful to vertebrates. These toxins may be hepatotoxins, which affect the liver and kidney; neurotoxins, which affect the central nervous system; or dermatotoxins, which are skin irritants. Cyanotoxins are capable of causing both acute and chronic illnesses. Cyanobacteria have been linked to human and animal illnesses around the world, on all continents, and in connection with both recreational exposure and drinking water. The most common types of toxin-producing cyanobacteria in New Hampshire are *Aphanizomenon*, *Dolichospermum (formerly called Anabaena)*, *Microcystis* and *Oscillatoria*. Cyanobacteria can also produce taste and odor compounds, but attempts to use taste and odor parameters as potential indicators of the presence of toxins have been inconclusive.

**Are they regulated?**

Although cyanotoxins are **not** currently regulated by the U.S. Environmental Protection Agency (USEPA) as contaminants in drinking water, USEPA has established non-regulatory health advisory levels for two cyanotoxins – microcystin and cylindrospermopsin – and in December 2016 included 10 cyanotoxins in the 2018-2020 round of monitoring for unregulated contaminants at selected public water systems under the Unregulated Contaminant Monitoring Rule, or UCMR4. The health advisories identify concentrations of microcystin and cylindrospermopsin at or below which no adverse human health effects would be expected for up to 10 days of exposure. For children younger than school age the health advisory levels (HALs) are 0.3 micrograms per liter (ug/L) for microcystin and 0.7 ug/L for cylindrospermopsin as values not to be exceeded in drinking water. For all other ages, the HALs for drinking water are 1.6 ug/L for microcystin and 3.0 ug/L for cylindrospermopsin. Although not enforceable, the published HALs are intended to trigger water utility actions including increased monitoring, changes in treatment strategies, and public notification of "do not drink/do not boil" advisories (cyanotoxins are not destroyed by boiling).

EPA has issued health effects support documents for both microcystin and cylindrospermopsin, and for a third cyanotoxin, anatoxin-a, but has not established a HAL for the last. (See the list of documents at the end of this fact sheet for citations.) Cyanotoxins are on USEPA's current Contaminants Candidate List, meaning they are under consideration for regulation under the Safe Drinking Water Act in the future. Inclusion of cyanotoxins in UCMR 4 is potentially a step toward establishment of regulatory limits for those contaminants in drinking water in the future.

**How big a problem are cyanobacteria in New Hampshire?**
At this time, it is not known whether cyanobacteria are a significant problem for New Hampshire water systems, other than as a source of taste and odor problems. Cyanobacterial blooms have been reported in at least 30 lakes, ponds and reservoirs in the state. A survey of 44 lakes during 1999 and 2000 found microcystins (the most common class of cyanotoxins) in all of the lakes, both clean and high-nutrient lakes, although the latter were more likely to have high concentrations of microcystin. Based on the results of that study, it is believed that HCBs could develop in many New Hampshire waterbodies. NHDES knows of no studies of cyanotoxins in New Hampshire rivers, but HCBs do occur in rivers around the world. Blooms are most noticeable in late summer and early autumn, but may occur any time of year. Although there have been several instances of confirmed blooms of cyanobacteria that are capable of producing toxins in lakes and ponds used as sources by water systems in New Hampshire, until recently there were no protocols in place to provide for monitoring of raw or finished water for cyanotoxins. NHDES released its "CyanoHAB Response Protocol for Public Water Supplies" in December 2016.

**How can you tell whether you have a problem?**
There is no single predictor of which lakes will have a cyanobacteria problem and which will not. Although phosphorus concentration seems to be the biggest risk factor, low-nutrient lakes may have blooms too. While many cyanobacteria blooms are recognizable by appearance alone, the absence of an obvious bloom does not rule out significant concentrations of cyanobacteria and their toxins in the raw water. At the same time, the presence of a bloom does not necessarily mean that toxins are present at dangerous levels. "Managing Cyanotoxins in Drinking Water: A Technical Guidance Manual for Drinking Water Professionals," prepared by American Water Works Association and Water Research Foundation (listed at the end of this fact sheet) is designed to help water system managers consider the full range of management options for cyanobacteria and cyanotoxins.

Monitoring raw and finished water for cyanotoxins is the surest way to determine whether they are present and at what concentrations. However, given the cost of cyanotoxin monitoring, for water systems without a known cyanotoxin issue, NHDES recommends a tiered approach that includes daily or more frequent monitoring for easy-to-measure parameters, followed by microscopic identification and counting of cells, followed by more expensive but more reliable chemical testing triggered by positive indications along the way.

The frequency and sophistication of monitoring would depend on past experience with taste and odor issues or suspected HCBs affecting a given source. Consider the following options:

- At a minimum, monitor the source water every day for visual signs of a cyanobacteria bloom. If you see what you suspect is a cyanobacteria bloom, consult NHDES' CyanoHAB Response Protocol for Public Water Supplies or call NHDES' Drinking Water and Groundwater Bureau.

- If your source has experienced cyanobacteria blooms in the past, develop and implement an ongoing monitoring program to characterize the water quality (temperature, pH, transparency, odor, appearance), weather conditions, and the time(s) of year that are most likely to herald cyanobacteria blooms in your source. Cyanobacteria concentrations tend to vary significantly with wind direction, time of day, location and depth within a given water body.

- Participate in the Northeast Cyanobacteria Monitoring Program coordinated by USEPA's New England Regional Laboratory in Chelmsford, Massachusetts, particularly if your water system has experienced suspected blooms. The program uses low-cost, hand-held fluorometers to monitor for levels of the cyanobacteria pigment phycocyanin as an indicator of the abundance of cyanobacteria. Participants who are interested can also learn to identify cyanobacteria using a microscope. The cost of participating is minimal and may be covered by the NHDES Local Source Water Protection Grant Program.

- Use a real-time phycocyanin probe. Either alone or in conjunction with a chlorophyll-a probe, a probe that measures phycocyanin fluorescence can be a reliable way for water systems that are prone to cyanobacteria blooms to keep a close eye on cyanobacteria and algae abundance, using the results to trigger adjustments to treatment processes (see below) and/or grabbing samples to send to NHDES for cell identification and counting, and/or cyanotoxin analysis.

- If your system has experienced confirmed detections of cyanotoxins, use a cyanotoxin (or "algal toxin") test kit to check for cyanotoxins when visual or other parameters (e.g., pH, phycocyanin readings) indicate the possibility of a cyanobacteria bloom.

**What can water systems do to prepare for and manage the problem?**

Water systems should review the most recent guidance from USEPA, American Water Works Association (AWWA), and Water Research Foundation (WRF). The guides cited below are intended to help water systems evaluate source waters for vulnerability to HCBs, and develop plans to (1) monitor for cyanobacteria and cyanotoxins; (2) treat water for cyanotoxins; and, (3) communicate with stakeholders. The November 2016 USEPA guide contains sample plans and a template for water systems to develop their own plans.

***Source Water Protection***

Factors contributing to blooms include nutrient (phosphorus and nitrogen) availability, sunlight and temperature. Water suppliers can help reduce the risk of cyanobacteria blooms through source water protection efforts that limit nutrient and sediment loads to source waters. Controlling nutrient and sediment loads can also help minimize problems with taste, odor and disinfection byproducts.

***Develop a Response Plan***

If you find that your source is susceptible to cyanobacteria blooms, develop a protocol that describes how you plan to respond, beginning with a suspected cyanobacteria bloom through confirmed detections of cyanotoxins in your raw water. NHDES recommends that water systems develop plans that are consistent with its CyanoHAB Response Protocol for Public Water Systems.

***In-Reservoir (In-Lake) Strategies***

While not practical for all sources, some systems can reduce concentrations of cyanobacteria and toxins reaching their intakes by drawing water from locations or depths with lower concentrations of cyanobacteria and/or by diverting surface scums away from the intake. In-reservoir techniques that focus on manipulating the conditions that affect cyanobacteria growth include destratification (vertical mixing), aeration, increasing flushing by diverting river flow into the problem reservoir, and covering or removing nutrient-rich sediment. A number of water systems have had success using algaecide before blooms occur, but using this technique successfully with a minimal amount of algaecide depends on an appropriate monitoring program. Copper sulfate or other algaecides should be used with caution, *prior to bloom formation, if at all*. Concerns associated with algaecide use include the potential release of toxins by cyanobacterial cells and unpredictable ecological effects, such as nutrient release leading to subsequent algae or cyanobacteria blooms. Permits from NHDES and the New Hampshire Division of Pesticide Control ((603) 271-3550) are required prior to the use of algaecide in a water body.

***Manage Treatment Processes to Optimize Removal of Cells and Toxins***

The overall strategy for treatment optimization is removal of intact cyanobacteria cells through coagulation and filtration, followed by removal or destruction of dissolved toxin through adsorption and/or post-filtration oxidation. The June 2016 white paper from the Water Research Foundation cited below states, "There are several conventional and advanced treatment options available for the removal of cyanotoxins. The key is in understanding the specific toxin of concern, because different toxins are removed/inactivated at varying degrees by different treatment technologies. For example, several research studies indicate that water treatment plants that meet Stages 1 and 2 of the Disinfectants/Disinfection By-product Rule by using ozone have a considerable level of protection from several types of cyanotoxins (such as microcystin), but not from saxitoxin. On the other hand, pre-oxidants such as potassium permanganate, ozone and chlorine (which are used to mitigate cyanobacteria) have been found to lyse cyanobacteria, which releases toxins; therefore, it is recommended that coagulation be used prior to oxidation to remove whole cells." For more information and to help prepare for a potential HCB in your water system, see the October 2016 treatment optimization guide from USEPA.

As with any drinking water contaminant, the best strategy is to minimize the need for treatment through effective source water protection. According to the November 2016 USEPA guide, even with treatment optimization, "public water systems may face challenges in providing drinking water during a severe bloom event when there are high levels of cyanobacteria and cyanotoxins in source waters."

**Detailed guidance for public water systems** (most recent listed first):

USEPA (June 2019) Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems. EPA-810F11001.

USEPA (November 2016) Cyanotoxin Management Plan Template and Example Plans. EPA 810-B-16-006.

USEPA (October 2016) Water Treatment Optimization for Cyanotoxins, Version 1.0. EPA 810-B-16-007.

American Water Works Association and Water Research Foundation (September 2016). Managing Cyanotoxins in Drinking Water: A Technical Guidance Manual for Drinking Water Professionals.

USEPA (June 2015). Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water. EPA 815-R-15-010.

**For More Information**

Please contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgbinfo@des.nh.gov or visit our website at des.nh.gov.

Note: This fact sheet is accurate as of July 2019. Statutory or regulatory changes or the availability of additional information after this date may render this information inaccurate or incomplete.