Potential Actions Public Water Systems and States Can Take to Prepare for and Respond to Cyanotoxin Health Risks in Drinking Water

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May 11, 2015
Stakeholder Meeting

Presentation Overview

- Setting the Stage
- A preliminary approach to determine presence of cyanotoxins in drinking water
- Today's topics relate to preparation and response in the context of:
  - communication
  - monitoring
  - treatment

Setting the Stage

- Desired outcome:
  - Obtain public input on preliminary approach
  - Gather input on additional information the Agency can provide to States, utilities, and other affected entities
  - Develop insight on targeted actions EPA can take in the near-term to support States and utilities
- While we are not seeking consensus today, input provided will be instrumental in how EPA focuses its resources in near-term efforts to support States and utilities

Setting the Stage: Definitions (*For purpose of this presentation)*

- Source water – water from lakes, reservoirs, rivers, or streams that is used as a drinking water source
- Raw water – water that enters the drinking water intake, but has not yet received any treatment
- Finished water – "water that is introduced into the distribution system of a public water system and is intended for distribution and consumption without further treatment, except as treatment necessary to maintain water quality in the distribution system. . . ." (40 CFR 141.2)

Setting the Stage: EPA Health Advisory Recap

- Joint effort between Health Canada and EPA initiated in 2012
- Heath advisories are non-regulatory concentrations at which adverse health effects are not anticipated to occur over specific exposure durations: one-day, ten-day, and lifetime
- 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
- Please refer to this morning's presentation from Dr. Lesley D'Anglada for additional information

Setting the Stage: Microcystin Methods Overview

Summary Options	ELISA-Field (Tube/Strips)	ELISA-Lab	HPLC-UV (PDA)	HPLC-MS/MS
Specificity	Total Microcystins	Total Microcystins	Total Microcystins– limited specificity	6 Specific Microcystin congeners (EPA method 544)
Approx. Limit of Quantification (LOQ)	~0.5 – 1 ug/L	~ 0.3 µg/L	~ 0.3 µg/L	~ 0.02 µg/L
Time to result	10 – 60 minutes	4 hours or less	~ 1 day	~ 1 day
Estimated Cost per Analysis	$30-100	$50-150	$150-250	$200-350

Setting the Stage: Treatment Overview

- Conventional treatment is effective in removing cyanobacterial cells (containing intracellular cyanotoxins)
  - Greater than **90%** cell removal when using coagulation, sedimentation, and filtration
  - Greater than **80%** buoyant cell removal when using coagulation/flocculation and Dissolved Air Flotation (DAF)
  - Adjustment of current treatment may achieve higher levels of cell removal
  - Conventional treatment is not consistently effective for removal of dissolved (extracellular) cyanotoxins
  - Pre-oxidation can lyse the cells, releasing toxins and increasing the problem (by increasing dissolved cyanotoxins)

Setting the Stage: Treatment Overview

- Activated Carbon is effective in removing cyanotoxins
  - Powdered Activated Carbon (PAC) has greater than 80% removal efficacy for dissolved cyanotoxins
  - Ineffective for removal of cells containing intracellular toxins
  - Jar testing can be used to determine an effective PAC dose
- Ozone is effective in oxidizing dissolved cyanotoxins
  - Ozone documented to destroy greater than 95% of dissolved cyanotoxins
  - Given adequate dosing, ozone can achieve destruction of cells as well as the dissolved toxins released due to cell lysis caused by ozone
  - May increase the potential for the formation of bromate and other disinfection byproducts

Setting the Stage: Treatment Overview

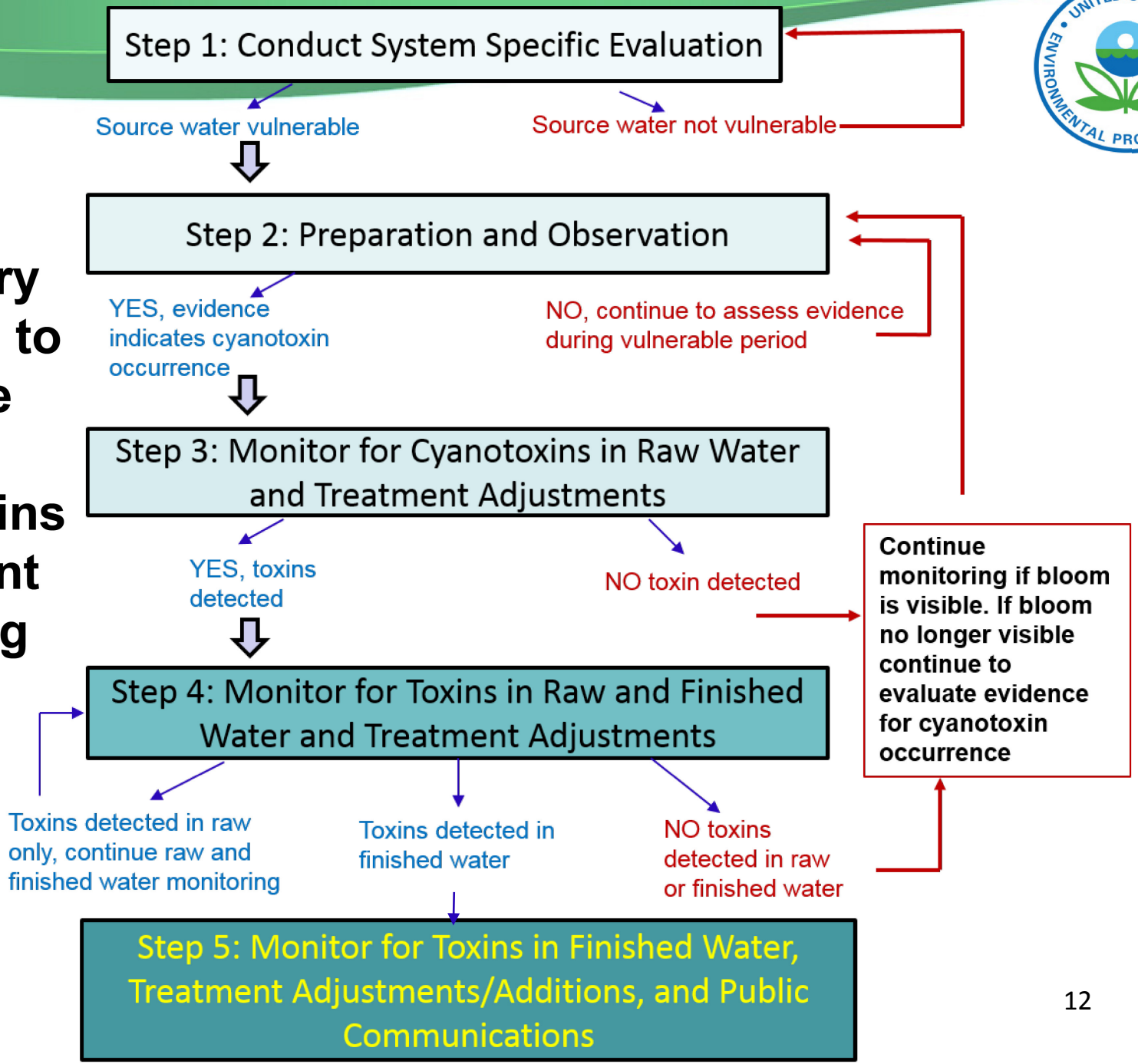
- Chlorine is effective in oxidizing dissolved microcystins and cylindrospermopsin
  - Greater than 85% cyanotoxin destruction has been found within 30 minutes to 22 hours (pH of 5-7.2). Effectiveness depends on pH and contact time. Pilot tests can determine cyanotoxin destruction in individual systems
  - Lysis of intact cells can result, which can release intracellular toxins if intact cells are not first removed
  - May increase the potential for the formation of disinfection byproducts
- Chloramines do not appear effective in oxidizing cyanotoxins
- Potassium permanganate appears effective in oxidizing dissolved microcystins
  - Greater than 90% microcystin destruction observed (dependent on water quality conditions). Ineffective on cylindrospermopsin
  - Not effective for destroying cyanobacterial cells or intracellular toxins

Clarifying questions?

A Preliminary Approach for Discussion

- Step-wise approach for systems to reduce risks from cyanotoxins in drinking water
- Includes a “traffic light” approach to guide communication and other actions in response to elevated concentrations of cyanotoxins in finished drinking water

Preliminary Approach to Determine Whether Cyanotoxins are Present in Drinking Water



Step 1: Conduct System Specific Evaluation

- Key objective: Determine if source water is vulnerable to harmful algal blooms
- Potential information to consider when conducting a system-specific evaluation:
  - Evaluation of source waters at or near the intake:
    - Review historical information (e.g., occurrence information on HABs such as previous blooms, cyanotoxin data, cell count data)
    - Source water characteristics (e.g., prone to stratification, information from systems on the same or hydrologically connected source, land use within watershed for indication of nutrient inputs)
    - Review available source water indicator data (pH, temperature, chlorophyll a, phosphorus, nitrogen levels)

Step 1: Conduct System Specific Evaluation

- Periodic reevaluation:
  - Periodically reassess source water vulnerability, if source waters are determined NOT to be vulnerable to cyanotoxins at the time of the site specific evaluation
  - Systems may consider reassessing frequently if changes within source water or treatment occur (e.g., new land uses, new treatment practices)
  - Other potential actions?

Discussion

- Key questions to consider:
  - What data are currently available for source waters? What other parameters may help indicate whether specific waters might have a cyanotoxin problem?
  - What data and tools are available today? What is in development?
  - How might I leverage resources?
  - How might I approach seeking partners?

Step 2: Preparation and Observation

Preparation

- Potential actions to consider if a system is determined to be vulnerable in Step 1:
  - Determine when (e.g., which seasons) systems are most vulnerable to HABs
  - System Evaluation
    - Assess status of treatment plant operations and maintenance (O&M) pre-harmful algal bloom season
      - If source water is vulnerable and existing treatment is not sufficient to remove cyanotoxins from peak blooms, evaluate whether supplemental treatment (e.g., coagulant) might be needed during bloom season, or
      - If source water is vulnerable and existing treatment is frequently challenged by cyanotoxins, consider whether long-term treatment enhancements are needed

Step 2: Preparation and Observation

Preparation (Cont'd)

- Monitoring
  - Prepare for possible future cyanotoxin monitoring by ordering necessary lab materials for screening tests or setting up contracts with outside labs
- Communication
  - Develop a strategy to educate public on potential health risks if source waters are determined to be vulnerable to cyanotoxins (e.g., establish partnerships with primacy agencies, local health department/medical community)

Step 2: Preparation and Observation

Observation

- Key observation objective: Identify potential cyanotoxin occurrence in source and raw water
- 3 Key Potential Observations:
  1. Visual: Visually confirm the presence of a bloom at intake structure or confirm public reports of blooms near raw water intake
  2. System effects: Track changes in treatment plant operations, water quality parameters, etc.
  3. Indicators: Monitor indicator occurrence in source water and raw water at intake

Step 2: Visible Observation of Blooms

- Potential actions to consider when assessing/collecting information on visible blooms (note, not all blooms are visible):
  - Location: Identify locations to monitor for presence of blooms and implications for the PWS (e.g., a bloom near a raw water intake vs. a bloom 50 meters away from an intake)
    - Consider how to determine whether a bloom is occurring (e.g., what factors indicate the presence of a bloom, what measurements, if any, should be taken, what training may be necessary, etc.)
  - Evaluate whether the public can assist with collecting information on blooms

Step 2: Observation of System Operation

- Potential actions to consider when assessing/collecting information on changes in system operations:
  - Examine raw water quality parameters (e.g., pH changes, turbidity)
  - Evaluate potential treatment changes (e.g., shortened filter run times, increased chlorine demand, etc.)
  - Investigate consumer complaints (e.g., taste and odor concerns)
  - Communicate with nearby/upstream systems (e.g., blooms in source water or cyanotoxin occurrence in their raw water)

Step 2: Observation of HAB Indicators

- Important information to collect on indicators of system vulnerability to HABs
  - Examine available data to determine if there has been an increase in nutrient concentrations (nitrogen or phosphorus) in source water
  - Examine other source water indicator data (pH, temperature, cyanobacterial cells, chlorophyll a levels, phycocyanin, phosphorus, nitrogen)
  - Participate/organize watershed monitoring programs collecting source water indicator data
  - Seek out secondary data on bloom occurrence in source water (e.g., satellite remote sensing, local or regional program surface water monitoring data) and information on intake characteristics

Discussion

- Key questions to discuss today:
  - What are the capabilities of existing treatment?
  - When and how to evaluate whether a system's current treatment is sufficient to remove cyanotoxin concentrations from source waters?
  - What source water approaches are part of the treatment toolbox?
  - What resources are available?

Step 3: Monitor for Cyanotoxins in Raw Water and Treatment Adjustments

- Key objective: Determine if cyanotoxins have reached or are likely to reach the raw water
- EPA recommends two methods for raw water microcystin monitoring:
  - Field Enzyme Linked Immunosorbent Assay (ELISA) tests (e.g., tube/test strips field kits) or
  - Laboratory ELISA tests
  - Consider test detection limits, time to complete tests, and budget when selecting method to use for raw water

Step 3: Monitor for Cyanotoxins in Raw Water and Treatment Adjustments

Recommended Microcystin Monitoring Methods

Sample Type	ELISA-Field	ELISA-Lab	HPLC-UV (PDA)	HPLC-MS/MS
Raw	X	X		
Raw and Finished		X		
Finished		X	X	X

Step 3: Monitor for Cyanotoxins in Raw Water and Treatment Adjustments

- Potential actions to consider when monitoring for cyanotoxins in raw water:
  - If no cyanotoxins detected in raw water, but visible blooms exist near intake, EPA recommends monitoring raw water at least 2-3 times per week until bloom dissipates or until indicators of bloom no longer occur
  - Adjust treatment plant O&M (as identified in Step 2)
- Other potential actions?

Discussion

- Key questions to consider:
  - How should raw water be monitored and with what frequency?
  - What methods are available? What do the analyses cost and is there sufficient laboratory capacity?
  - What operational adjustments to treatment can be made to reduce cyanotoxin risks?

Step 4: Monitor for Toxins in Raw and Finished Water and Treatment Adjustments

- Key objectives:
  - Determine the effectiveness of cyanotoxin removal via drinking water treatment operations, and
  - Adjust treatment to reduce risks from cyanotoxins in drinking water
- Potential actions to consider when monitoring for cyanotoxins in raw water and finished water:
  - Determine methods to use for raw water vs. finished monitoring
    - EPA recommends Laboratory ELISA tests for initial finished water sampling
  - Recommend analysis of paired raw and finished water samples
    - Preserve samples appropriately to account for lag time in the treatment process

Step 4: Monitor for Toxins in Raw and Finished Water and Treatment Adjustments

- Potential actions to consider when monitoring for cyanotoxins in raw water and finished water:
  - If cyanotoxins are not found in raw or finished water, continue observations as described in Step 2, monitor raw water as indicated
  - If cyanotoxins are found in raw water but not found in finished water, continue monitoring raw and finished water
  - If cyanotoxins are found in both raw and finished water, move to Step 5 to continue monitoring finished water, starting with a second finished water sample
  - Adjust treatment plant O&M
  - Additional treatment if necessary
- Other potential actions?

Discussion

- Key questions to discuss today:
  - How should raw and finished water be monitored and with what frequency?
  - What should be done if finished water concentrations exceed a Health Advisory value for a single sample?
  - What changes or additional treatment processes can help to reduce cyanotoxin risks?

Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments, and Public Communication

- Key objectives:
  - Reduce risks from cyanotoxins in drinking water
  - Inform the public of the need to take actions to reduce their risks
  - Continue monitoring for cyanotoxins in finished water after initial detection in Step 4

Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments, and Public Communication

- Potential actions to consider when communicating with the public:
  - Determine how the facility will respond to short-term, low-level exceedances versus short-term, high-level exceedances
  - Determine how the facility will respond to medium to longer term exceedances of any health advisory value
  - Notify consumers, medical community, government agencies, if health advisory levels are exceeded
    - How many samples above the HA levels would be needed before notification occurs?

Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments, and Public Communication

- Potential actions to consider when monitoring finished water:
  - Recommend monitoring for microcystins in finished water with laboratory ELISA (for most users)
  - HPLC-UV (PDA) can also be utilized and HPLC-MS/MS may be used if specific microcystin congener analysis is needed
  - Methods are currently undergoing evaluation for analysis of cylindrospermopsin
    - EPA recommends facilities consider monitoring finished water for cylindrospermopsin using LC-MS/MS methods if they detect microcystin in their finished water

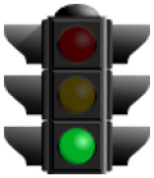
Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments, and Public Communication

- Potential actions to consider when monitoring finished water:
  - Recommend monitoring frequency based on concentrations of cyanotoxins detected
    - At least 2-3 times per week if cyanotoxins below HA concentrations in finished water (but detected in raw water)
    - At least daily sampling if cyanotoxins are measured above HA concentrations in finished water
      - Finished water samples using ELISA test kits can be used to monitor effectiveness of treatment modifications
  - Continue monitoring until samples are below child health level in at least 2 consecutive samples

Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments, and Public Communication

- Potential communication actions to consider:
  - Notify consumers, medical community, government agencies, if Health Advisory levels are exceeded
    - EPA recommends two or more consecutive samples above the HA levels should be taken before notification occurs
  - If exceedance of the microcystin HA value of 0.3 µg/L for children younger than school age is confirmed, recommend use of alternative sources of drinking water for these young children
  - If the microcystin HA value of 1.6 µg/L for all others is exceeded, recommend Do Not Drink/Do Not Boil Water advisory for all consumers

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.

Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments, and Public Communication

- Potential actions to consider when adjusting treatment:
  - Ensure treatment system is properly adjusted for removal of cyanobacteria and algal toxins
  - Add additional emergency treatment as necessary (e.g., addition of PAC)
  - Notify consumers, medical community, government agencies, if health advisory levels are exceeded
    - EPA recommends two or more consecutive samples above the HA levels should be taken before notification occurs
    - How many samples below HA levels would be needed to end action notices (two or more)?

Step 5: Monitor for Cyanotoxins in Finished Water, Treatment Adjustments, and Public Communication

- Potential long-term actions to consider:
  - Make necessary adjustments to existing treatment strategies
  - Implement long-term treatment strategies (e.g., source water protection, granular activated carbon (GAC), supplemental treatment processes) if the PWS is continually challenged by cyanotoxins
  - Other potential actions?

Discussion

- Key questions to consider:
  - How should finished water be monitored and with what frequency?
  - What should be done if finished water concentrations are confirmed to exceed a Health Advisory value?
  - How to most effectively communicate with the public about a 10-day Health Advisory with different levels for young children and other age groups?
  - How to most effectively communicate about a detection above the Health Advisory concentrations for young children, but not above the concentration for everyone else?
  - Who should be contacted and when?
  - What risk communication approaches are likely to be most effective?
  - How can cyanotoxin challenges be mitigated for the long-term?
  - How should preventive solutions (e.g., source water nutrient management) be incorporated as part of the long-term strategy?