

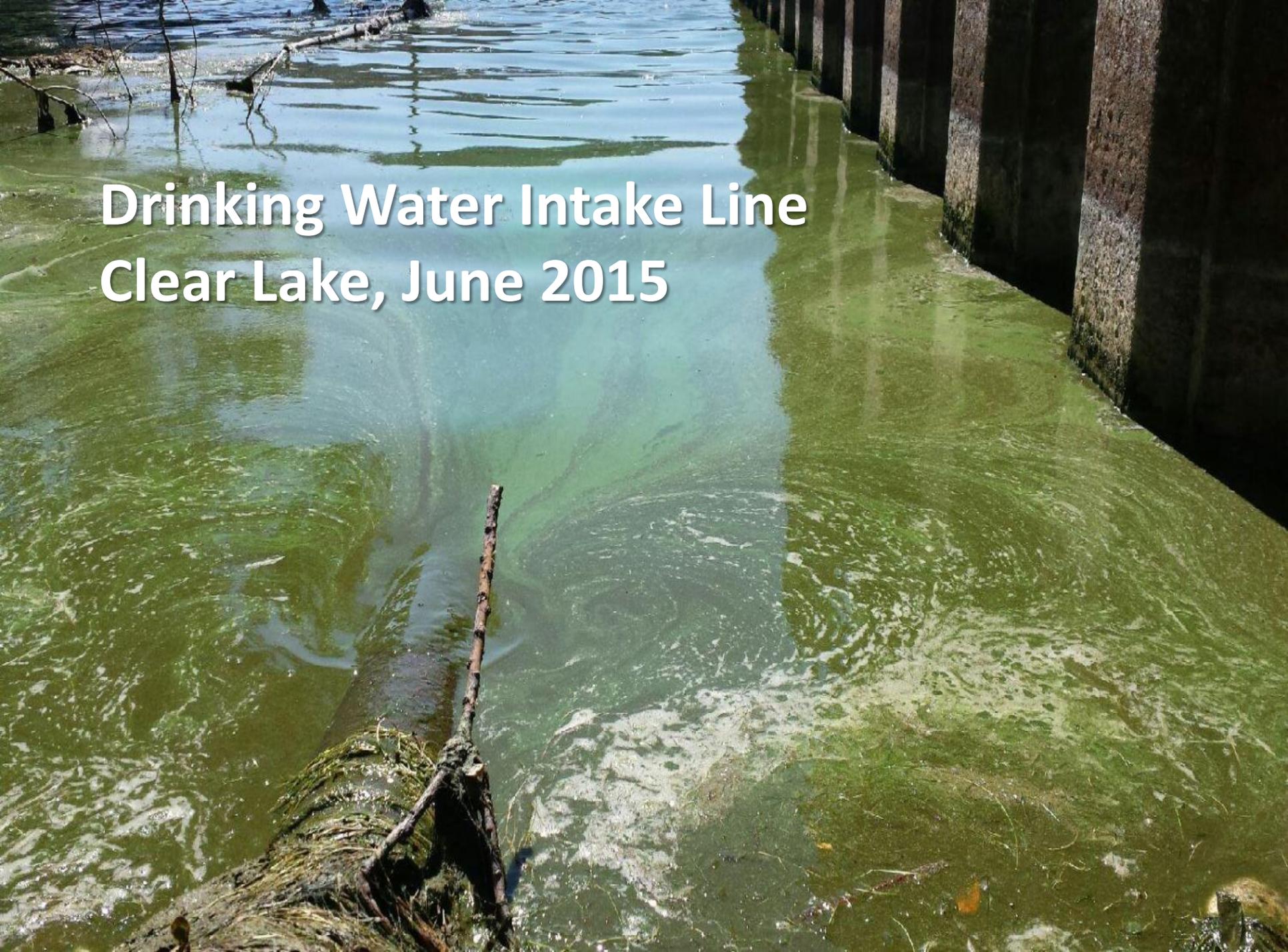


Harmful Algal Blooms and Drinking Water

CA Water Quality Monitoring Council

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State Water Resources Control Board

August 23, 2016

A photograph showing a drinking water intake line in a lake. The intake line is a concrete structure on the right side of the image, with a clear channel of water flowing through it. The surrounding water is heavily covered in green algae. A wooden stick is visible in the foreground, partially submerged in the water. The text "Drinking Water Intake Line Clear Lake, June 2015" is overlaid on the image in white font.

**Drinking Water Intake Line
Clear Lake, June 2015**

Today's Talk

- Harmful Algal Blooms – a growing concern for drinking water
- US EPA's Health Advisories and Recommendations
 - *Cyanotoxin Management Plans*
- California, and the Division of Drinking Water's role
- Assessment and Monitoring Considerations
- Public Communication
- Treatment Considerations



Harmful Algal Blooms

A Drinking Water Concern

- Cyanobacterial blooms increasing – climate change and nutrient loading are driving factors
- Recreational/environmental exposure has been the primary focus of regulatory agencies (beach closures, dog deaths, impact on tribes, businesses)
- Drinking water community has traditionally focused on taste, odor, impact on treatment processes – with background awareness of toxicity issues
- August 2014: Toledo, OH episode focuses national attention on potential drinking water risks
- US EPA accelerates schedule for addressing HABs



Drinking Water Health Advisories

- Per US EPA: Health advisories are **non-regulatory** concentrations at which adverse health effects are not anticipated to occur over specific exposure durations (e.g., one day, ten days, and lifetime).
- In June 2015, US EPA issued **10-day** Drinking Water Health Advisories (HAs) for two cyanobacterial toxins: total microcystins and cylindrospermopsin.
- HAs are not legally enforceable, and are subject to change based on new information.

Drinking Water Health Advisories

- 10-day Health Advisory recommended concentrations for total microcystins are:
 - 0.3 µg/L for children younger than school age
 - 1.6 µg/L for all other age groups
- 10-day Health Advisory recommended concentrations for cylindrospermopsin are:
 - 0.7 µg/L for children younger than school age
 - 3.0 µg/L for all other age groups

Health Advisories are accompanied by...



**Recommendations for
Public Water Systems to
Manage Cyanotoxins in
Drinking Water**

June 2015

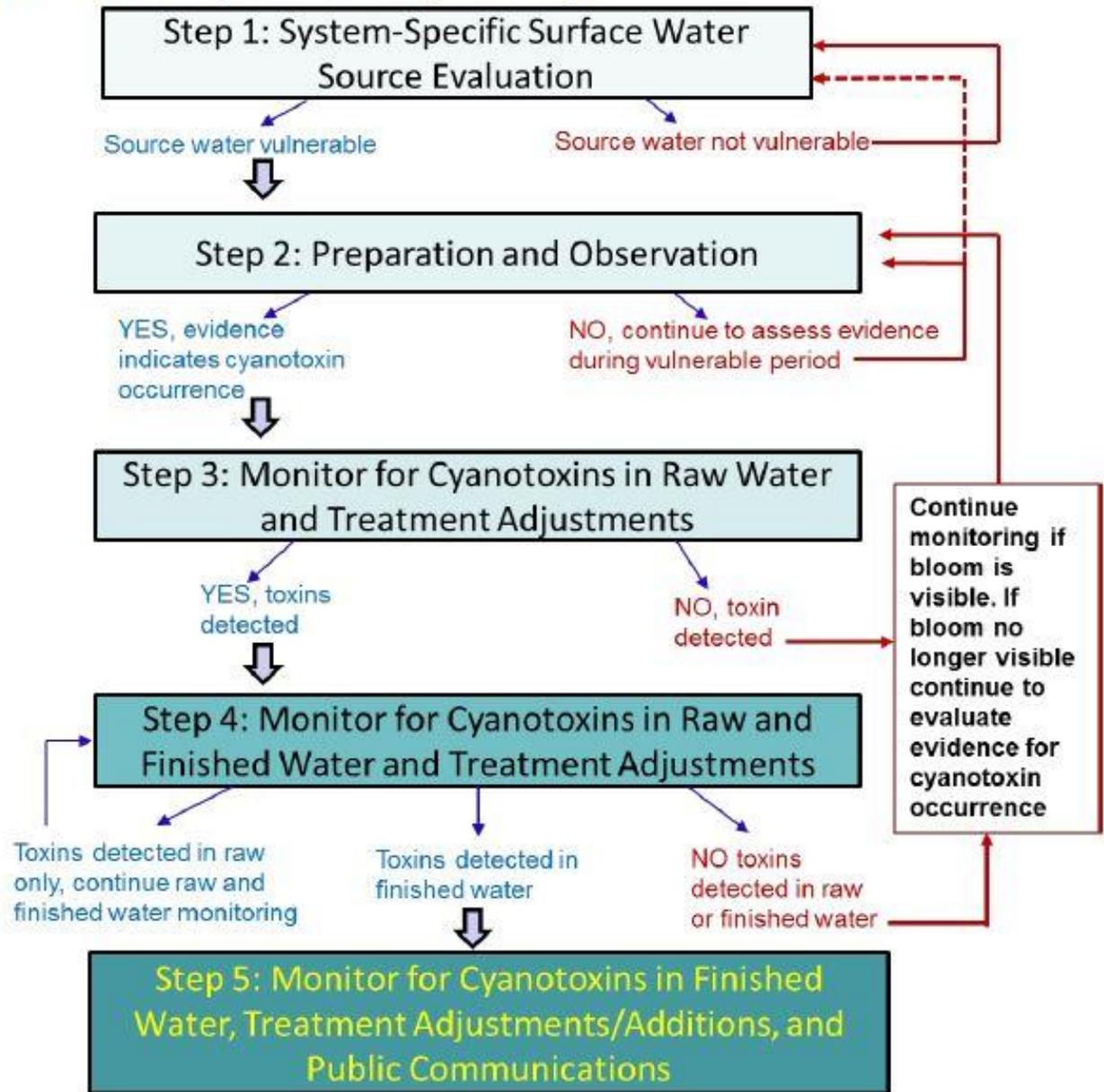
US EPA's *Recommendations*

- *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*
- Issued June 2015, concurrent with release of HAs
- Discusses:
 - Health Advisories
 - Cyanotoxin Management Plan Development, addressing Monitoring, Treatment, and Communication
 - Models a “stepwise process” to help water systems reduce the risk of cyanotoxins in finished water

Cyanotoxin Management Steps

Figure taken from USEPA, *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*, June 2015

D. Potential Cyanotoxin Management Steps



Areas in California with Recurrent Toxic Algae Blooms

Klamath Basin

And...

CA State Water Project!

Clear Lake



San Francisco Bay area/Delta



Pinto Lake/Monterey Bay



**Southern California
Prymnesium "Golden algae"**



Revision of Office of Environmental Health Hazard Assessment (OEHHHA) Fact Sheet (2012)

HABs and Division of Drinking Water

- DDW regulates **Public Water Systems** in CA (PWSs have 15 or more **service connections** or regularly serve at least 25 individuals daily at least 60 days out of the year).
- DDW does not have specific authority to require action from PWSs in response to the Health Advisories – but we cannot ignore the potential threat posed by cyanotoxins.
- DDW Recommends that water systems refer to USEPA's Health Advisories and its *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*.
- DDW offers to collaborate with water systems in developing Cyanotoxin Management Plans, monitoring plans, and communication/public messaging (if needed).
- This is new territory – we need to learn together!



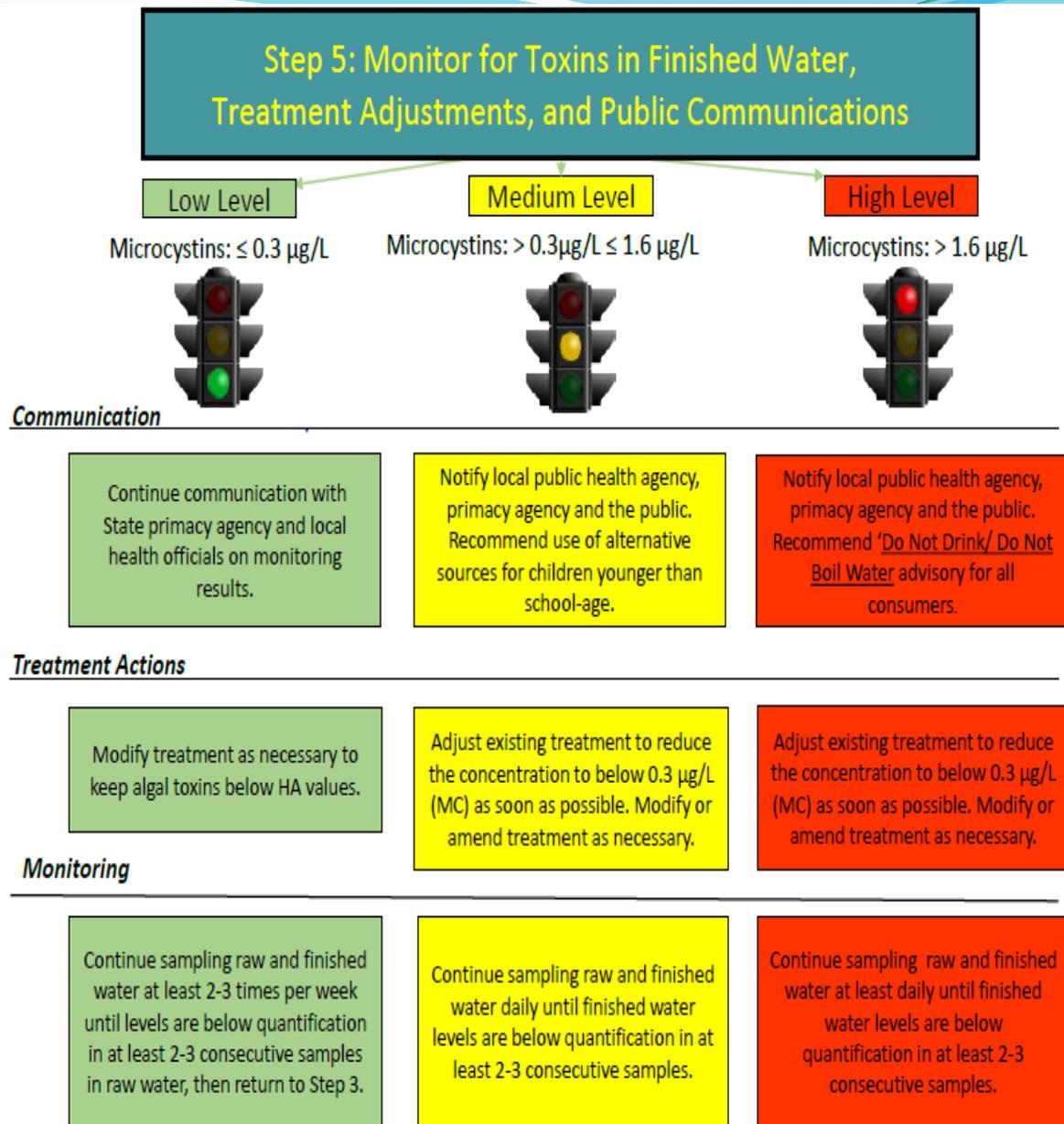
Assessment and Monitoring Considerations

- Need for:
 - Overall assessment of vulnerability, early warning of events
 - Identification of species
 - Chemical analysis of toxins
 - Speedy response to events!
- Obstacles
 - Lab availability, capacity, turnaround time
 - Limitations of analytical methods for microcystins
 - Cost! \$\$\$\$\$\$ (especially for smaller water systems)



HAs and Public Communication

Figure taken from USEPA, *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water*, June 2015



Public Communication

- Not regulated – will water systems choose to notify if Health Advisory levels exceeded in finished water?
- Is a two-tiered HA realistic?
- How to communicate that cyanotoxins are a threat, but there is no MCL, no required response from water system?
- DDW has enlisted help from CDPH/EHIB in developing language for public notice template.

Sample Public Notice



WARNING: Do Not Drink Your Tap Water



We found [*insert specific cyanotoxin*], a very **harmful toxin**, in tap water in your area.

- **This toxin may be dangerous to everyone.** Use a different source of water for drinking and cooking.
- **Boiling or filtering your tap water will not get rid of the problem.** Do not use your tap water for drinking or cooking even if it has been boiled or filtered.
- Your tap water is safe for bathing, washing hands, shaving, washing dishes, house cleaning, laundry and watering the yard/plants.

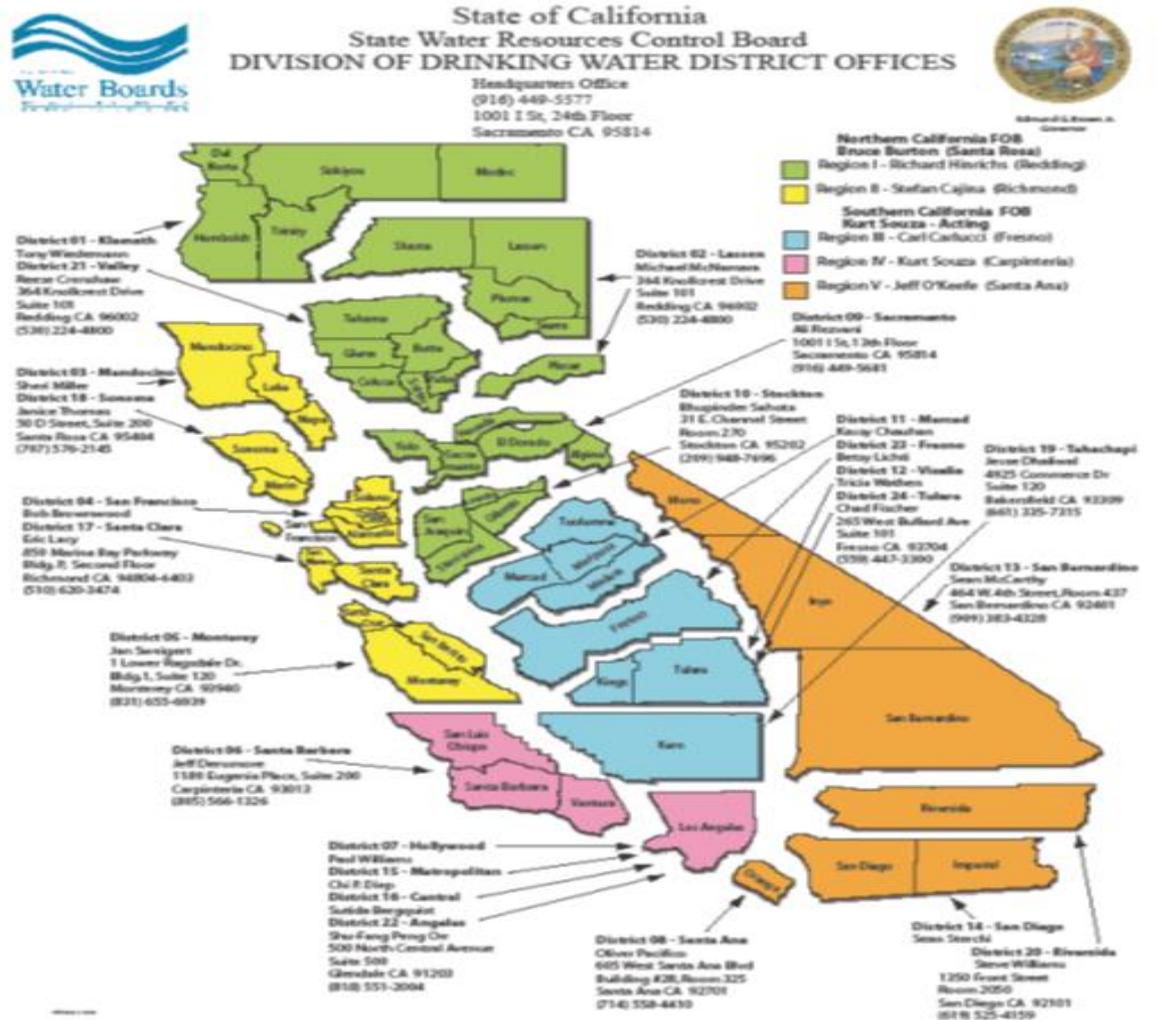
Water systems may be apprehensive about providing public notice – or monitoring in the first place. But, will customers accept NOT knowing?

Interagency Communication

- CalEPA, Water Boards: DDW, DWQ, OIMA, Regions, Public Affairs
- Affected Public Water Systems/Agencies
- Federal: USEPA, US Bur. Reclamation, others?
- CA DWR, DFW, Parks
- CA DPH: DEOCD, EMB, L&C (for dialysis centers) – reach all via EPO/Duty Officer?
- IMPORTANT: involve local health officer and director of environmental health.

DDW District Offices

If you are aware of a Harmful Algal Bloom that might affect drinking water, contact the local DDW office!





Treatment Considerations

- USEPA and AWWA/WRF offer general treatment recommendations (Further EPA guidance forthcoming!)
- Conventional treatment (coagulation, sedimentation, filtration) is effective in removing in-tact cells, but not extracellular toxins
- Pre-oxidation can lyse cells, releasing toxins that will pass through conventional filters
- Activated carbon can remove extracellular toxins (depends on TOC, type of carbon)
- Some oxidants, such as ozone and free chlorine, can destroy some extracellular toxins

Basic Treatment Guidelines

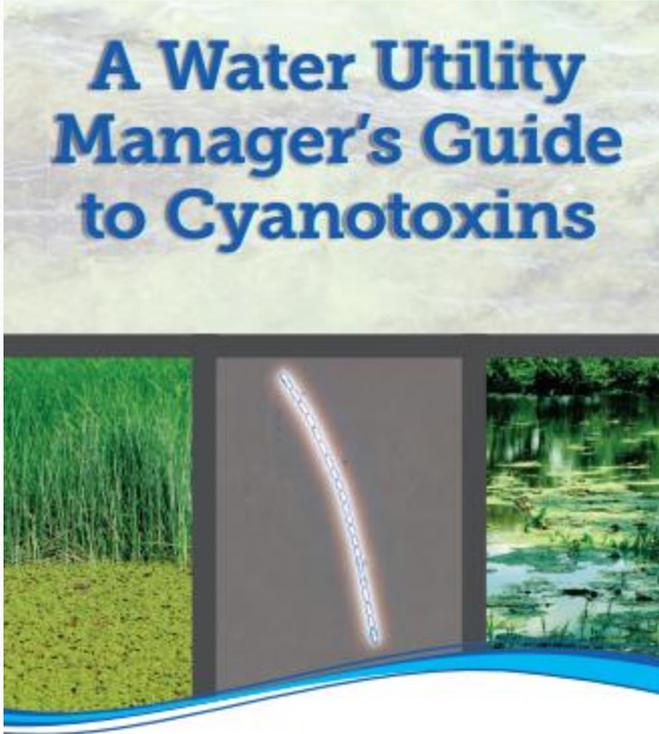


Table 5 Common cyanotoxin treatment practices and their relative effectiveness

Treatment Process	Relative Effectiveness
Intracellular Cyanotoxins Removal (intact cells)	
Conventional coagulation, sedimentation, filtration	Effective for the removal of intracellular/particulate toxins by removing intact cells. Generally more cost effective than chemical inactivation/degradation, removes a higher fraction of intracellular taste and odor compounds, and easier to monitor.
Flotation (e.g., dissolved air flotation)	Effective for removal of intracellular cyanotoxins because many toxin-forming cyanobacteria are buoyant.
Pretreatment oxidation (oxidant addition prior to rapid mix)	Overall, can either assist or make treatment more difficult, depending on the situation. Pre-oxidation processes may lyse (cause dissolution or destruction of) cells, causing the cyanotoxins contained within to release the toxins. Ozone may be an exception (see "Ozone" row) because it both lyses cells and oxidizes the cyanotoxins.
Membranes (microfiltration or ultrafiltration)	Effective at removing intracellular/particulate toxins. Typically membranes require pretreatment.
Extracellular Cyanotoxins Removal/Inactivation	
Chlorination	Effective for oxidizing extracellular cyanotoxins (other than anatoxin-a) when the pH is below 8
Chloramines	Not effective
Potassium permanganate	Effective for oxidizing microcystins and anatoxins. Not effective for cylindrospermopsin and saxitoxins.
Chlorine dioxide	Not effective with doses typically used in drinking water treatment
Ozone	Very effective for oxidizing extracellular microcystin, anatoxin-a, and cylindrospermopsin
Activated carbon (powdered activated carbon and granular activated carbon)	Most types generally effective for removal of microcystin, anatoxin-a, saxitoxins, and cylindrospermopsin. Because adsorption varies by carbon type and source water chemistry, each application is unique; activated carbons must be tested to determine effectiveness.
UV radiation	Degrades toxins when used at high doses, but not adequate to destroy cyanotoxins at doses used for disinfection.
Membranes (reverse osmosis [RO] or nanofiltration [NF])	RO effectively removes extracellular cyanotoxins. Typically, NF has a molecular weight cut off of 200 to 2,000 Daltons, which is larger than some cyanotoxins. Individual membranes must be piloted to verify toxin removal.



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AWWA has also produced CT and PAC calculators.

Treatment Considerations

- From what we've observed: there are no “one size fits all” solutions. Treatment systems must be fine-tuned based on source water, treatment train, technical ability, analytical ability.
- That said, general advice to PWSs may be feasible (e.g., optimizing pre- and post-oxidation to destroy dissolved toxins while avoiding cell lysis before filters).
- None of this advice applies to recreational or household treatment systems. Use of camping filters, over-the-counter systems is not advised. **Boiling water is not effective!**



By David
Bienick
BIO »

Clearlake struggles against dual green menace

Algae, marijuana threaten city's water supply

UPDATED 7:16 PM PDT Jul 14, 2014

Text Size: A **A** A



Water Treatment Plant Impacts

- Source Water Quality Changes:
 - pH fluctuations and elevated total organic carbon (> 10 mg/L)
- Suite of Treatment Issues Encountered:
 - Short filter run/filter clog/breakthrough
 - Increase pre-oxidant demands
 - Increase coagulant demands
 - Increase filter backwashing/clarifier sludge removal
 - Increase disinfection applications to maintain residuals
 - Increase DBP formation potential
 - Taste & Odor complaints
 - Unless monitoring, unknown cyanotoxin impacts



Clear Lake – Cyanotoxin Results

Range of Microcystin concentrations, µg/L

SOURCE WATER
@ INTAKE

PROCESS
WATER

FINISHED WATER
RESULTS

Sept 8, 2011

<RL – 7.97

<RL – 0.53

Aug 20-21, 2013

<RL – 2.36

<RL – 0.24

July 24-28, 2014

<RL – 23.8

<RL – 7.4

NO DETECTIONS
IN FINISHED WATER
INCLUDING AT
DIALYSIS CENTERS

RL – reporting limit



Conclusions?

- This is new territory, and we're going to be here a while
- We (the Drinking Water Community) are learning as we go, and need to work together
- Analytical, treatment, and communication challenges will require attention and creativity
- Is this a chance for YOU to be on the leading edge? (You might not have a choice!)



Additional Information

- **Division of Drinking Water Website:**

http://www.waterboards.ca.gov/drinking_water/programs/index.shtml

http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/publicwatersystems.shtml

- **California CyanoHAB Network (CCHAB)**

http://www.mywaterquality.ca.gov/monitoring_council/cyanohab_network/index.shtml

- **Contact your local DDW Field Office**

http://www.swrcb.ca.gov/drinking_water/programs/documents/ddwem/DDWdistrictofficesmap.pdf

- **DDW Cyanotoxin Web Page:**

http://www.waterboards.ca.gov/drinking_water/programs/habs/

- **USEPA Cyanotoxin Web Page:**

<http://www.epa.gov/nutrient-policy-data/cyanobacteriacyanotoxins>

- **AWWA/WRF Guidance for Water Utilities:**

<http://www.waterrf.org/PublicReportLibrary/4548a.pdf>

Contact Information

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