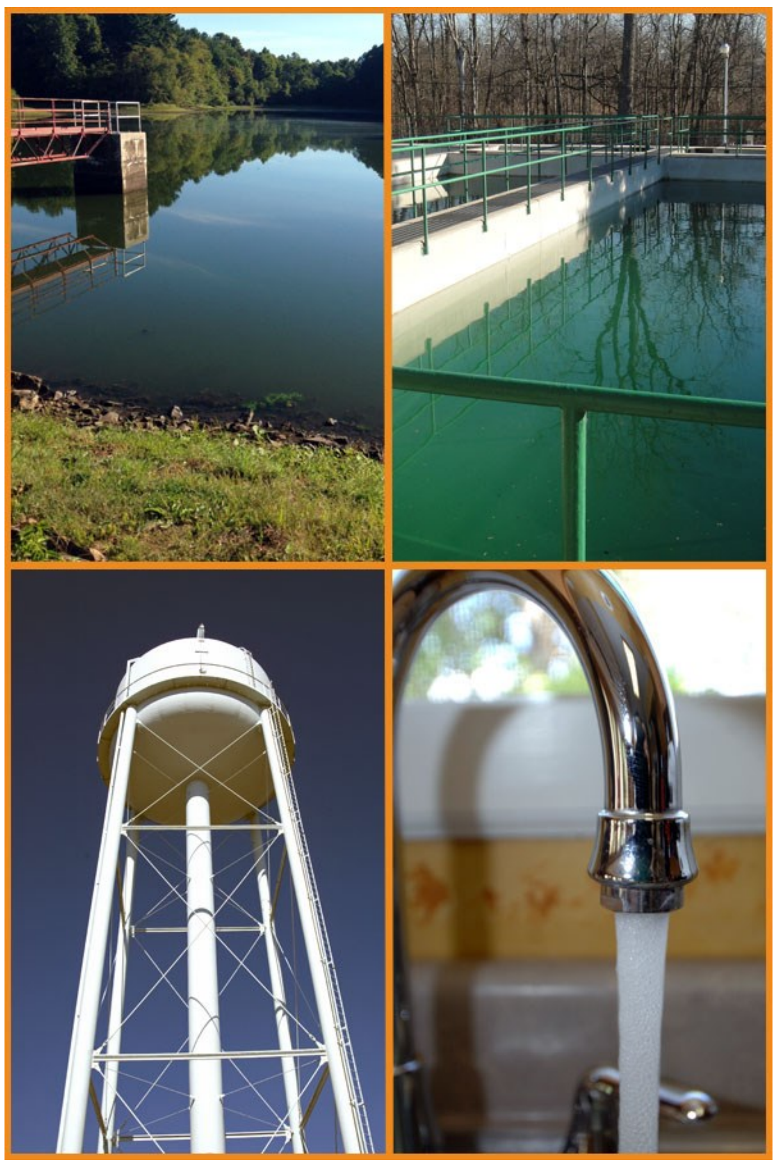
Ohio Environmental Protection Agency

Guidance For Public Water Systems

Developing a Harmful Algal Bloom (HAB) General Plan



Division of Drinking and Ground Waters
Version 2.0 January 2019

Introduction

This guidance was developed to assist a public water system (PWS) in submitting all the necessary information for Ohio EPA review and approval of a Harmful Algal Bloom (HAB) general plan. It provides an overview of both short- and long-term actions that a PWS can take to develop a multiple-barrier approach to address microcystin concentrations in the raw water, and the required justification for determining adequacy of treatment. The guidance also outlines how a PWS can request a reduction in increased routine monitoring.

Short and long-term actions that address intracellular microcystins removal should also be effective at intracelluar removal of other cyanotoxins, such as saxitoxins and cylindrospermopsin. Strategies that address extracellular saxitoxins and cylindrospermopsin removal may differ, however, from strategies to remove extracellular microcystins. For example, oxidation kinetics may vary for different cyanotoxins. Water systems with a history of source water saxitoxins and/or cylindrospermopsin detections are encouraged, but not required, to include strategies for addressing those cyanotoxins in addition to microcystins in the HAB general plan.

In accordance with Ohio Administrative Code (OAC) Rule 3745-90-05, a public water system will be required to submit a HAB general plan if total microcystins concentrations exceed 1.6 micrograms per liter in a sample collected at the raw water sampling point more than once within a consecutive 12-month period, or when total microcystins are detected in any sample collected at a finished water sampling point or a distribution sampling point. By rule, the general plan is due within 120 days of the trigger (date of completion of microcystins analysis). When a PWS is required to submit a general plan to address HABs, the PWS must look at its source and treatment processes to formulate a plan to include both short-term actions (adjustments that can be made with existing infrastructure) and long-term actions (require planning, designing and/or construction) to prevent finished water exceedances of the total microcystins action levels. This plan should include a combination of the following:

- source water protection activities;
- avoidance strategies;
- reservoir management; and
- enhancement of existing processes or addition of new treatment processes, or demonstration that existing optimized processes are sufficient to address established raw water microcystins challenge concentrations (see Section I).

Section II of this document describes these short- and long-term actions in more detail.

The general plan must include a schedule for implementation or a demonstration that existing practices are sufficient (see Section III).

Short- and long-term actions must follow the generally accepted principles for removal of intracellular or extracellular cyanotoxins, as outlined in the following references:

1) Ohio EPA's *Guidance for Public Water Systems on Developing a Harmful Algal Bloom Treatment Optimization Protocol.* ***epa.ohio.gov/ddagw/HAB.aspx***

2) Ohio EPA/AWWA's draft *White Paper on Cyanotoxin Treatment*. ***epa.ohio.gov/portals/28/documents/HAB/AlgalToxinTreatmentWhitePaper.pdf***

3) Other applicable references – for example:
   a. U.S. EPA's *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*, June 2015. ***https://www.epa.gov/sites/production/files/2017-06/documents/cyanotoxin-management-drinking-water.pdf***
   b. U.S. EPA's *Water Treatment Optimization for Cyanotoxins* Version 1.0, October 2016. ***https://www.epa.gov/sites/production/files/2018-11/documents/water_treatment_optimization_for_cyanotoxins.pdf***
   c. *Harmful Algae Blooms in Drinking Water* textbook (Walker 2015)
   d. *AWWA M57: Algae, Source to Treatment (*1st ed. 2010) manual
   e. WQRA guidance, *Management Strategies for Cyanobacteria: A Guide for Water Quality Utilities* 2010
   f. AWWA's Cyanotoxin CT calculator and PAC jar test procedure — ***www.awwa.org/resources-tools/water-knowledge/cyanotoxins.aspx***
   g. U.S. Army Corps of Engineers, *Review and Evaluation of Reservoir Management Strategies for Harmful Algal* Blooms 2017. ***http://dx.doi.org/10.21079/11681/22773***

These references will be used to guide Ohio EPA's review of the proposed actions in the general plan. Other existing Ohio EPA policies and plan review documents will also be used.

The HAB general plan must be prepared, sealed, signed, and dated by an Ohio Registered Professional Engineer. The plan should be developed in coordination with the public water system administration and operator of record. The submittal letter must be signed by the responsible public official or, for a privately-owned project, the owner or his authorized representative. The plan must be submitted to the appropriate Ohio EPA district office, along with a $150 review fee. The plan will receive a formal action of the director, either an approval, with or without conditions, or a denial, in accordance with provisions of OAC Chapter 3745-91.

The HAB general plan must include basic general planning information, as well as describe a comprehensive approach to address concurrent water quality concerns the public water systems faces in addition to HABs. The impacts on all finished water quality objectives must be evaluated and addressed. For example, source and treatment changes can impact the formation of disinfection byproducts or the corrosivity of lead and copper. Even if an exceedance of a drinking water standard has not occurred, changes to source or treatment which could impact water quality and potentially impact compliance with a drinking water standard, must be addressed in the general plan. See Section IV for components of a HAB general plan.

Public water systems, upon request, may qualify for a reduction in monitoring as outlined in OAC Rule 3745-90-03 upon approval of the general plan. See Section V for more information.

Section I. Challenge Concentrations of Source Water Microcystins

Data collected by Ohio EPA over the last several years was used to establish microcystin occurrence data for various source water bodies. PWSs must have treatment capability, or sufficient avoidance or source control strategies, to address the concentrations of microcystins outlined below (“challenge concentrations”). All systems must assume their challenge concentration is entirely extracellular (not bound within a cell) to address the worst case scenario.

Lake Erie Source Water

The Lake Erie basin has been divided into three sub-basins: the Western Basin; the Lake Erie Islands and Sandusky Sub-basin; and the Central Basin. Ohio EPA used historical microcystins data with a safety factor to set microcystins concentration ranges for expected treatment capability for each of the Lake Erie sub-basins:

1) Western Basin PWSs’ challenge concentration – 100 μg/L extracellular microcystins. Intake microcystins levels have been detected over 50 μg/L and open source water samples have exceeded 1,000 μg/L. The following PWSs are in this category: Toledo; Oregon; Carroll Water and Sewer; and Ottawa County Regional Water District.

2) Lake Erie Islands and Sandusky Sub-basin PWSs’ challenge concentration – 50 μg/L extracellular microcystins. Intake levels have been detected at 28 μg/L. The following PWSs are in this category: Lake Erie Utilities; Put-In-Bay; Kelleys Island; Camp Patmos; Marblehead; Sandusky; Huron; Vermilion; Elyria; Lorain; and Avon Lake.

3) Central Basin PWSs’ challenge concentration – 10 μg/L extracellular microcystins. Intake levels have been detected at 3.9 μg/L. The following PWSs are in this category: all other existing Lake Erie source water systems not listed in 1 or 2 above.

Inland Lake, Reservoir, Stream and River Source Waters

Due to limited data for these source water bodies, a minimum challenge concentration of 50 μg/L extracellular microcystins will be applied, or the maximum level detected in raw water, whichever is greater. Source strategies, discussed in Section II, in conjunction with low raw water concentrations can be considered in justifying a reduced treatment capability.

Blended Ground Water Sources

If a PWS has Ohio EPA approval to blend surface water with a ground water source, and the ground water source is fed at the head of the plant and not mixed within a surface water reservoir, the challenge concentration can be lowered based on the percentage of ground water that can be fed and still meet peak demand. For example, if an inland lake system can blend 50% ground water and still meet peak demand, their challenge concentration can be lowered from 50 ug/L to 25 ug/L extracellular microcystins.

Section II. Source and Treatment Processes, Short-Term and Long-Term Actions

Ohio EPA will require a multiple barrier approach, which can address both intracellular and extracellular microcystins, to ensure adequate barriers to microcystins breakthrough into the finished water supply under varying water quality conditions. Any approach should take into consideration all the finished water compliance objectives for the system.The following are a list of barriers that a PWS can consider, and document, in its approach to address HABs events.

1) Source Water Protection Activities

   Discuss source water protection activities the water system participates in and the status of source water protection plan development. These activities can be vital to the success of a long-term strategy to control the occurrence of cyanobacteria blooms but may take time to yield improvements in source water conditions needed to prevent HABs. The goal of source water protection activities as part of this general plan is to reduce the net nutrient loading to the raw water sources of the treatment plant. Nutrient reduction has been linked to a reduction in HABs and associated cyanotoxins.

   A PWS is strongly encouraged to develop a source water protection plan, if they have not already done so. Ohio EPA has guidance to assist PWSs in developing a source water protection plan and source water protection staff are available to assist with plan development. The PWS should contact their Ohio EPA representative for further direction. The *Developing Source Water Protection Plan for Public Water Systems Using Inland Surface Waters* guidance can be found at ***epa.ohio.gov/portals/28/documents/swap/swap_sw_protplan.pdf***.

   If chosen as an option, the source water protection portion of the General Plan should describe the activities to be implemented by the public water system, and others helping implement these actions. This should include what will be done, who will do it, when they'll do it and, if needed, how they'll do it. Source water protection activities may include promoting supplemental raw water sampling, coordinating with local emergency agencies, sharing information about the water source, and promoting ways to reduce nutrient loading. PWS engagement in regional partnerships to address common source water concerns is an important part of any sorce water protection program. Implementing source water protection for large bodies of water, such as Lake Erie or the Ohio River, presents additional challenges that requires including these partners.

   Although strongly encouraged, source water protection activities alone are not sufficient to reduce the current risk of cyanotoxin exceedances. These activities should be part of a comprehensive strategy which includes additional source and treatment processes.

2) Avoidance Strategies

   A. Alternate source - Wells

      Describe capacity of existing wells and any proposed wells. Describe how the wells will be operated in conjunction with the surface water source. For instance, will the wells be pumped directly to the treatment plant or into a reservoir to supplement the surface water supply? Include the percentage of peak flow that can be provided by alternate ground water sources.

B. Alternate source - Secondary Reservoir or River/Stream Intake
If a system has multiple reservoirs and/or river/stream intakes, and/or multiple intake depths, describe how the system will determine that the reservoir(s), different intake depths, or river(s) are impacted or not impacted by cyanotoxins. Describe how one or more of the reservoirs can be isolated to allow the direct use of a non-impacted reservoir or a river/stream intake. If the system can draw directly from stream or river, describe intake and capacity of raw water pumping. Please note, before alternate sources are used, sampling of the alternate raw water source should confirm either no detection of cyanotoxins, or cyanotoxins at a level that can be effectively removed by the treatment plant.

C. Connection to another system
Describe terms of the purchased water agreement. Also, describe available capacity from the wholesaler, as well as size and adequacy of the connection to provide both quantity and pressure needs. Consider impacts purchased water will have on distribution water quality. For example, for lead and copper, consider differences in pH, free chlorine residual, alkalinity, DIC and whether a phosphate inhibitor is used.

Although strongly encouraged, avoidance strategies alone may not be sufficient to reduce the current risk of cyanotoxins exceedances. These activities should be part of a comprehensive strategy which includes additional source and treatment processes. When considering switching to the use of an alternative source or connecting to another system consult the Ohio EPA's *Guidelines for Determining When Source or Treatment Changes Trigger New Optimal Corrosion Control Evaluation* to see if the use of the alternative source and/or interconnection will require a corrosion control study.

3) Source Water Monitoring and Treatment Actions (Reservoir Management)
For a more comprehensive guidance, refer to Ohio EPA's *Treatment Optimization Protocol* document; U.S. EPA's *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water* document, Section 2.4 Source Water Mitigation and Appendix E; and U.S. Army Corps of Engineers' *Review and Evaluation of Reservoir Management Strategies for Harmful Algal Blooms*. The following are examples of applicable strategies:

A. Algaecide Treatment
Describe current use of algaecides and monitoring parameters that are used to target effective algaecide application. A general permit and Notice of Intent (NOI) for algaecide application must be obtained prior to application to raw water sources. More information is available in the Ohio EPA algaecide application fact sheet which can be found online at ***epa.ohio.gov/Portals/28/documents/HABs/Publications/AlgaecideApplicationFactSheet.pdf***. To prevent release of cyanotoxins, algaecides must not be applied to a severe bloom on an in-service reservoir without prior approval from Ohio EPA. Ideally, algaecides should be applied during the early stages of bloom

formation, when cyanobacteria cell counts are low (<10,000 cells/mL) or if measured toxin concentrations in the source water (bloom) are not detected, because: 1) this is when the potential for cyanotoxin release is low; and 2) if the treatment is applied at the early stages of a bloom and toxins are released into the water, the toxins may be removed effectively during the treatment processes.

B. Selective Withdrawal of Higher Quality Water
Describe monitoring parameters and strategies that will be used to select for low nutrient (high quality) water. The system should exercise the option to selectively draw water from a river/stream when water quality is desirable to fill the reservoir, if this option is available.

C. Other reservoir treatment or reservoir management strategies
Describe any structures or strategies that will be used to limit nutrients or control cyanobacteria abundance in the sources water. Some examples include: dilution and flushing of a reservoir system with higher quality water; sonication; phosphorus inactivation treatment (alum, coagulants); hypolimnetic aeration (oxygenation); reservoir mixing/circulation; physical removal of scums or biomass; floating covers; and nutrient removal/control (wetlands, dredging). The success of a particular approach will be site-dependent and should be thoroughly reviewed and investigated before significant investment is made. New source water treatment may require plan approval by Ohio EPA.

Although strongly encouraged, reservoir management strategies alone may not be sufficient to reduce the current risk of cyanotoxins exceedances. These activities should be part of a comprehensive strategy which includes additional source and treatment processes.

4) Existing In-Plant Treatment Processes
A PWS may provide justification that existing treatment plant processes are sufficient to address the risk posed by microcystins in the raw water source. Treatment must be capable of addressing worst case historical raw water microcystins concentrations or challenge concentrations of microcystins detailed in Section I (whichever is greater). Treatment train microcystins data can be used to help document the microcystins removal capacity of existing processes. If historical treatment train data is not available, a comprehensive evaluation of the adequacy of existing treatment processes must be made (see Section III).

In lieu of providing a description of treatment strategies in this document, a PWS should refer to guidance documents listed in the introduction, including: Ohio EPA's *Guidance for Public Water Systems on Developing a Harmful Algal Bloom Treatment Optimization Protocol,* ***epa.ohio.gov/ddagw/HAB.*****aspx** and Ohio EPA/OAWWA's *Algal Toxin White Paper,* ***epa.ohio.gov/portals/28/documents/HAB/ AlgalToxinTreatmentWhitePaper.pdf***

Treatment processes should be paired with source water protection, avoidance, and management to provide a multiple barrier approach for microcystins removal.

5) Enhanced and New In-Plant Treatment Process(es)

New or enhanced treatment may be necessary if the PWS does not have a multiple barrier approach in place to address the challenge concentration of microcystins. Also, additional treatment is necessary if a PWS is currently limited or reaching the limit of the capability of its existing treatment processes to remove historical levels of microcystins detected in its raw water. Indicators of insufficient treatment may include, but are not limited to, detecting significant microcystins on top of filters; blinding filters or stressing the sedimentation process and sludge handling with increased solids loading due to PAC addition; and/or, detecting significant microcystins at the clearwell influent. A finished water detection that cannot be corrected through rapid response optimization, or creates other compliance issues, will require addition of new or enhanced treatment.

A. Enhanced Treatment - Examples of enhanced treatment that can be used to address microcystins include:
   1) Increase PAC feeder capacity and storage and/or add additional feed points.
   2) Optimize pH for microcystins destruction within the normal operational range for the PWS.
   3) Increase storage/handling ability for backwash waste and sludge to facilitate ceasing recycling and more frequent backwashing.
   4) Cease backwash waste recycling.
   5) Slow flow through plant to increase CT while still meeting treatment demands.
   6) Add a filter aid or polymer to enhance coagulation/filtration.

   The success of a particular enhancement to treatment may vary. Provide justification that supports the adequacy and reliability of treatment. The same type of information should be provided as outlined above under new treatment.

B. New Treatment — Examples of new treatment that can be used to address microcystins are: ozone; GAC contactors; membranes; PAC; UV/peroxide; additional finished water storage to increase CT; and permanganate (if applicable).

Section III provides more details on establishing the adequacy of enhanced or new proposed treatment.

Section III. Establishing Adequacy of Existing or Proposed Treatment

The following guidance outlines the minimum criteria necessary to establish the adequacy of a treatment process to address microcystins. For new or proposed treatment, bench or pilot testing will be necessary for a majority of the processes. New and/or existing treatment must demonstrate capability to address historical or challenge concentration of microcystins in the raw water, as designated in Section I.

The PWS must provide justifications that support the adequacy and reliability of treatment. Justifications must include the following:

1) A summary of microcystins and cyanobacteria screening compliance data. For example, maximum and average concentrations and duration of occurrence.
2) Additional source water and treatment train microcystins data, if available, including intracellular and extracellular results.
3) Bench scale studies, pilot studies, modeling and/or published literature establishing an expected intracellular and extracellular microcystins removal efficiency for each existing and proposed treatment process. Impacts of competing contaminants or water quality considerations on treatment effectiveness must be considered.
4) Demonstration that combined processes are adequate to address the extracellular microcystins challenge concentration established in Section I. If unimpacted alternate sources (such as ground water) are available, blending source waters can lower your challenge concentration. For example,

General Statement on Treatment Barriers

Ohio EPA expects that a PWS will provide at least two treatment barriers to address extracellular microcystins challenge concentrations. The treatment barriers must be recognized as effective for extracellular microcystins removal, and should include at least two of the following:

A. A PAC feed system capable of dosing at least 40 mg/L PAC. At least two application points should be available. An adequate reaction time must be provided and interference with oxidants minimized (for example, separation of permanganate feed and PAC feed by at least 20 minutes).
B. A chlorine contact time that is at least two times the necessary CT for reducing the PWS's challenge microcystins concentration to 0.3 ug/L, as determined by the AWWA calculator CyanoTox Calculator 2.0.
C. An additional effective barrier, such as: GAC contactor, ozonation, nanofiltration/reverse osmosis (NF/RO), or ultraviolet irradiation with advanced oxidation.

The following justifications must be provided for each treatment process that is proposed as a barrier:

1. PAC
   See Above. If relying on this barrier and chlorine oxidation only, a minimum feed rate of 40 mg/L is required. If this is not a typical feed rate, the PWS should demonstrate through trial the capacity to feed at this rate (ensure higher feed rates do not result in clogging lines or downstream impacts to treatment performance). PAC should be well mixed upon addition at each feed point. Ideally, PAC should be fed at multiple locations to increase its removal efficiency. A PWS should aim to maximize the distance between any oxidant and PAC application point. The application points of any oxidant and PAC should be separated by at least 20 minutes to avoid interference.
   An adequate supply and safe handling and storage of PAC must be provided. A minimum of two weeks of PAC storage dosed at 40 mg/L or greater should be kept on site or be readily available from the manufacturer/supplier to meet demand. Handling and storage of PAC must ensure operator safety is maintained.

   The general plan must include information on the type of PAC that will be used during a HAB event. Wood-based PAC with a greater mesopore volume (between two nanometers and 50 nanometers) has been shown to be most effective in microcystins removal, but not all wood-based PACs are equal, in some instances, other PAC types may perform better. Jar testing is strongly recommended to determine the best PAC type and dosing requirements for each system. If microcystins adsorption data (including treatment train data, or Ohio EPA or other published jar test results) is not available for the PAC the PWS plans on utilizing in response to a HAB (and PAC is a primary treatment barrier), a jar test may be required prior to general plan approval.

   AWWA developed guidance for conducting jar testing to estimate PAC dosage, which is available here: ***www.awwa.org/resources-tools/water-knowledge/cyanotoxins.aspx***. Once you log in or register (free), click on the "Testing Protocols for Site-Specific Powdered Activated Carbon Assessments" and "Powder Activated Carbon Calculator for Site Specific Assessments" links.

   Ohio EPA Central Office HAB staff can provide assistance on designing an appropriate PAC jar test to best determine site specific microcystins adsoprtion rates. Staff can also provide guidance on how to concentrate microcystins in the water system's source water instead of purchasing expensive commercial microcystins standards, which may not adequately represent source water conditions

2. Ozone
   At a minimum, spiked samples used during a bench scale analysis or side-stream pilot studies must be conducted with water quality representing the system's quality at the point of application (including DOC concentrations typical of a HAB event). For the bench scale analyses, the sample should be spiked with expected levels of microcystins that will be addressed by the ozone process. Microcystins sourced from the water system's raw water

are preferred over commercial MC-LR standards, which may not represent source water microcystin variants. The pilot must establish the dose and contact time necessary to provide required treatment under varying water quality and design flow rate. Ozone dose must be sufficient to meet water quality demands (such as TOC) and produce a residual of ozone to address microcystins concentrations with contact time provided. [WQRA 2010 guidance recommends pH > 7, residual >0.3 mg L-1 for at least five minutes contact to treat for microcystins (Newcombe et al., 2010)]. Establish that bromate formation will not exceed the maximum contaminant level for bromate of 0.010 mg/L.

For existing treatment, a PWS may instead provide historical data demonstrating effectiveness and/or that design meets the minimum established criteria for microcystins reduction in guidance and published literature to be approved at the discretion of the Ohio EPA.

3. Ultrafiltration/Microfiltration (UF/MF)
   Use membranes validated for log removal. Conduct piloting showing the treatment process meets the established goals for turbidity removal and other applicable goals found in Ohio EPA's ENG-05-001: *Guidelines for Obtaining Approval of Membranes to Meet Particulate and Microbiological Removal Requirements for Surface Water*, available at ***epa.ohio.gov/portals/28/documents/pws/ENG-05-001.pdf***.

   For existing treatment, a PWS may instead provide historical data demonstrating effectiveness for microcystins cell removal and/or data showing water quality goals are being met, especially in regard to turbidity and/or particulate removal, and total organic carbon removal.

4. Nanofiltration/Reverse Osmosis (NF/RO)
   The chosen membrane must have the necessary molecular weight cut-off, in Daltons, to remove cyanotoxins. Research has shown that a well-operated membrane process can see a significant percentage of cyanotoxins (up to 97 percent) removed with membranes having a molecular weight cut-off of 150 Daltons or lower (Walker, 2015). This molecular weight cut-off typically applies to reverse osmosis membranes and tight nanofiltration membranes. According to a summary in U.S. EPA's 2015 guidance (3a), the exact removal efficiencies by NF depend on the membrane material (Westrick et al., 2010), and on the membrane pore size and water quality for NF and RO (Gijsbertsen-Abrahamse et al., 2006).

   A pilot is required and should be conducted in accordance with ENG-07-001: *Guidelines for Obtaining Approval of Membranes to Meet Treatment Requirements for Ground Water Treatment*, available at ***epa.ohio.gov/portals/28/documents/pws/ENG-07-001.pdf***. The primary contaminant targeted for removal during the study is microcystins, in addition to the other water quality parameters listed that are impacted through this treatment. Pretreatment is necessary to prevent fouling as well as post treatment to ensure stability of water and optimal corrosion control. At a minimum, a desktop study supporting a corrosion control treatment recommendation will be required and must be submitted with the pilot study results.

For existing treatment, a PWS may instead provide historical data demonstrating effectiveness and/or that design meets the minimum established criteria for microcystins reduction in guidance and published literature.

5. Granulated Activated Carbon (GAC) contactors
If relying on GAC as a microcystins barrier, a rapid small-scale column test (RSSCT) must be conducted to determine expected media longevity and effects of competing contaminants on removal of microcystins. For existing treatment, a PWS may provide historical data demonstrating effectiveness and/or that design meets the minimum established criteria for microcystins reduction in guidance and published literature. If available, full scale operational data (including treatment train microcystins, TOC, and/or UV254 data) may be acceptable for demonstrating microcystins removal and media longevity.

   PWSs must establish a media reactivation or replacement frequency to ensure GAC readiness to address microcystins during a HAB event and provide justification for this frequency. Ohio EPA's guidance, ENG-09-001: *Guidelines for Evaluating Granular Activated Carbon (GAC) for Disinfection By-product (DBP) Precursor Removal* (***epa.ohio.gov/portals/28/documents/pws/ENG-09-001.pdf***) can be used and tailored to microcystins removal.

6. Ultraviolet Irradiation with Advanced Oxidation using Hydrogen Peroxide (UV/peroxide)
A pilot study must be conducted to determine effective dose and contact time necessary for microcystins reduction.

   For existing treatment, a PWS may instead provide historical data demonstrating effectiveness and/or that design meets the minimum established criteria for microcystins reduction in guidance and published literature.

7. Permanganate
Permanganate should be used with caution as it will lyse cyanobacteria cells. Permanganate does have the capacity to destroy microcystins, however, dose and contact time are factors in its effectiveness, and pH and competing oxidant demands may also be a factor. Permanganate use should be reserved for removing microcystins when the significant majority of cyanotoxins are extracellular (and intracellular removal from coagulation/flocculation/filtration treatment processes will provide little assistance in total cyanotoxins reduction). If permanganate addition is necessary for other treatment objectives, an additional extracellular treatment barrier (PAC addition, ozone, GAC) should follow to address cyanotoxins released but not destroyed by permanganate.

8. Dissolved Air Flotation
Conduct piloting to determine the effective air injection rate, coagulant dose and loading rate necessary for cyanobacteria cell reduction.

9. Biologically Active Filtration (BAF)
   Conduct piloting to determine the effectiveness of extracellular microcystin removal. The filter also must meet effluent turbidity requirements. For existing treatment, in order to obtain credit for extracellular microcystins removal from the filter without piloting, historical data demonstrating removal of microcystins is necessary.

10. CT with chlorine
    AWWA has developed a calculator for estimating oxidant dose, which is available here: ***www.awwa.org/resources-tools/water-knowledge/cyanotoxins.aspx***. Once you log in or register (free), click on the "Cyanotoxin Oxidation Calculator 2.0" link. A PWS can start with the AWWA calculator but must consider other chlorine demands. CT should be calculated using both standard and worst-case scenario operational parameters with an additional minimum safety factor of two for both cases. The safety factor is included to account for differences in oxidation kinetics of individual microcystin variants and competing oxidant demands that may not be accounted for in the calculator, such as elevated DOC.

11. Conventional treatment
    Coagulation, flocculation and sedimentation processes followed by filtration should be optimized to enhance intact cell removal. Turbidity removal and/or TOC removal should be optimized to improve performance of the conventional treatment process in removing cyanobacteria cells and their intracellular toxins. For existing treatment, a PWS should provide information demonstrating this process is optimized. A PWS should consider achieving a settled water turbidity less than 2.0 NTU (when average raw water turbidity is greater than 10 NTU) or a settled water turbidity less than 1.0 NTU (when average raw water turbidity is equal to or is less than 10 NTU), and filtered water turbidity less than 0.1 NTU, 95 percent of the time.

12. Other treatment processes
    Determination of adequacy of treatment will be made on a case-by-case basis with proper justification.

Conditional Approval

In some instances, a conditional approval of the general plan~~s~~ will be considered. For this consideration, the treatment must meet recommended design parameters established in guidance and published literature for microcystins removal. The conditional approval will require collection of cyanotoxin treatment train data showing adequacy of treatment. If adequacy is not demonstrated, conditional approval will require additional treatment. As part of the condition, a schedule to evaluate and submit the cyanotoxin treatment train data and propose additional treatment must be provided.

Section IV. Elements of a HAB General Plan

The following general planning information must be provided with the HAB general plan. If a PWS is receiving or requesting funding through the WSRLA, the general plan must contain all elements found in the WSRLA nomination instructions:

1) Introduction and Purpose

   Discuss the project scope. Include any compliance issues or actual or potential standards violations that will be addressed.

2) Current Conditions

   Provide the following:
   - Description of the raw water sources, capacities and water quality data.
   - Discussion of all known treatment and distribution system deficiencies.
   - Description of the consecutive systems and current population (PWS and consecutive) to be served.
   - Existing water demand (average and maximum daily demand for past five years).
   - Engineering description of the existing water treatment facilities.
   - Other compliance issues or treatment challenges.

3) Future Conditions

   Provide the following:
   - The projected average and peak water demands based on population trends. Projections should be for at least 20 years in five-year increments.
   - Description of the projected service area and the projected population to be served, if PWS intends on expanding water service.

4) Current Cyanotoxin Management and Treatment Approaches

   Include the following, if applicable:
   - Source water protection activities;
   - Avoidance strategies;
   - Reservoir management; and/or
   - In-plant treatment technologies. Evaluate each major unit process for both intra- and extracellular microcystins removal.

   If the PWS proposes that existing infrastructure is sufficient to address challenge microcystins concentrations, the general plan must include an evaluation of each major unit process's ability to remove/destroy microcystins (see Section III) and a demonstration that multiple barriers exist to reduce extracellular microcystins at that water system's provided challenge concentration (see Section I) to below the 0.3 ug/L microcystins action level.

5) Proposed Cyanotoxin Management and Treatment Approaches

Describe the technical, managerial, financial, operational and local decision-making rationale for the selected approaches. A regionalization alternative should be considered for projects that are for new water treatment plants, major plant rehabilitations or plant expansions. For new raw water sources and/or new in-treatment facilities, include an engineering description of the facilities to be constructed, including a basic layout (schematic and site plan), sizing of treatment units and a desired approved capacity of the treatment facilities.

Overall, please provide:

- A description of how each proposed project will address microcystins challenge concentrations and, if applicable, any potential drinking water standard compliance issue caused by a proposed change in source or treatment, and current compliance issues.
- An engineering description that includes proposed use of existing facilities (if applicable) and treatment and disposal to be installed. Include the construction phases, if overall project is to be completed in steps.
- A discussion of any proposed alterations to the system or plant operation that could affect approved capacity.

All proposed facilities must be sized for current needs with a moderate allowance for future growth. The methodology for determining approved capacities for treatment facilities can be found in the document titled *Approved Capacity Planning and Design Criteria for Establishing Approved Capacity for: 1) Surface Water and Ground Water Supply Sources, 2) Drinking Water Treatment Plants (WTPs) and 3) Source/WTP Systems*
https://epa.ohio.gov/portals/28/documents/engineering/ApprovedCapacity.pdf

6) Residuals

Describe how any water treatment residuals will be properly disposed of, whether on-site, via a publicly owned wastewater treatment facility or to a receiving stream following proper treatment and in compliance with the appropriate discharge permit.

7) Schedule for Implementation

Systems that will need to add or modify treatment, or are planning on implementing reservoir management or source water protection, must submit a detailed schedule with applicable milestone dates for the significant events that are necessary to complete the project(s). An estimated schedule for designing, bidding, constructing and initiating operation of proposed facilities must be included as part of the schedule for implementation.

Section V. Reduction in Increased Routine Monitoring

A reduction in increased routine microcystins monitoring (three days per week when microcystins in raw water exceed 5 ug/L) to once per week may be granted, as outlined in OAC Rule 3745-90-03, as part of general plan approval. For the purposes of the general plan, a reduction in increased routine microcystins monitoring will not be approved at a frequency of less than once per week if microcystins are detected in raw water compliance samples. To qualify for a monitoring reduction, the following applies:

1) The PWS establishes adequacy of existing treatment.
    a) Provide at least one year of historical microcystins concentration data in the raw and finished water. Results of sampling conducted throughout the treatment train during a HAB event must also be included. It is strongly recommended that both total and extracellular microcystins data be collected during a HAB event and be submitted. This data must demonstrate effective treatment of microcystins.
    b) Provide a summary of baseline conditions for other relevant water quality parameters, to include TOC, pH, turbidity and temperature during HAB events.
    c) Summarize chemical dosing/usage during HAB events for those processes targeting microcystins reduction (for example, permanganate, chlorine, PAC, ozone). Summarize operational changes made during HAB events (such as increasing backwash frequency and sludge withdrawal and ceasing backwash recycle). If the PWS's Treatment Optimization Protocol is up to date, it may be referenced in lieu of this summary.

2) Reduced monitoring will only apply when microcystins concentrations in the raw water compliance samples do not exceed historical raw water data presented. If raw water concentrations exceed worst case historical values, routine monitoring will again apply as outlined in OAC Rule 3745-90-03.

3) Include a letter with your General Plan submission formally requesting a reduction in increased routine monitoring when raw water microcystins concentrations exceed 5 ug/L.