We work with others to protect the health of the people of Washington State by ensuring safe and reliable drinking water.

POTENTIAL RISKS FROM ALGAE BLOOMS IN WATER SUPPLIES

Washington State Department of Health
Office of Drinking Water

Overview

- Review of Cyanobacteria History and Health Effects
- Regulatory Background
- Basic Treatment Information
- Potential Issues Under UCMR4 Monitoring
  - Basics
  - Communication
  - Sampling

Algal Toxins—The Big Picture

Cyanobacteria in the Headlines

- Before Toledo
  - "OR City Drinking Water Unsafe to Touch" (KTVZ – 9/2007)
  - "Algae Swamps Chief Water Supply" (Daily Telegraph – 8/2007)
  - "Blue-Algae Spawns More Drinking Water Bans" (CBC News – 10/2006)
  - "Toxic Algae Claims Another Family Pet" (TNT– 10/2004)

The Seattle Times
Winner of a 2010 Pulitzer Prize

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Toxic algae closes Chimicum lake to fishing

Washington state and Jefferson County authorities have closed Anderson Lake near Chimacum to fishing and boati
a bloom of toxic algae.

The Associated Press

CHIMACUM, Wash. —
Washington state and Jefferson County authorities have closed Anderson Lake near Chimacum
boating because of a bloom of toxic algae.

Water samples taken May 11 showed high levels of neurotoxin.

The Peninsula Daily News reports that a similar blue-green algae outbreak in 2006 is suspected
dogs.

Health Effects—Past Events

- 1931—Charleston, WV
  - Microcystis bloom sickens 5,000 to 8,000
- 1975—Sewickley, PA
  - Majority of customers sickened
- 1979—Queensland, Australia
  - More than 140 children hospitalized
- 1996—Caruaru, Brazil
  - At least 51 deaths at a dialysis clinic
- 2009—Oregon (Recreational)
  - 18 human cases; 10 animal cases

Wheeling, WV – 8/21/15

Credit: Wheeling-Ohio County Health Dept.

Algal toxins—Short-term Toxicity

Compound	LD50 (ug/kg)
Strychnine	2000
Microcystin LR	50
Cobra Venom	20
Anatoxin-a(s)	20
Saxitoxin	9

Regulatory Background (Pre-2015)

- Freshwater cyanobacteria can produce toxins that could cause adverse human health impacts.
- Guidance values for drinking water had been adopted by many countries and some states.

Ohio

- 1 µg/L MC-LR Tox EQ
- 20 µg/L Anatoxin-a
- 1 µg/L Cylindrospermopsin
- 0.2 µg/L Saxitoxin

Oregon

- 1 µg/L MC-LR Tox EQ
- 3 µg/L Anatoxin-a
- 1 µg/L Cylindrospermopsin
- 3 µg/L Saxitoxin

- Increased concern following "Do Not Drink" advisory in Toledo in August 2014

Regulatory Update

- EPA's drinking water Contaminant Candidate List (CCL).
  - CCL 1 and 2 (1998, 2005) include cyanobacteria (blue-green algae), other freshwater algae, and their toxins
  - CCL 3 (2009) includes three algal toxins (anatoxin-a, microcystin-LR, and cylindrospermopsin)
  - CCL4 (2016) includes four algal toxins (anatoxin-a, microcystins, cylindrospermopsin, and saxitoxin)
- EPA evaluated algal toxins for regulatory determination
  - RD1, RD 2 and RD 3 (2003, 2008, 2016) – No regulatory determination

Regulatory Update *(Continued)*

- UCMR4
  - Proposed - Dec. 2015
    - Included source water and finished water with a tiered sampling analysis approach.
  - Finalized – Dec. 2016
    - Only finished water sampling with tiered analysis.
- EPA published Health Advisory Levels (HALs) for algal toxins (June 2015) . . .

EPA Health Advisories (June 2015)

- EPA Health Advisory Levels (HALs) for algal toxins
  - Microcystins –
    - 0.3 ug/L for children less than 6 years old
    - 1.6 ug/L for general population
  - Cylindrospermopsin –
    - 0.7 ug/L for children less than 6 years old
    - 3.0 ug/L for general population

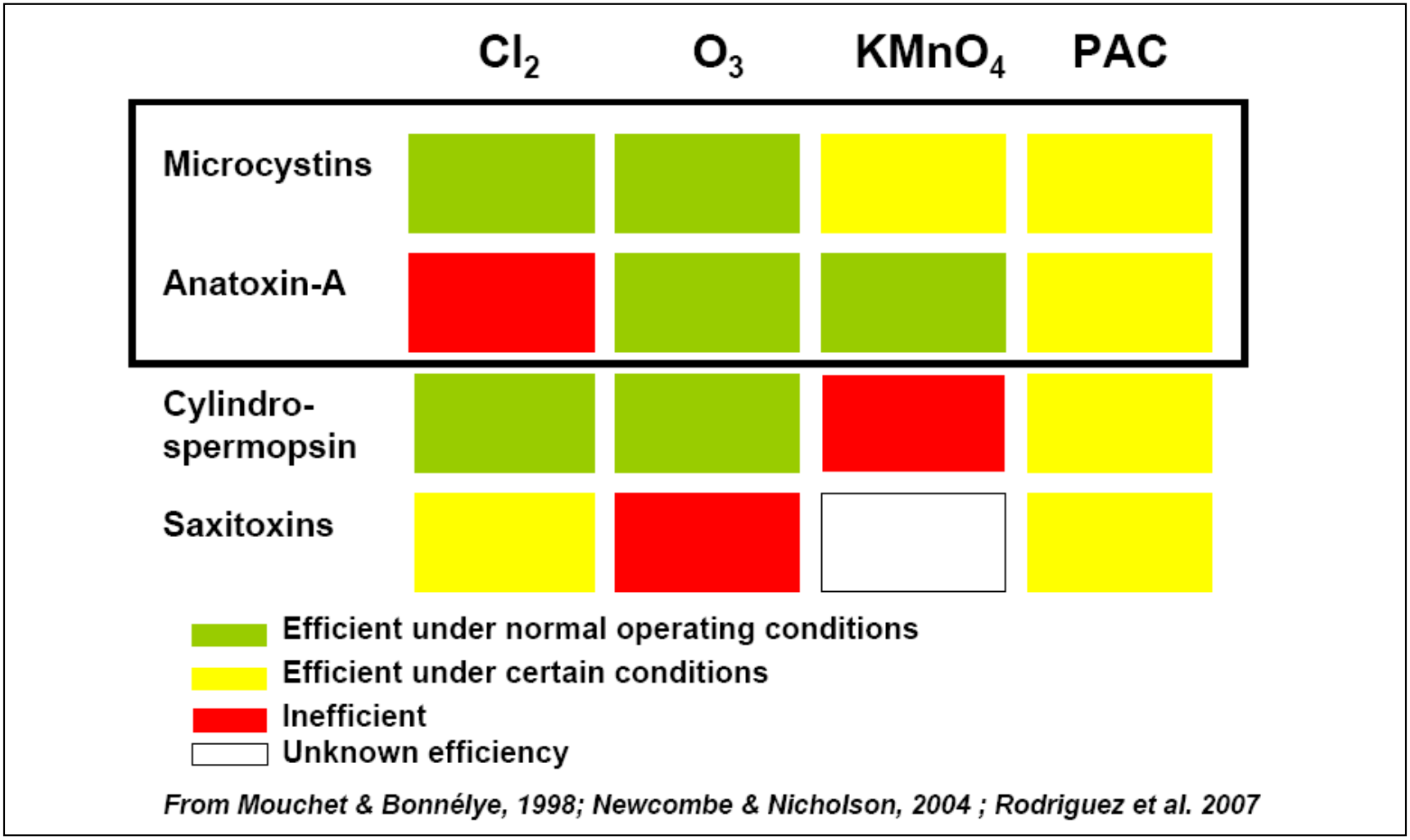
Step 5: Monitor for Toxins in Finished Water, Treatment Adjustments, and Public Communications

Low Level	Medium Level	High Level
Microcystins: ≤ 0.3 µg/L	Microcystins: > 0.3µg/L ≤ 1.6 µg/L	Microcystins: > 1.6 µg/L
		
Communication		
Continue communication with State primacy agency and local health officials on monitoring results.	Notify local public health agency, primacy agency and the public. Recommend use of alternative sources for children younger than school-age.	Notify local public health agency, primacy agency and the public. Recommend 'Do Not Drink/ Do Not Boil Water advisory for all consumers.
Treatment Actions		
Modify treatment as necessary to keep algal toxins below HA values.	Adjust existing treatment to reduce the concentration to below 0.3 µg/L (MC) as soon as possible. Modify or amend treatment as necessary.	Adjust existing treatment to reduce the concentration to below 0.3 µg/L (MC) as soon as possible. Modify or amend treatment as necessary.
Monitoring		
Continue sampling raw and finished water at least 2-3 times per week until levels are below quantification in at least 2-3 consecutive samples in raw water, then return to Step 3.	Continue sampling raw and finished water daily until finished water levels are below quantification in at least 2-3 consecutive samples.	Continue sampling raw and finished water at least daily until finished water levels are below quantification in at least 2-3 consecutive samples.

Water Treatment - Overview

- DO NOT ADD AN ALGICIDE IF A BLOOM IS PRESENT.
- Physical processes are very effective at removing algae cells, which contain most of the cyanotoxins (50-95%).
- Shorten filter runs.
- Don't recycle backwash water.
- Minimize preoxidation that can lyse cells.
- DOH and EPA Guidance
  - Harmful Algal Blooms: Water System Guidance (DOH 331-531)
  - Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems (EPA 9/2014)
  - Water Treatment Optimization for Cyanotoxins (EPA 10/2016)

Algal Toxins—Treatment



Chlorination Effectiveness

Chlorination (CT Required to reduce Microcystin-LR to 0.3 ug/L)				
pH	MCY-LR Concentration	CT(mg/L x min)		
		10ºC	15ºC	20ºC
6	50	71.2	61.5	53.5
7		83.1	73.0	64.7
8		189.3	174.4	162.2
9		680.7	615.0	557.4
6	10	48.8	42.2	36.6
7		56.9	50.1	44.3
8		129.8	119.7	111.2
9		466.6	421.7	382.0

Note: Anatoxin-a is not appreciably degraded by chlorine.

(Source EPA 2016).

However, An Ounce Of Prevention…

Risk	History of Cyanobacteria	Water Temp (°C)	Total P (ug/L)	Thermal Stratification
Very Low (Good)	No	<15	<10	No
Low	Yes	<15-20	<10	Infrequent
Moderate	Yes	20-25	10-25	Occasional
High	Yes	>25	25-100	Frequent & Persistent
Very High (Poor)	Yes	>25	>100	Frequent & Persistent/Strong

UCMR4 & Algal Toxins

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American Water Works Association

ALERT!

TO UTILITY MEMBERS

Utility Advisory

Who: AWWA utility members
What: Cyanotoxins management in UCMR4
When: Prepare now

Under the Fourth Unregulated Contaminant Monitoring Rule (UCMR4), surface water systems and consecutive systems receiving water from these systems are required to monitor for cyanotoxins. These systems should consider preparing for the complexities of assessing and responding to a cyanotoxins event now, prior to possible detections. As there are no federal MCLs for cyanotoxins in drinking water, UCMR4 does not require public notice if monitoring results are above the U.S. Environmental Protection Agency's non-regulatory health advisory concentrations.

Systems should have operational and communication plans in place for:

(1) How to monitor beyond the UCMR requirements in the case of detections,
(2) How to respond internally if elevated levels are observed, and

UCMR 4 Contaminants – Algal Toxins

Cyanotoxin— EPA Method 546 (Adda ELISA)
"total microcystins"

Cyanotoxins—EPA Method 544 (LC-MS/MS)	
microcystin-LA	microcystin-RR
microcystin-LF	microcystin-YR
microcystin-LR	nodularin
microcystin-LY	

Cyanotoxins—EPA Method 545 (LC/ESI-MS/MS)	
anatoxin-a	cylindrospermopsin

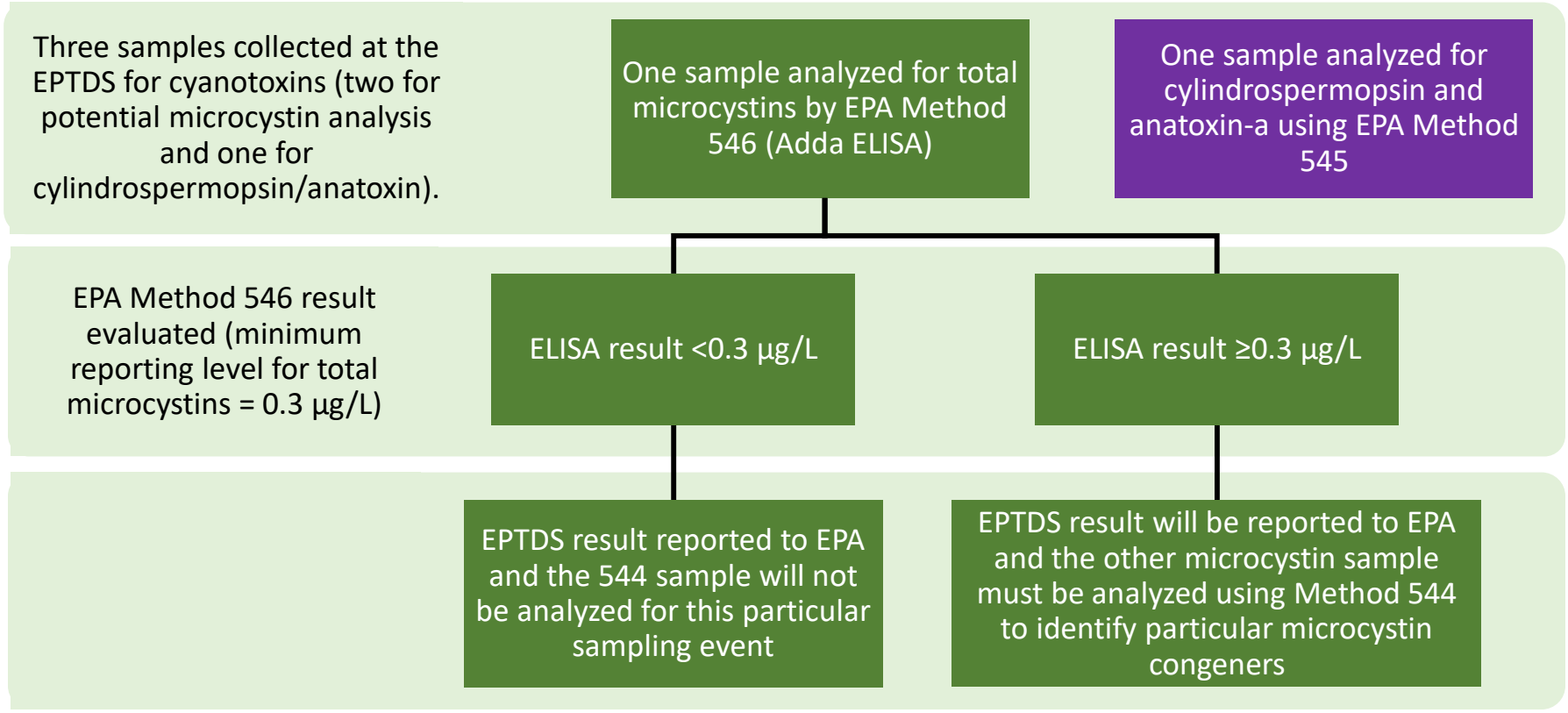
UCMR 4 Implementation Timeline

2017	2018	2019	2020	2021
Pre-monitoring Implementation • Lab Approval • PWS SDWARS registration/ notification/ inventory • EPA Outreach/trainings	**Assessment Monitoring List 1 Contaminants** **Implementation Activities** • Assist PWSs with compliance • Implement small system monitoring • Post data quarterly to NCOD **Reporting and analysis of data** • All large systems serving more than 10,000 people • 800 SW and GWUDI small systems serving 10,000 or fewer people for cyanotoxins			**Post-monitoring Phase** • Complete resampling • Conclude data reporting • Finalize NCOD • Continued enforcement

UCMR4 Algal Toxin Monitoring Basics

- Timing
  - Period March – November
  - Twice a month for four consecutive months (eight sample events)
    - Two samples for microcystins/event
      - EPA Method 546 (ELISA); EPA Method 544 (LC/MS/MS)
    - One sample for anatoxin-a and cylindrospermopsin/event
- Wholesale and consecutive systems on different schedules

Sampling Process – Algal Toxins



UCMR4 – Algal Toxin Data Elements

- "Yes/No/Do not know" info w/ each sample
- Data Element 27 – Bloom Occurrence
  - Q: Did you observe an algal bloom in your source waters near the intake?
- Data Element 28 – Algal Toxin Occurrence
  - Q: Were cyanotoxins ever detected in your source waters - based on sampling by you or another party?
- Data Element 29 – Treatment
  - Q: Did you notice any changes in your treatment system operation and/or treated water quality that may indicate a bloom in the source water?
- Data Element 30 – Source Water Quality Parameters
  - Q: Did you observe any notable changes in source water quality parameters (if measured)?

UCMR4 – Lessons to Date

- Large (supplying/wholesale) systems:
  - Heads up - Your consecutive systems are sampling March 2018 to November 2020.
    - EPA Method 546 (ELISA) – Minimum Reporting Limit (MRL) for microcystins is at a Health Advisory Level (HAL) (0.3 ug/L)
  - Suggest – Collect and hold a treated water sample for analysis when consecutive systems sampling.
  - Analyze confirmation sample(s) if needed.
- Small (independent and consecutive) systems:
  - Sampling requirements are complex.
  - Coordinate and communicate with wholesale suppliers (as applicable).

Summary

- You are not alone. Freshwater HABs are an issue throughout the world
- Protect your source (especially from P)
- Water treatment can be very effective in removing cyanobacteria and their toxins
- UCRM4 - Be prepared for sampling elements and “what if” results
- Collect a confirmation sample if needed

Questions?

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Health Effects—Chronic (Past Info)

- New South Wales, Australia (1980s)
  - Liver damage associated with microcystin in drinking water
- China Provinces (1990s)
  - Significant increase in liver cancer
- USEPA Draft RfD for Cyanotoxins (2006)
  - Anatoxin: $5x10^{-4}$ mg/kg-day (subchronic)
  - Microcystin: $3x10^{-6}$ mg/kg-day
  - Cylindrospermopsin: $3x10^{-5}$ mg/kg-day (subchronic)