Microbial & Disinfection Byproduct Rules: EPA's Journey to Strengthen Regulations

Process, Dreams & Potential Futures

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American Water Works Association
Pacific Northwest Section

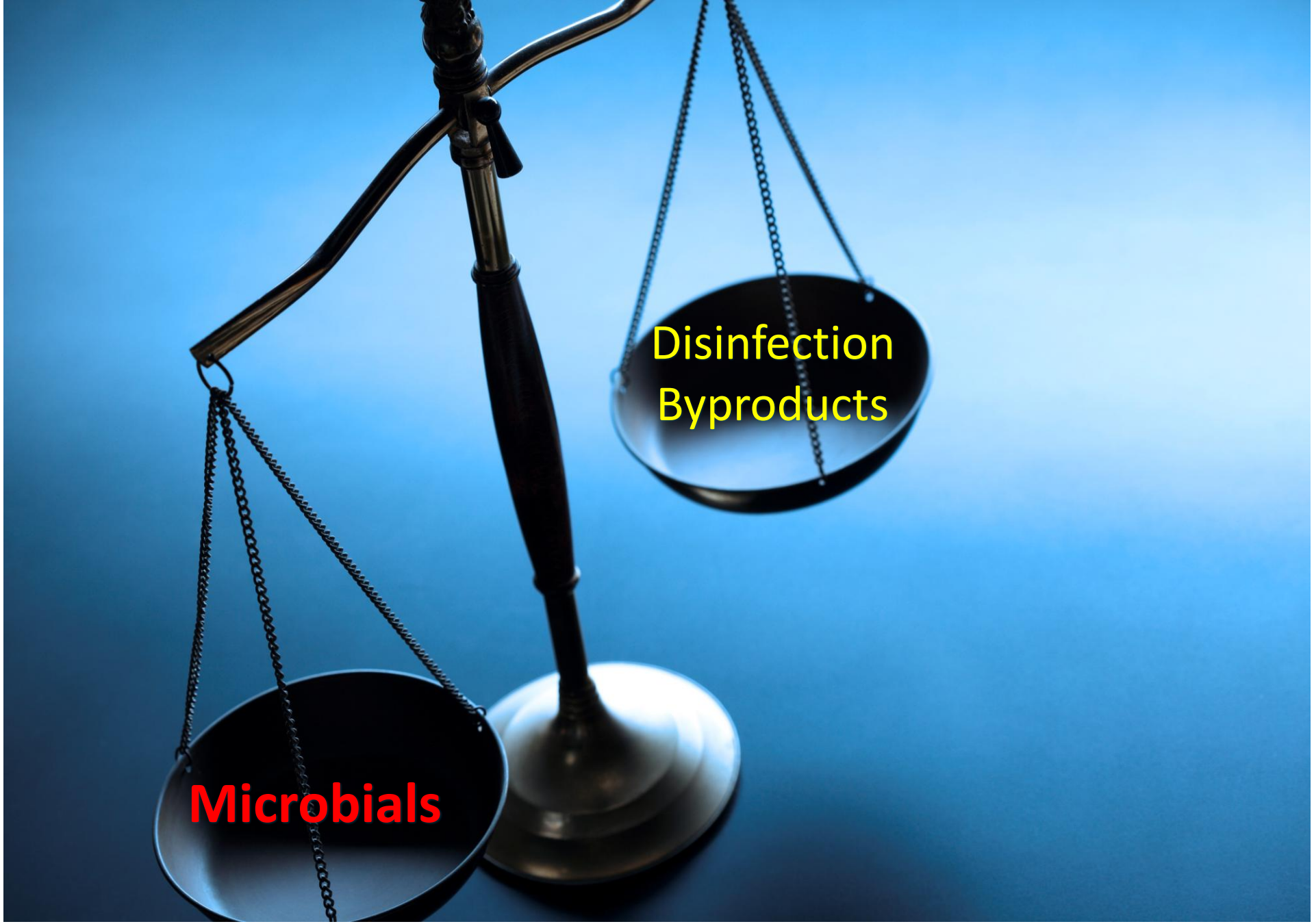
PNWS Annual Conference
May 7-9, 2025, Boise, ID

confluence
ENGINEERING GROUP LLC

Washington State Department of
HEALTH

Prelude

- Risk-Risk Tradeoff
- Acute vs Chronic vs. latent
- 51 Years of TTHM Regulation



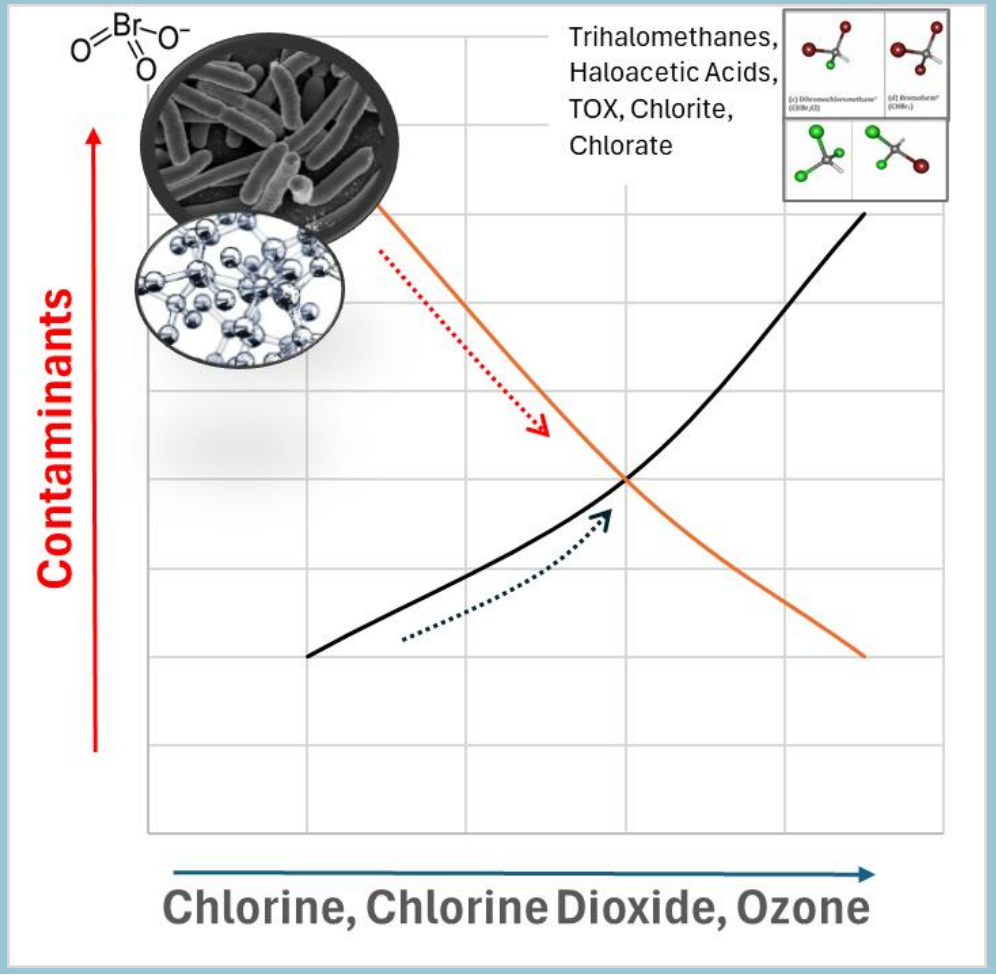
Chlorine disinfection byproducts drinking water and bacteria risk balance -- https://deepai.org/

Presentation Objectives

Microbial and Disinfection Byproduct (MDBP) Rules Revisions – Provide backstory context

Discuss EPA Response: NDWAC & Federalism Consultations. Glimpse into the Crystal Ball

Best Practices (that will also help meet possible Regulations)



Adapted from T. W. Ng, et al. (2015) Formation of Disinfection By-Products from Bacterial Disinfection in *Recent Advances in Disinfection By-Products (pp.235-250)*

Simultaneous Compliance

1 Regulatory Backstory

EPA: The Six Year Review

"The Administrator (of EPA) shall, not less often than every 6 years, review and revise, as appropriate, each national primary drinking water regulation promulgated under this title. Any revision of a national primary drinking water regulation shall be promulgated in accordance with this section, except that each revision shall maintain, or provide for greater, protection of the health of persons."

Section 1412(b)(9)
1996 SDWA Amendments

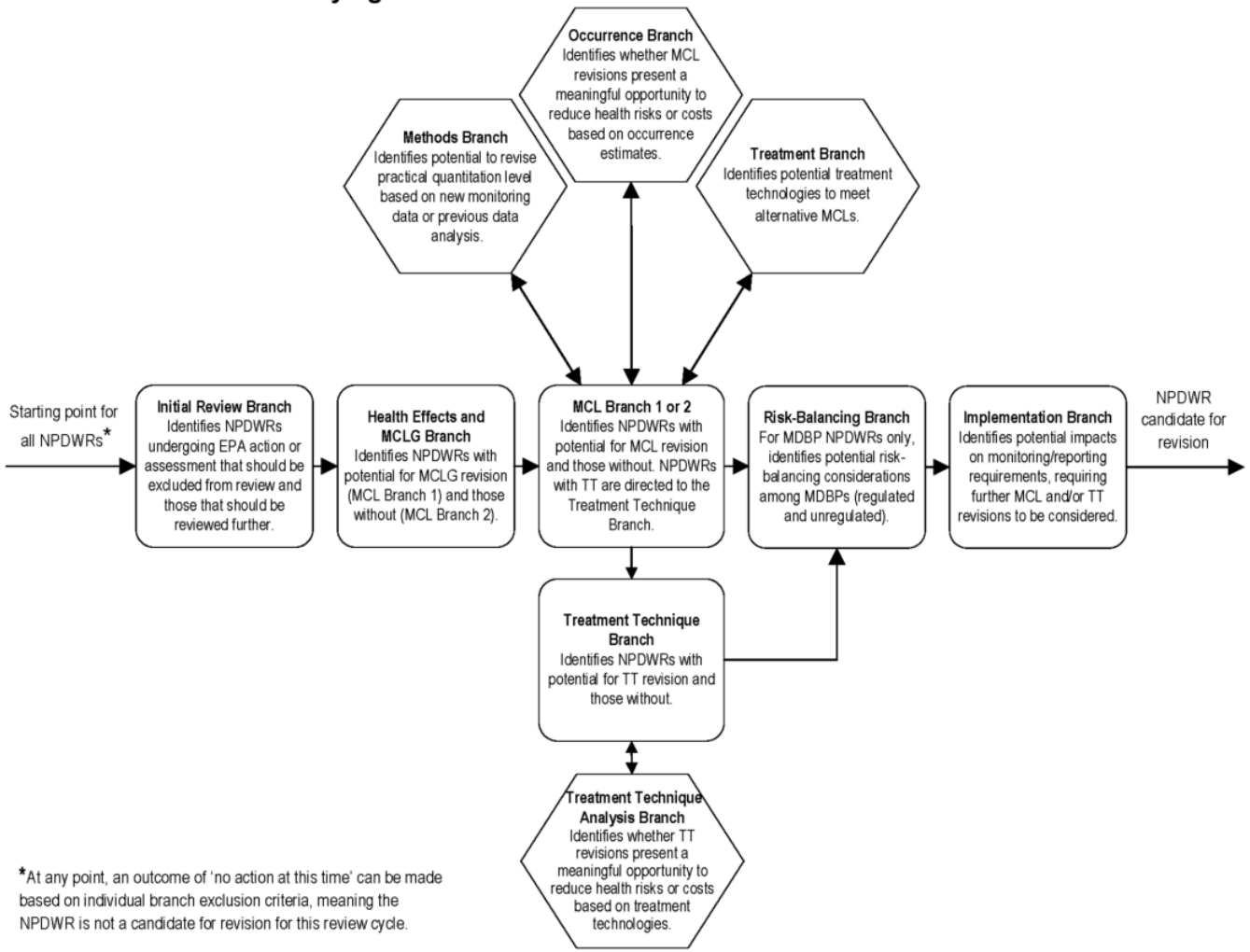
EPA: The Six Year Review

"Every 6 years, EPA shall review (revise as needed) primary drinking water regulations to maintain or improve public health protection."

Section 1412(b)(9)
1996 SDWA Amendments
Condensed

Six Year Review Process

Exhibit 2.1 Process for Identifying NPDWRs that are Candidates for Revision



Is there compelling data that a contaminant is more present, or dangerous than we thought, or are there changes in monitoring or treatment that warrant a new look?

- Improve health protection?
- Same protection – save money?

https://www.epa.gov/system/files/documents/2024-04/syr4_protocol-document_508.pdf

Summary of Six-Year Review (SYR) Results

SYR 1 (July 2003)*:

Summary of Review Outcomes		Regulated Contaminants	
Candidate for Revision	Based on review of "other regulatory provisions" (1 NPDWR)	Total Coliform Rule (TCR)	
1. As of December 31, 2002, EPA was conducting or had scheduled a detailed review of health effects information.			

https://www.epa.gov/dwsixyearreview/six-year-review-1-drinking-water-standards

SYR 2 (March 2010)*:

Summary of Review Outcomes		Regulated Contaminants	
Candidate for Revision	Based on new information (4 NPDWRs)	Acrylamide[2] Epichlorohydrin	Tetrachloroethylene (PCE)[2] Trichloroethylene (TCE)[2]
2. Note that a health assessment is in process but new analytical feasibility and treatment technology information may justify a revision.			

https://www.epa.gov/dwsixyearreview/six-year-review-2-drinking-water-standards

* Omitting all items deemed “Not Appropriate for Revision at this Time”

Summary of Six-Year Review 3 Results – The MDBP Focus

Summary of Review Outcomes		Regulated Contaminants	
Candidate for Revision	New Information	Chlorite *Cryptosporidium* (under SWTR, IESWTR, LT1) *Giardia lamblia* Haloacetic Acids (HAA5)	Heterotrophic Bacteria *Legionella* TTHM Viruses (under SWTR)

- Published January 11, 2017 – Request for Comments

- Relevant Rules considered for revision:
  - Surface Water Treatment Rule (Interim Enhanced SWTR, Long Term 1 SWTR)
  - Stage 1 & Stage 2 Disinfection Byproducts Rule

Summary of Six-Year Review 3 Results – The "M" Part

Microbials (M)	Published Concern
Cryptosporidium	*Process for identifying groundwater under the direct influence of surface water (GWUDI) may be inadequate, resulting in inadequate protection against protozoan risk.*
Giardia lamblia	
Legionella	*SWTR requirements to maintain a "detectable" disinfectant residual may not be adequately protective of public health*
Viruses	*CT requirements for virus disinfection may not be stringent enough (for some viruses)*
Heterotrophic Bacteria	*Allowing <500 /mL HPC to count as a "detectable" disinfectant residual may be inappropriate.*

Federal Register/Vol. 82, No. 7/Wednesday, January 11, 2017

Summary of Six-Year Review 3 Results – The "DBP" Part

Disinfection Byproducts (DBP)	Published Concern
Chlorite	*Exposure via non-water routes may be higher than originally thought, potentially resulting in a lower calculated MCLG. Also concern with co-occurrence (and interrelationship) with chlorate*
Haloacetic Acids	*There may be opportunity to further reduce risk from exposure to both regulated and unregulated DBPs (new health risk information available, data indicating better precursor removal is possible)*
TTHM	
Nitrosamines*	*EPA stated that because chlorate and nitrosamines are DBPs that can be introduced or formed through disinfection practices, it is important to evaluate these unregulated DBPs in the context of the review of the existing DBP regulations.*
Chlorate*	*UCMR3 data showed that chlorate levels above the health reference level of 210 µg/L occurred frequently in systems that use hypochlorite, chlorine dioxide or chloramines.*

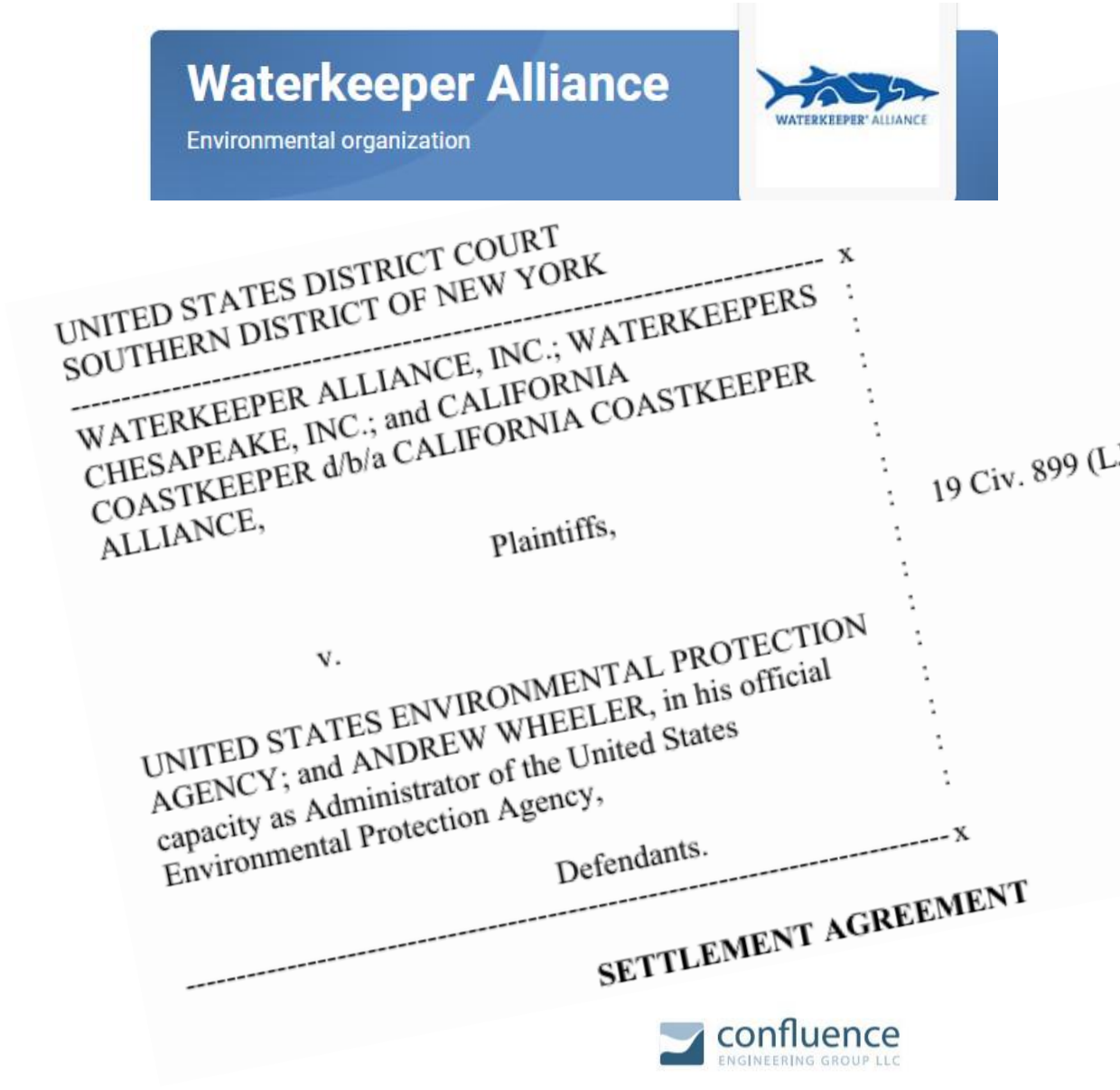
**Not currently regulated, but identified as of potential concern*

Federal Register/Vol. 82, No. 7/Wednesday, January 11, 2017

Six-Year Review 3 - Request for Comment (January 11, 2017)

- EPA remained listening for a while – still is.
- Waterkeeper's Alliance got tired of waiting – Filed Complaint on 1/30/19

  6/2020 Settlement Agreement–EPA Agreed:
  - 7/31/24: Proposal to Revise MDBP Contaminants identified in Six-Year Review
  - 9/30/27: Final Rule
- Agreement allows 1-year extension if EPA uses a consultation process (**and they did!**)
  - Proposed Rule due 7/30/25
  - Final Rule 10/3/28



2 EPA Response: NDWAC & Federalism Consultations

EPA Initiates Consultation (Nov 12, 2021)

National Drinking Water Advisory Council (NDWAC) MDBP Working Group

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 141

[FRL–5232–01–OW]

The National Drinking Water Advisory Council Microbial and Disinfection Byproducts Rule Revisions Working Group: Request for Nominations

AGENCY: Environmental Protection Agency (EPA).

ACTION: Request for nominations.

The NDWAC will provide advice, information, and recommendations on matters related to activities, functions, policies, and regulations of EPA under the Safe Drinking Water Act.

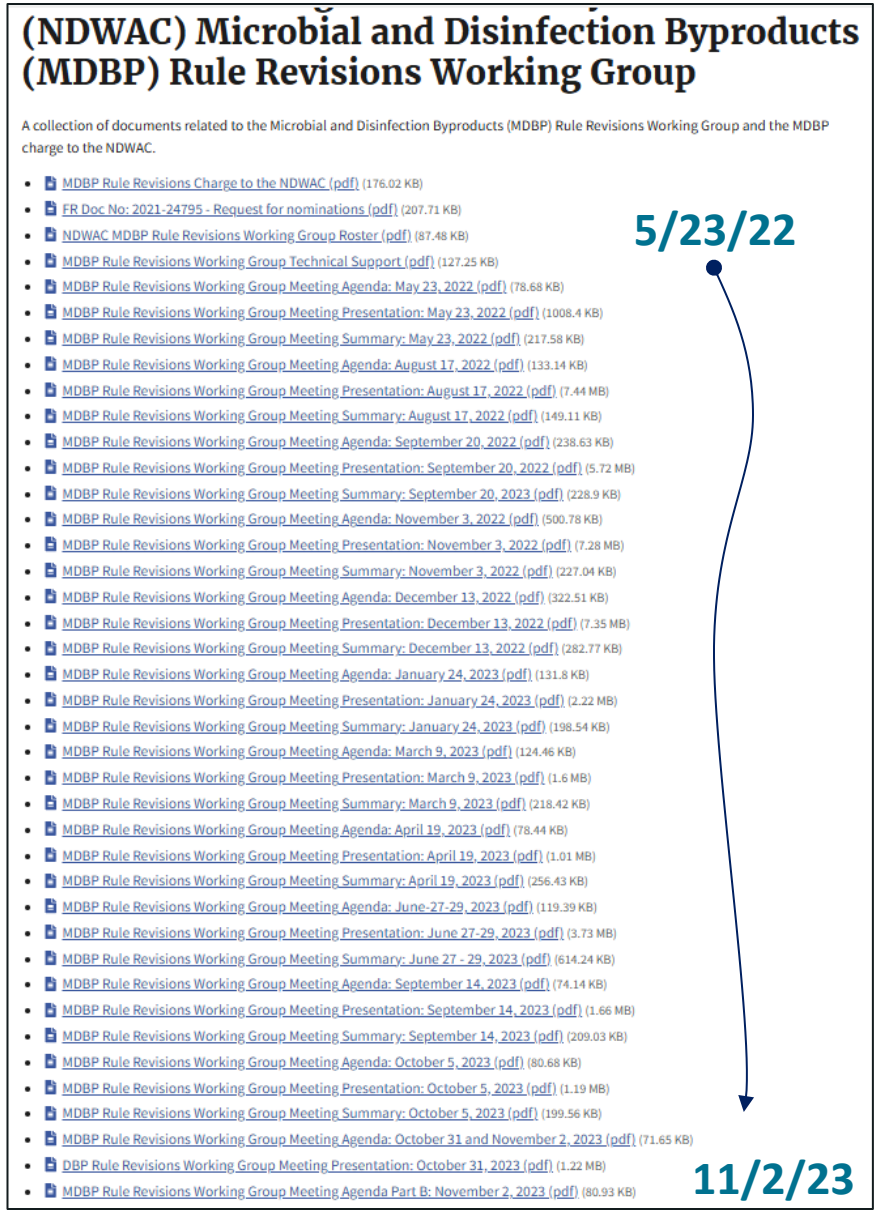
MISSION STATEMENT – EPA's Charge to the NDWAC

"EPA is seeking consensus recommendations from the NDWAC that will be used to inform the development of potential MDBP rule revisions."

- **Balance microbial control with disinfection byproduct formation**
- **Address concerns with**:
  - Opportunistic pathogens (e.g. *Legionella*)
  - Disinfection byproducts (e.g. unregulated haloacetic acids)
  - Emerging contaminants

While you are figuring that out – make sure to consider:

- Disinfectant residuals and opportunistic pathogens
- Regulated and unregulated DBPs
- Finished water storage facilities
- Distribution system water quality management
- Source water approach, including DBP precursor removal
- Mischaracterized ground water under the direct influence of surface water (GWUDI) sources
- Sanitary Surveys
- Water Safety Plans
- Consecutive and small systems



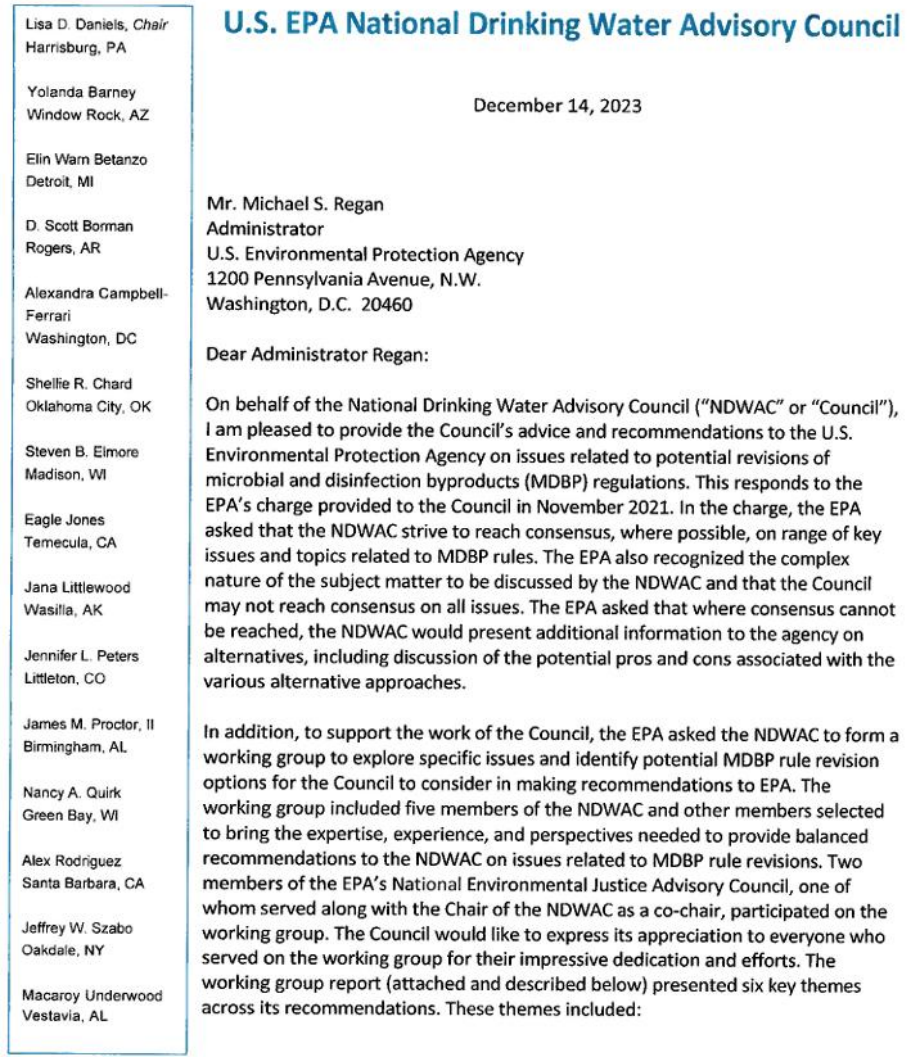
(NDWAC) Microbial and Disinfection Byproducts (MDBP) Rule Revisions Working Group

A collection of documents related to the Microbial and Disinfection Byproducts (MDBP) Rule Revisions Working Group and the MDBP charge to the NDWAC.

- MDBP Rule Revisions Charge to the NDWAC (pdf) (176.02 KB)
- FR Doc No: 2021-24795 - Request for nominations (pdf) (207.71 KB)
- NDWAC MDBP Rule Revisions Working Group Roster (pdf) (87.48 KB)
- MDBP Rule Revisions Working Group Technical Support (pdf) (127.25 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: May 23, 2022 (pdf) (78.68 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: May 23, 2022 (pdf) (1008.4 KB)
- MDBP Rule Revisions Working Group Meeting Summary: May 23, 2022 (pdf) (217.58 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: August 17, 2022 (pdf) (133.14 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: August 17, 2022 (pdf) (7.44 MB)
- MDBP Rule Revisions Working Group Meeting Summary: August 17, 2022 (pdf) (149.11 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: September 20, 2022 (pdf) (238.63 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: September 20, 2022 (pdf) (5.72 MB)
- MDBP Rule Revisions Working Group Meeting Summary: September 20, 2023 (pdf) (228.9 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: November 3, 2022 (pdf) (500.78 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: November 3, 2022 (pdf) (7.28 MB)
- MDBP Rule Revisions Working Group Meeting Summary: November 3, 2022 (pdf) (227.04 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: December 13, 2022 (pdf) (322.51 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: December 13, 2022 (pdf) (7.35 MB)
- MDBP Rule Revisions Working Group Meeting Summary: December 13, 2022 (pdf) (282.77 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: January 24, 2023 (pdf) (131.8 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: January 24, 2023 (pdf) (2.22 MB)
- MDBP Rule Revisions Working Group Meeting Summary: January 24, 2023 (pdf) (198.54 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: March 9, 2023 (pdf) (124.46 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: March 9, 2023 (pdf) (1.6 MB)
- MDBP Rule Revisions Working Group Meeting Summary: March 9, 2023 (pdf) (218.42 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: April 19, 2023 (pdf) (78.44 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: April 19, 2023 (pdf) (1.01 MB)
- MDBP Rule Revisions Working Group Meeting Summary: April 19, 2023 (pdf) (256.43 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: June-27-29, 2023 (pdf) (119.39 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: June 27-29, 2023 (pdf) (3.73 MB)
- MDBP Rule Revisions Working Group Meeting Summary: June 27 - 29, 2023 (pdf) (614.24 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: September 14, 2023 (pdf) (74.14 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: September 14, 2023 (pdf) (1.66 MB)
- MDBP Rule Revisions Working Group Meeting Summary: September 14, 2023 (pdf) (209.03 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: October 5, 2023 (pdf) (80.68 KB)
- MDBP Rule Revisions Working Group Meeting Presentation: October 5, 2023 (pdf) (1.19 MB)
- MDBP Rule Revisions Working Group Meeting Summary: October 5, 2023 (pdf) (199.56 KB)
- MDBP Rule Revisions Working Group Meeting Agenda: October 31 and November 2, 2023 (pdf) (71.65 KB)
- DBP Rule Revisions Working Group Meeting Presentation: October 31, 2023 (pdf) (1.22 MB)
- MDBP Rule Revisions Working Group Meeting Agenda Part B: November 2, 2023 (pdf) (80.93 KB)

NDWAC Working Group Process & Recommendations

- Working Group drew from industry, regulatory agencies, utilities, environmental groups, social justice interests, drinking water support consultants and trade organizations.
- Work Completed in long, largely virtual workshops (COVID shadow) the Group's recommendations can be found at:
  - https://www.epa.gov/system/files/documents/2023-12/report-of-the-mdbp-rule-revisions-working-group-to-the-ndwac-november-2023-1.pdf
- Individual member comments at end are interesting.



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U.S. EPA National Drinking Water Advisory Council

December 14, 2023

Mr. Michael S. Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Dear Administrator Regan:

On behalf of the National Drinking Water Advisory Council ("NDWAC" or "Council"), I am pleased to provide the Council's advice and recommendations to the U.S. Environmental Protection Agency on issues related to potential revisions of microbial and disinfection byproducts (MDBP) regulations. This responds to the EPA's charge provided to the Council in November 2021. In the charge, the EPA asked that the NDWAC strive to reach consensus, where possible, on range of key issues and topics related to MDBP rules. The EPA also recognized the complex nature of the subject matter to be discussed by the NDWAC and that the Council may not reach consensus on all issues. The EPA asked that where consensus cannot be reached, the NDWAC would present additional information to the agency on alternatives, including discussion of the potential pros and cons associated with the various alternative approaches.

In addition, to support the work of the Council, the EPA asked the NDWAC to form a working group to explore specific issues and identify potential MDBP rule revision options for the Council to consider in making recommendations to EPA. The working group included five members of the NDWAC and other members selected to bring the expertise, experience, and perspectives needed to provide balanced recommendations to the NDWAC on issues related to MDBP rule revisions. Two members of the EPA's National Environmental Justice Advisory Council, one of whom served along with the Chair of the NDWAC as a co-chair, participated on the working group. The Council would like to express its appreciation to everyone who served on the working group for their impressive dedication and efforts. The working group report (attached and described below) presented six key themes across its recommendations. These themes included:

NDWAC Working Group Recommendations

1. **Disinfectant Residual**: NDWAC's recommendations: a minimum of 0.5 mg/L for free chlorine and 0.7 mg/L for total chlorine in chloramine systems. Recommendation includes options to select lower values while increasing monitoring so that systems have improved disinfectant residual levels that do not significantly increase DBP formation. *****

2. **Premise Plumbing**: EPA initiatives to enhance partnerships with federal and state SDWA primacy agencies to improve premise plumbing safety (minimize pathogens), establish framework to identify high-risk buildings, foster building water management programs, and develop/implement *Legionella* public awareness for smaller-scale (e.g. single family residences) building owners.

3. **DBP Data Analysis**: Address data and analysis gaps associated with emerging DBPs.

4. **DBP and Disinfectant Demand Precursor Control**: Implement a source water evaluation screening requirement and possibly increase mandatory treatment requirements to further reduce DBP formation and disinfectant demand.*****

5. **Finished Water Storage Tanks**: Establish inspection and cleaning requirements for storage tanks that fill state-level regulatory gaps, update Operations and Maintenance guidance to control water age and mixing inadequacies, and support new inspection and cleaning requirements.

6. **Chloramine Practices**: Improve chloramine practices to promote microbial control, DBP formation control, and overall water quality consistency. This would include a requirement that utilities using chloramines follow an approved nitrification control plan (NCP)

****NDWAC did not have consensus for these recommendations in the transmittal letter to EPA.***

NDWAC Working Group Recommendations, *continued*

7. **Consecutive Systems**: Improve water quality and regulatory partnerships, actions, and compliance rates for consecutive systems. Develop a required, consultative process between wholesaler and consecutive systems, and provide guidance related to water service contracts.

8. **Source Control**: Improve prevention of contaminants into the water cycle and restrict discharges into all source waters that contribute to DBPs, growth of opportunistic pathogens (those that cause infection in a host with a weakened immune system), and introduction of frank pathogens (those that always have high probability of causing disease in anyone).

9. **Environmental Justice**: Characterize gaps in M/DBP rule implementation in systems serving communities with environmental justice concerns.

10. **Provide Technical, Management, and Financial (TMF) Support:** Increase TMF support to small, rural, and underserved communities with regard to new Public Water System (PWS) and MDBP Rule demands.

11. **Primacy Agencies:** Address SDWA Primacy Agency needs associated with new PWS and MDBP Rule demands.

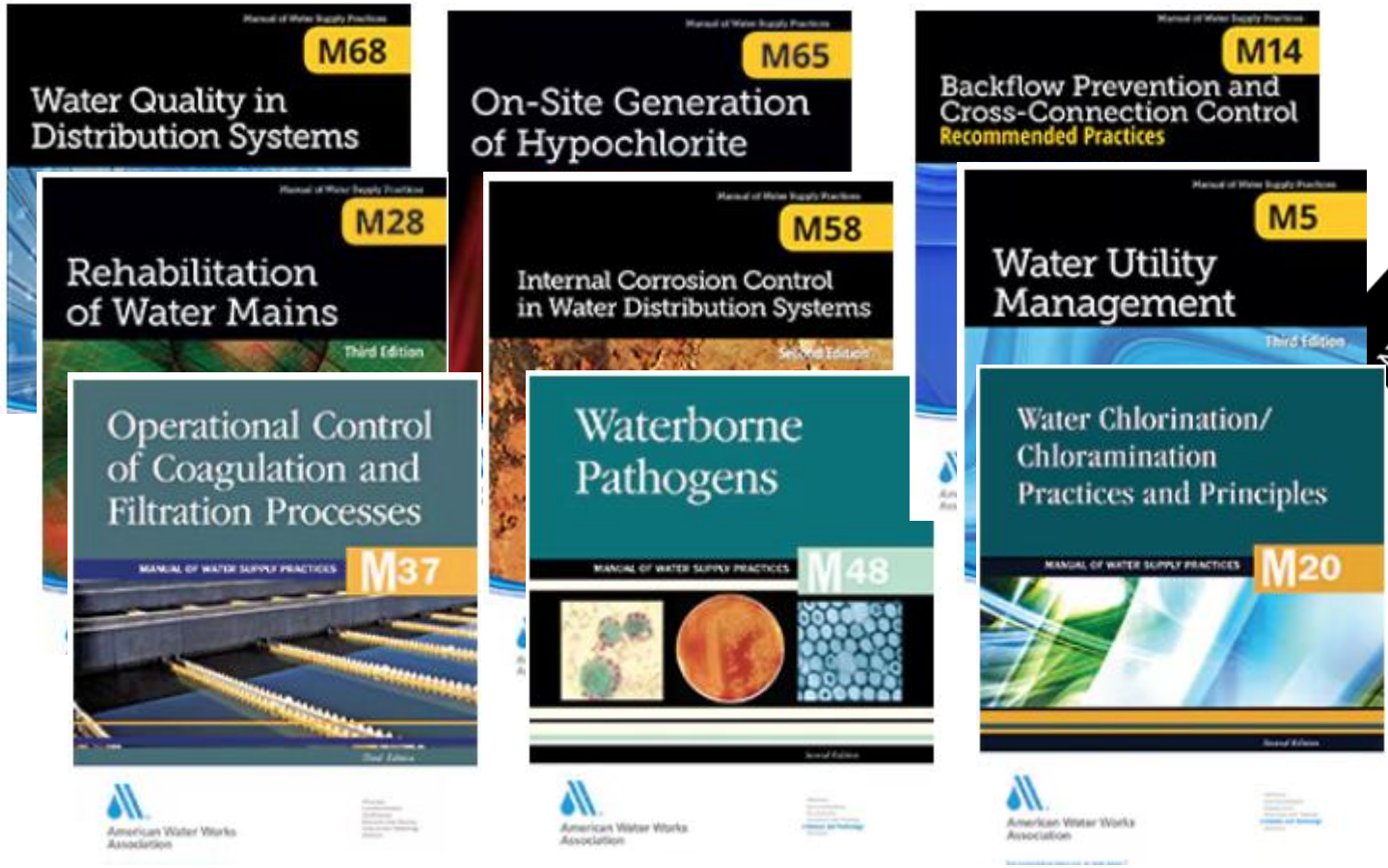
12. **Fill Data and Analysis Gaps:** This covered a broad array of MDBP-related data/gaps: source water, treatment, distribution systems, premise plumbing, and environmental data.

13. **Revisit the definition of Ground Water Under the Direct Influence of Surface Water (GWUDI):** Revise the GWUDI definition to add spores and other indicators, make the GWUDI determination simpler and more accurate, and have GWUDI systems periodically reevaluated.

Federalism Consultation – a glimpse into the crystal ball

EPA Specifically Seeking Input on the following:

- Revisions to minimum disinfectant residual requirements:
  - A national numeric disinfection residual requirement (not just "detectable")
  - Changing residual monitoring locations
  - More stringent compliance determination for residuals (*violations, public notification, etc.*)
- Enhanced DBP precursor control, including potential source vulnerability screening and treatment requirements
- Finished storage tank inspection and cleaning requirement
- Chloraminating Systems: Monitoring DBPs during free chlorine burns, nitrification control
  - **If you chloraminate – have a Nitrification Control Plan**
- Improving water quality at consecutive systems through monitoring and consultation
- Concerns about chlorate



Water System Design Manual

Washington State Department of Health

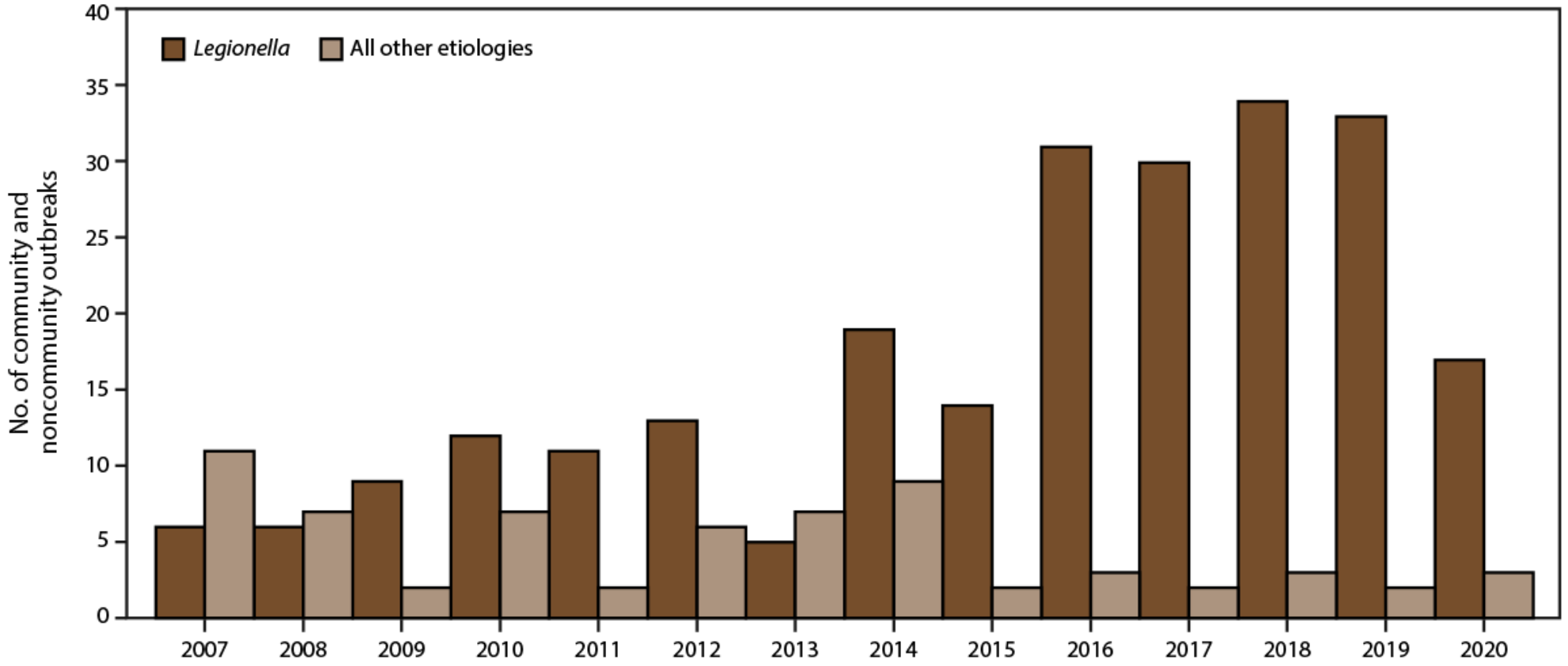
DOH Pub 331-123
Revised June 2020

3 The WHY: Best Practices

A Numerical Disinfection Residual

- Why? Generally about microbial control – mostly about *Legionella*

FIGURE 5. Number of reported drinking water-associated outbreaks in community and noncommunity water settings,* by *Legionella* compared with all other etiologies — Waterborne Disease and Outbreak Surveillance System, United States, 2007–2020

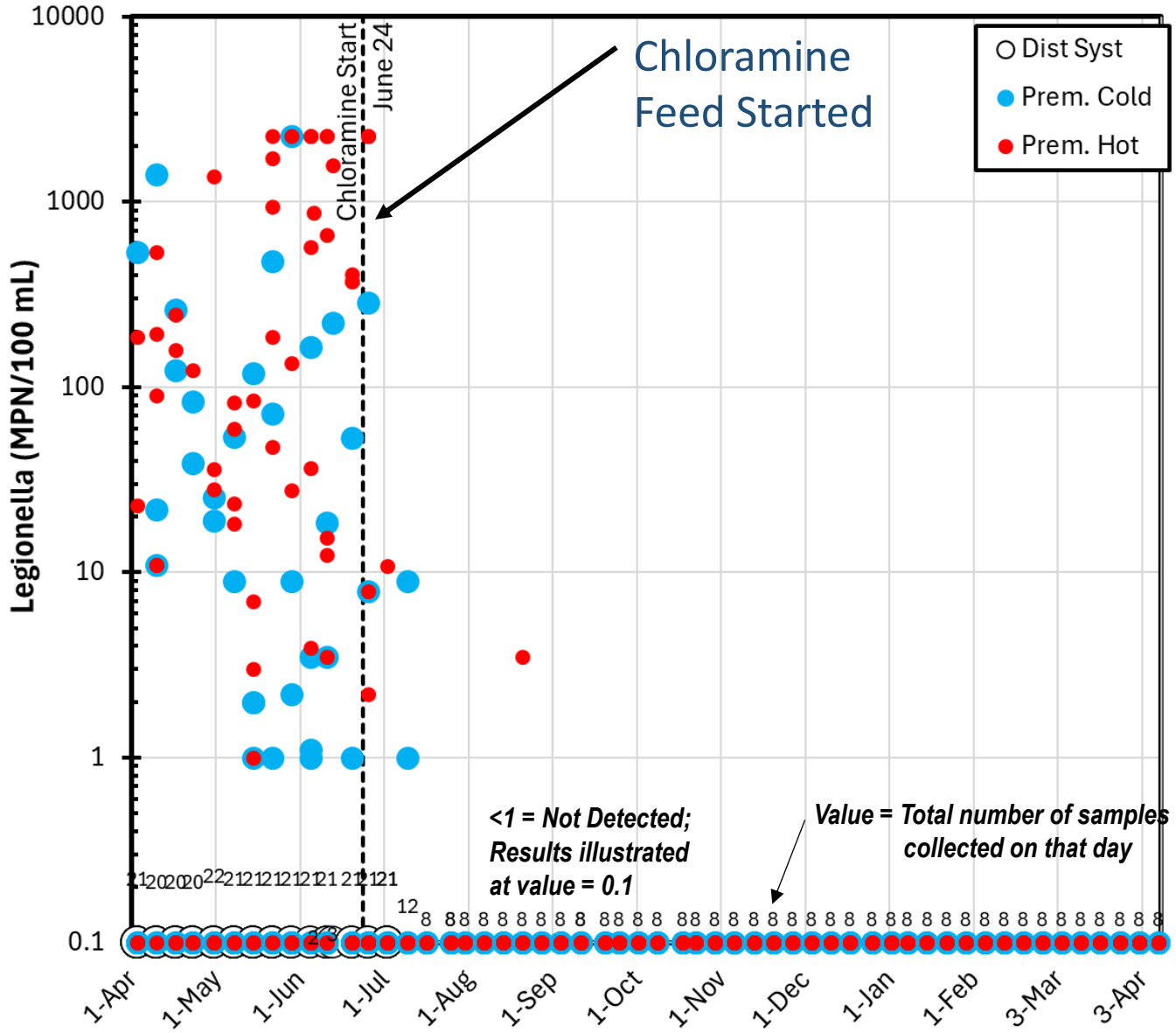


CDC, Surveillance of Waterborne Disease Outbreaks Associated with Drinking Water — United States, 2015–2020, *Surveillance Summaries* / March 14, 2024 / 73(1);1–23

Grand Rapids, MN Outbreak

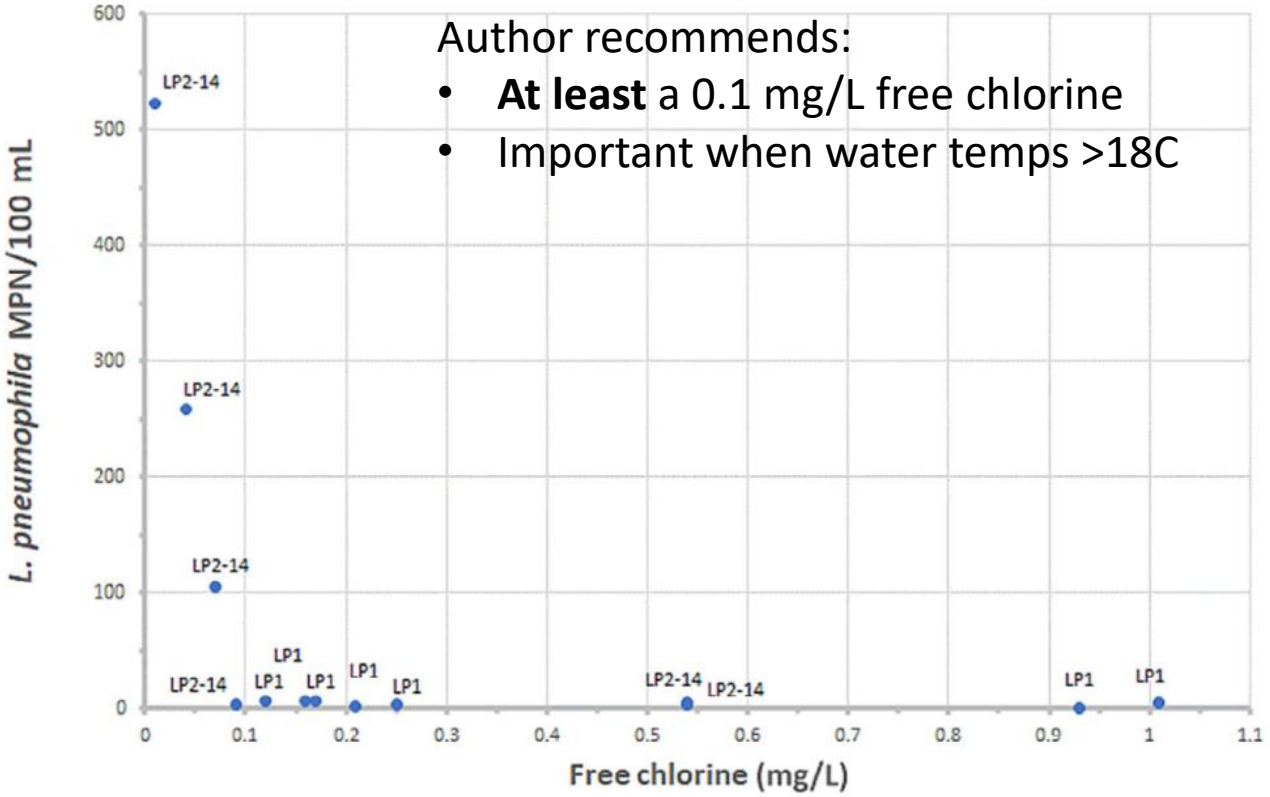
- All Results Apr-Jun 2024
  - Building Inlet (DS) *L. pneumophila*
  - Cold water premise *L. pneumophila*
  - Hot water premise *L. pneumophila*
- Chloramine Startup at WTP
  - **June 24, 2024**
  - **2 mg/L total Cl_2 target through the DS**
  - **Pipe scale stability monitoring started**
- No Cold-Water Premise Detections Since Jul 10
- No Hot-Water Premise Detections Since Aug 21

Legionella Count vs. Monitoring Date



Adapted from Mofidi, A., Utility Success in Overcoming *Legionella* with Treatment and Operations Improvements, PNWS-AWWA Conference, Boise, ID, 2025

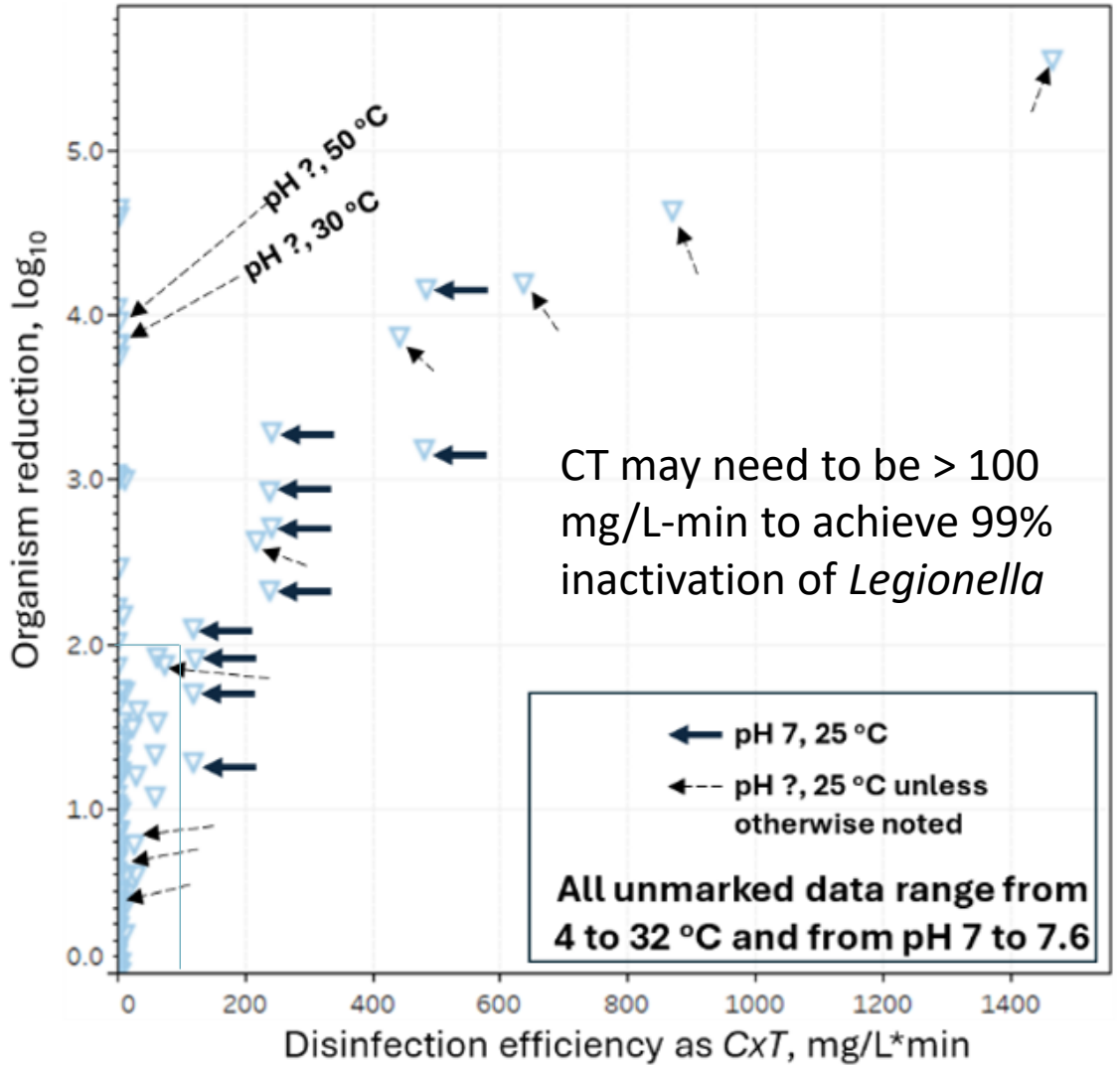
Legionella pneumophila & Chlorine



Author recommends:

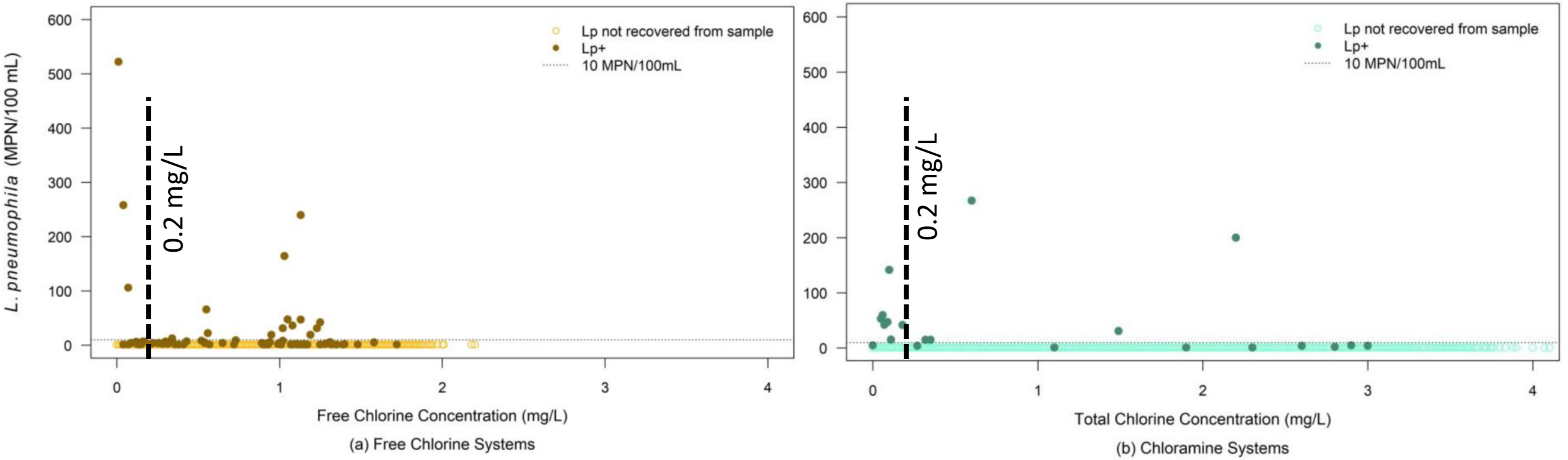
- **At least** a 0.1 mg/L free chlorine
- Important when water temps >18C

LeChevallier, M. Occurrence of culturable *Legionella pneumophila* in drinking water distribution systems. AWWA Water Science, 2019.



Mofidi, A. et al., Development of a Disinfection Efficiency Database for Bacterial Inactivation: A Systematic Literature Review for Selected Water Treatment Technologies. Critical Reviews in Environmental Science and Technology (Submitted 2025)

Legionella pneumophila management



Report Recommendations for Water Systems

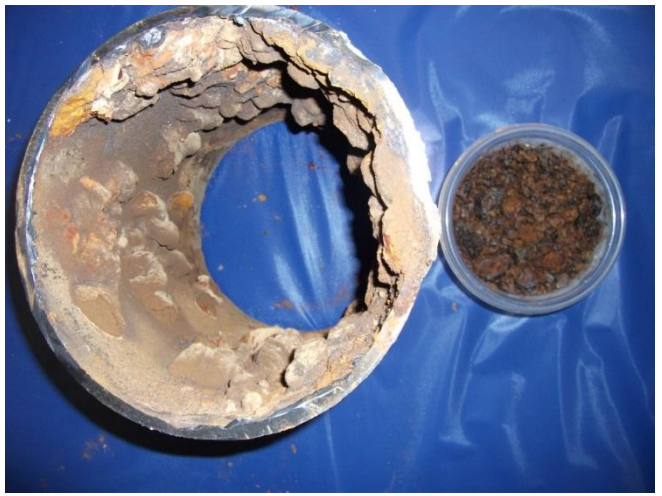
- **Proactively manage *L. pneumophila (Establish baseline, monitor, track & respond)***
- **Maintain at least 0.2 mg/L for both free chlorine and chloramine systems in 100% of samples; increase if indicated, respond if below**

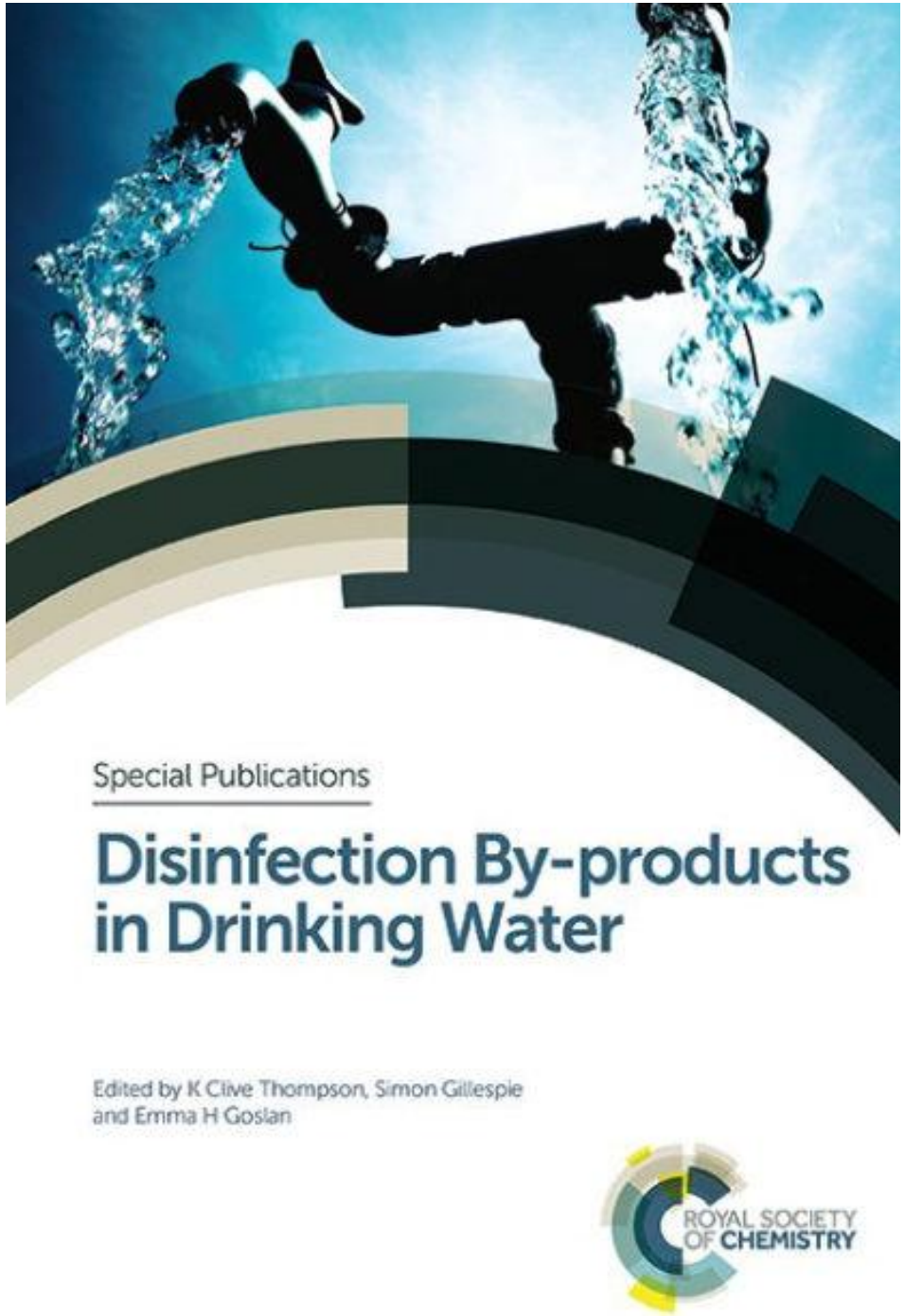
Bertrand, T. et al. Occurrence of *Legionella pneumophila* in Drinking Water Distribution, Water Research Foundation, Denver, CO, 2024

Burlingame, G., et al. Routine Monitoring for *Legionella pneumophila* in Drinking Water Distribution Systems. *Jour AWWA 117:3:6-15*

Myth: Chlorine Residual Only Matters for Microbial Control

Truth: Also very important for stabilizing accumulated metals and pipe scales





[Disinfection By-products in Drinking Water / Edition 1 by K Clive Thompson | 9781782620884 | Hardcover | Barnes & Noble®]

DBPs Why – EPA Briefings to THE NDWAC Working Group*

- Newly emergent health risks from DBPs
  - **Increased Bladder Cancer risk?**
  - **Reproductive and developmental risks**
- Co-occurrence of regulated and unregulated DBPs
  - **TTHMs and HAA5 as surrogates: is that sufficient?**
  - **Health effects risks from unregulated DBPs**

Major Data Gaps

- Occurrence of DBP precursors in source water (Bromide/Organic Carbon)
  - **Location, Location, Location**
- DBP occurrence affected by disinfection practices and precursors
  - **Precursors present and/or removed, disinfectant applied, system configuration**

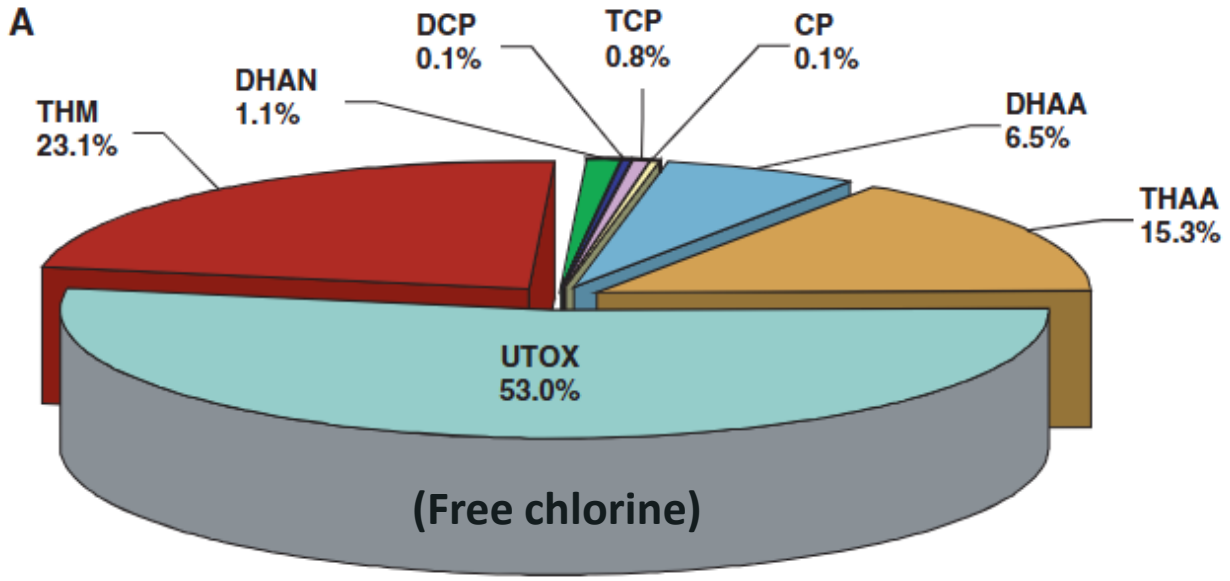
Site-Specific Complexity

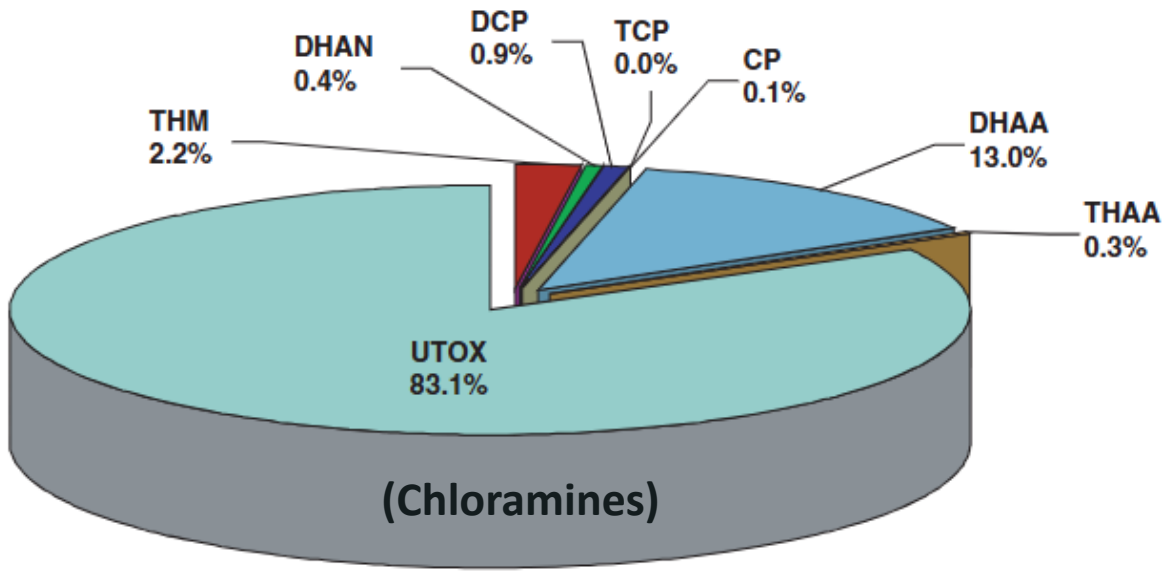
- DBP Compliance concerns including consecutive systems.
  - **Stage 2 DBPR violation rate for consecutive CWSs is 3.5x more than supplier systems**

Responsibility Challenge

*Microbial and Disinfection Byproducts Rule Revisions Working Group Meeting 3: September 20, 2022

DBPs and Enhanced DBP precursor control





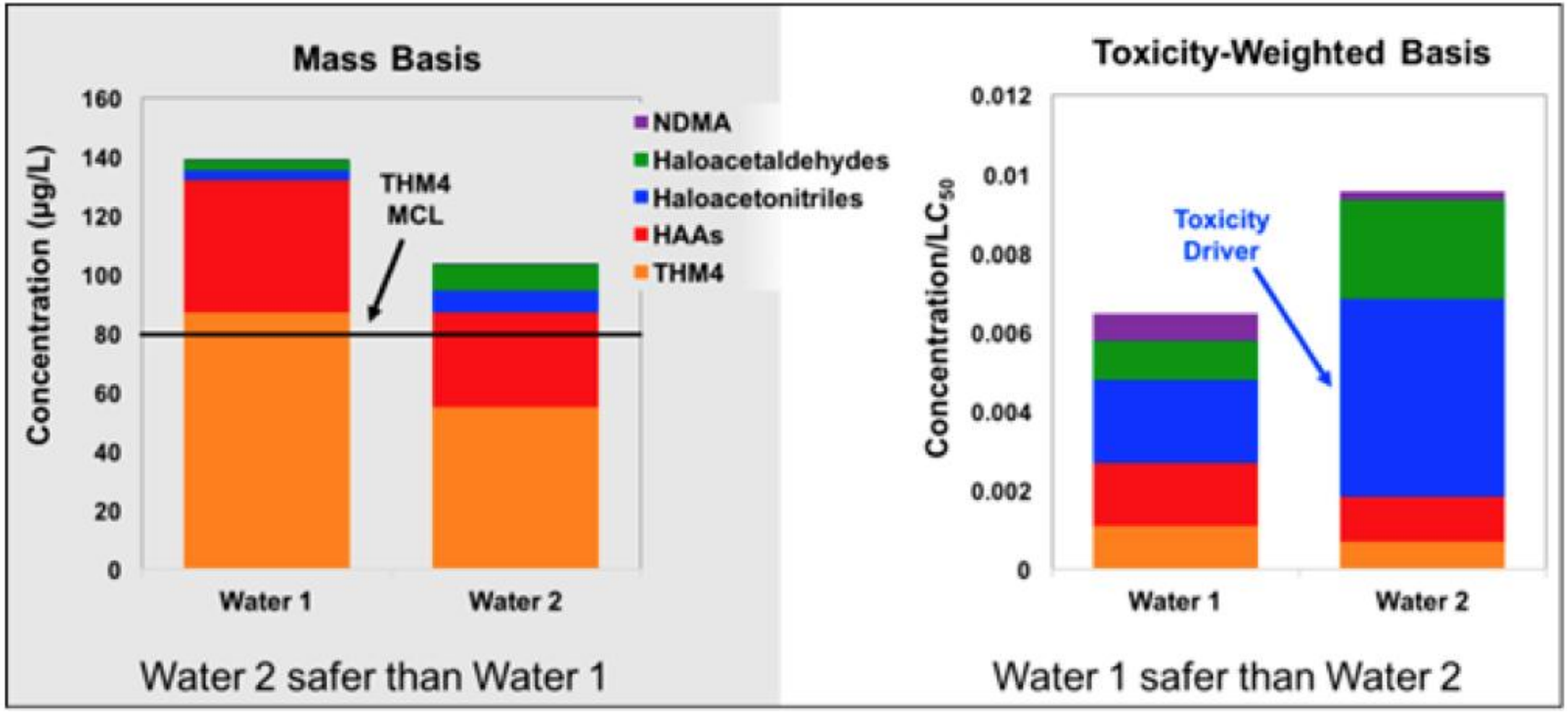
CP—chloropicrin, DCP—dichloropropanone, DHAA—dihaloacetic acid, DHAN—dihaloacetonitrile, DOC—dissolved organic carbon, TCP—trichloropropanone, THAA—trihaloacetic acid, THM—trihalomethane, TOX—total organic halogen, UTOX—unknown total organic halogen

**TOX = 878 µg/L, UTOX = 465 µg/L*
†*TOX = 106 µg/L, UTOX = 88 µg/L*

Reaction conditions were Cambridge, Mass., water DOC = 4.7 mg/L, chlorine dose = 8.1 mg/L, chloramine dose = 2.5 mg/L, temperature = 20°C, pH = 7, and contact time = 72 h.

Hua & Reckhow, 2008. DBP formation during chlorination and chloramination: Effect of reaction time, pH, dosage, and temperature. *Journal AWWA 100:8:82-95*

Current Regulation – Limit DBP mass concentration
Should a toxicity – weighted basis be used?



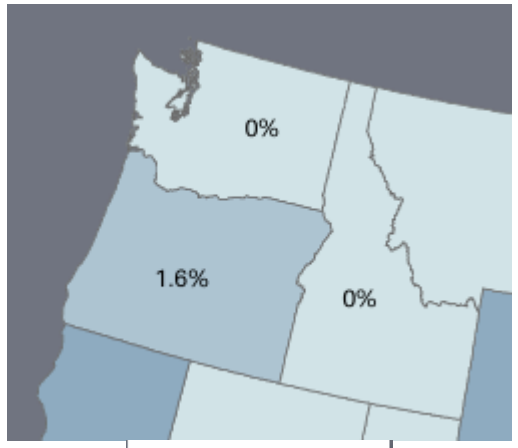
Xing-Fang Li and William A. Mitch, Drinking Water Disinfection Byproducts (DBPs) and Human Health Effects: Multidisciplinary Challenges and Opportunities *Environmental Science & Technology* **2018** *52* (4)

Precursors Affecting DBP Formation

Precursors	Example DBPs Formed	Miscellaneous
Organic Matter		
Natural organic matter	THMs, HAAs	Humic substances
Algal organic matter	Haloacetonitriles (HANs)	Amino acids
Wastewater effluent	Nitrosamines (e.g., NDMA)	Chloramine by-product
Inorganic		
Bromide	Brominated DBPs, bromate	Saltwater, connate water, oil field brines
Iodide	Iodinated DBPs	Chloramine by-product
Anthropogenic		
Certain pharmaceuticals	NDMA	Chloramine by-product
X-ray contrast agents	Iodinated DBPs	Chloramine by-product

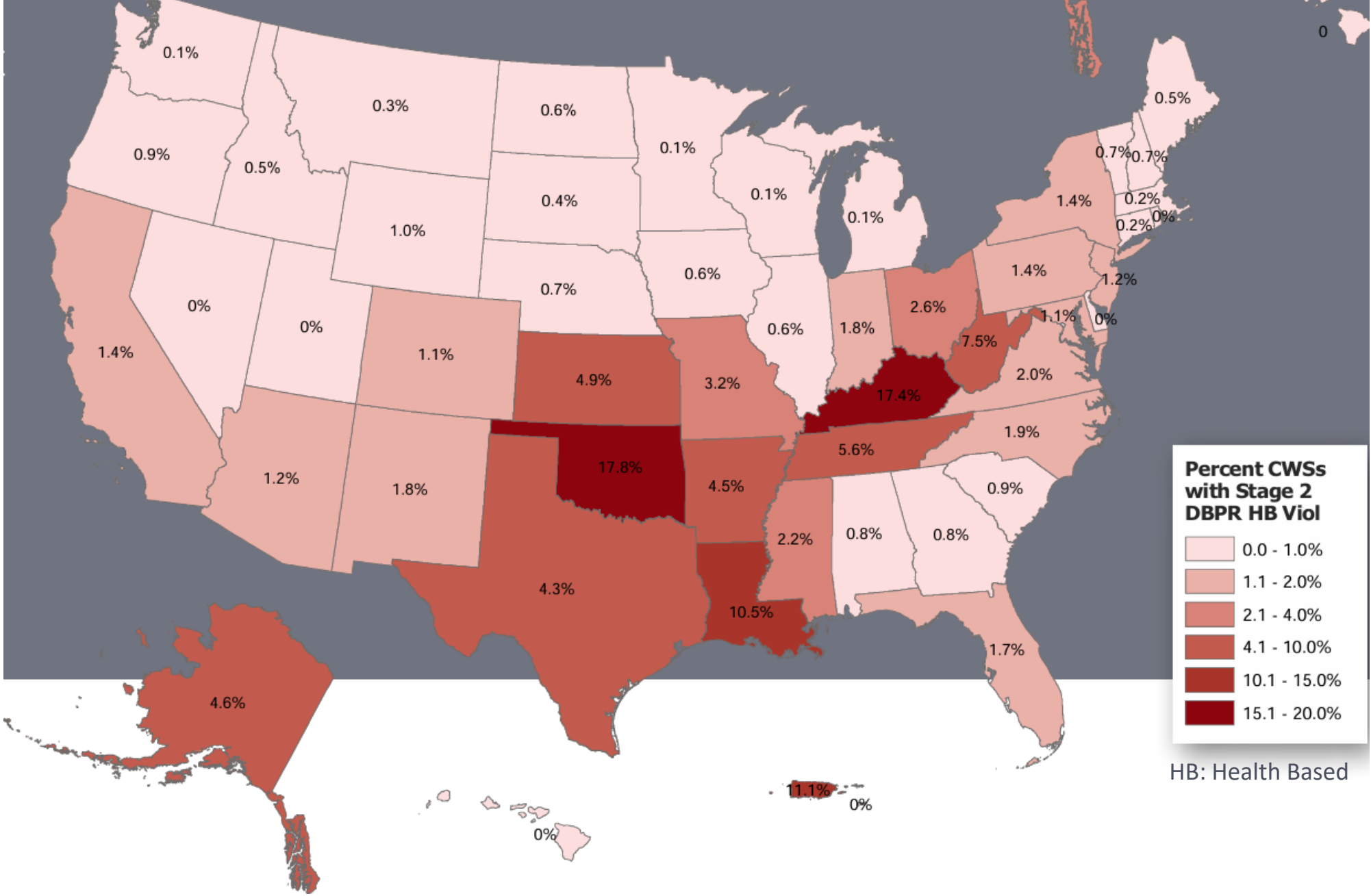
*Microbial and Disinfection Byproducts Rule Revisions Working Group Meeting 3: September 20, 2022. *Materials from Krasner, S.*

National & Regional Compliance Picture



Percent of Consecutive Systems with Stage 2 DBPR HB Viol

- 0.0 - 1.0%
- 1.01 - 2.0%
- 2.01 - 4.0%
- 4.01 - 10.0%
- 10.01 - 15.0%
- 15.01 - 23.0%



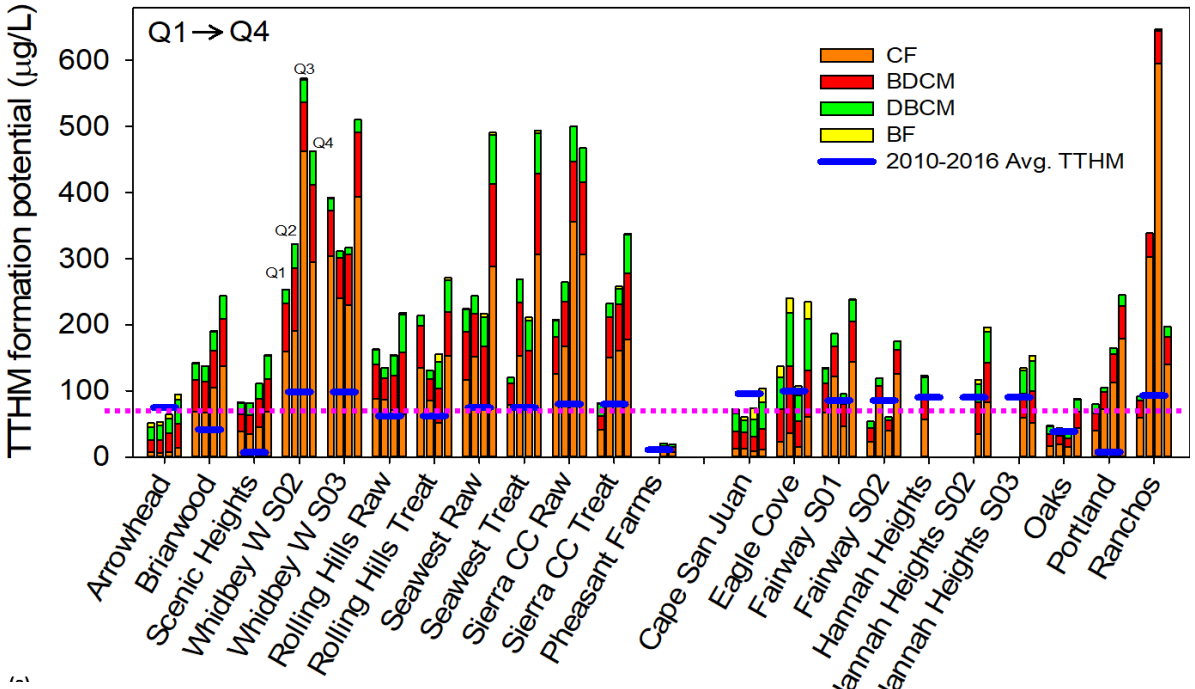
HB: Health Based

Final Report: Stage 2 DBPR and Consecutive System In-Depth Analysis; July 2019; EPA 815-R-19-001.
https://www.epa.gov/dwreginfo/diving-regulations#report

DBP Response – Best Practices

- Each Water System should assess site and operational-specific risks & realities
  - **Characterize precursors; evaluate seasonal variation & resulting DBPs**
    - ***May factor into EPA's Source Vulnerability screening concept – MUCH to be defined there***
  - **Evaluate operational changes, new sources, major system configuration changes**
  - **Understand your system's water age and then manage it**
  - **Mixers & Turnover (two different things!)**

TTHM-FP vs Regulatory Results

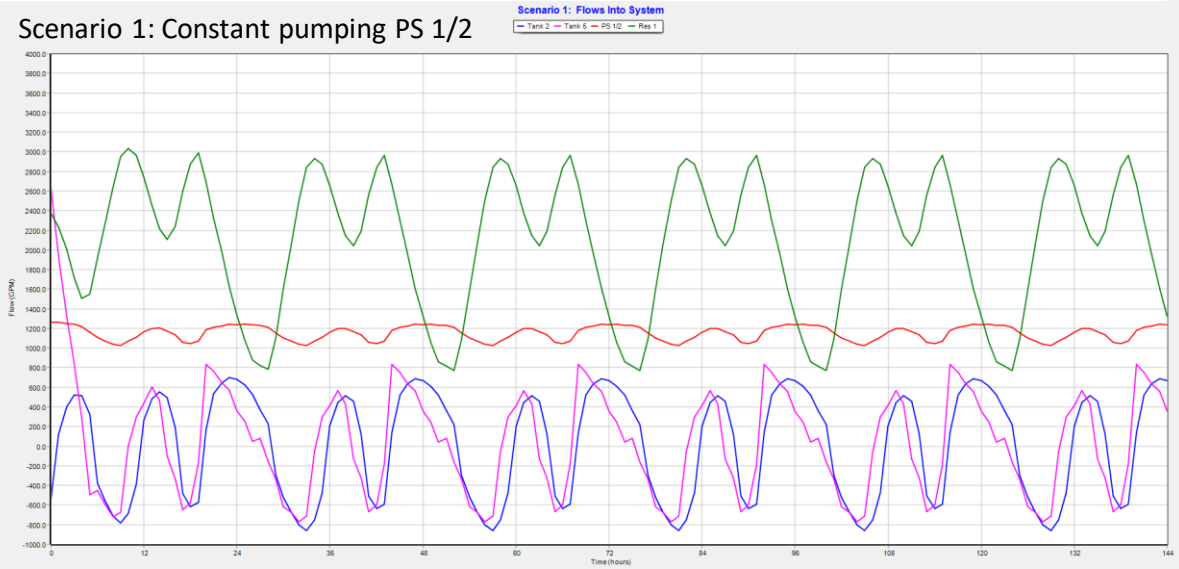


(Young, et al, 2020)

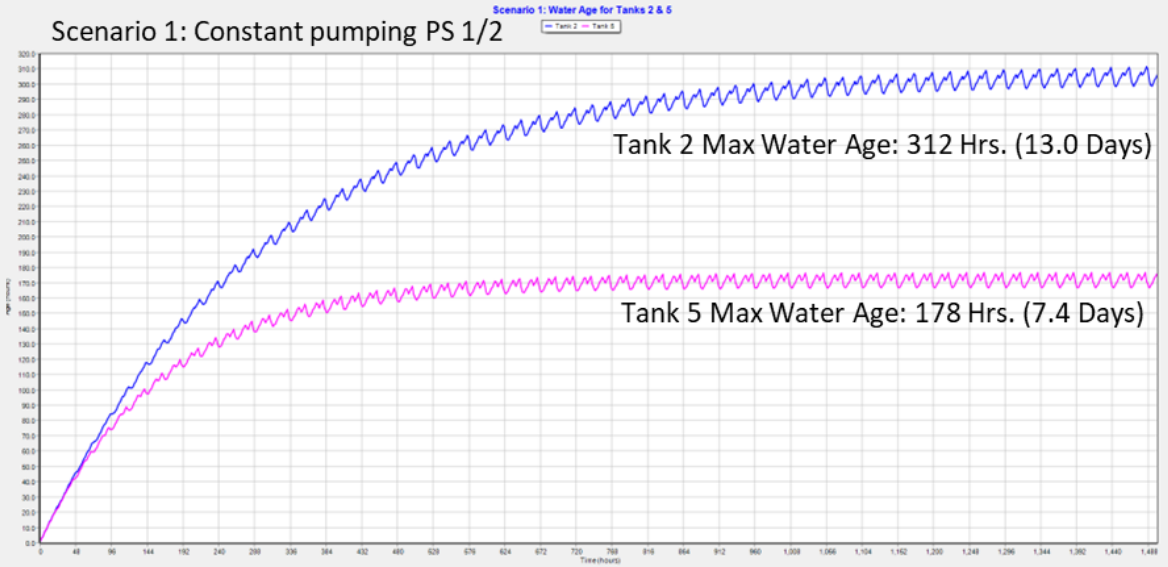
Young, T.R, et al. Drivers of disinfection byproduct formation and speciation in small, chlorinated coastal groundwater systems: relative roles of bromide and organic matter, and the need for improved source water characterization and monitoring. *Environmental Science: Water Research & Technology* Issue 12, 2020

DBP Control – Operational Response

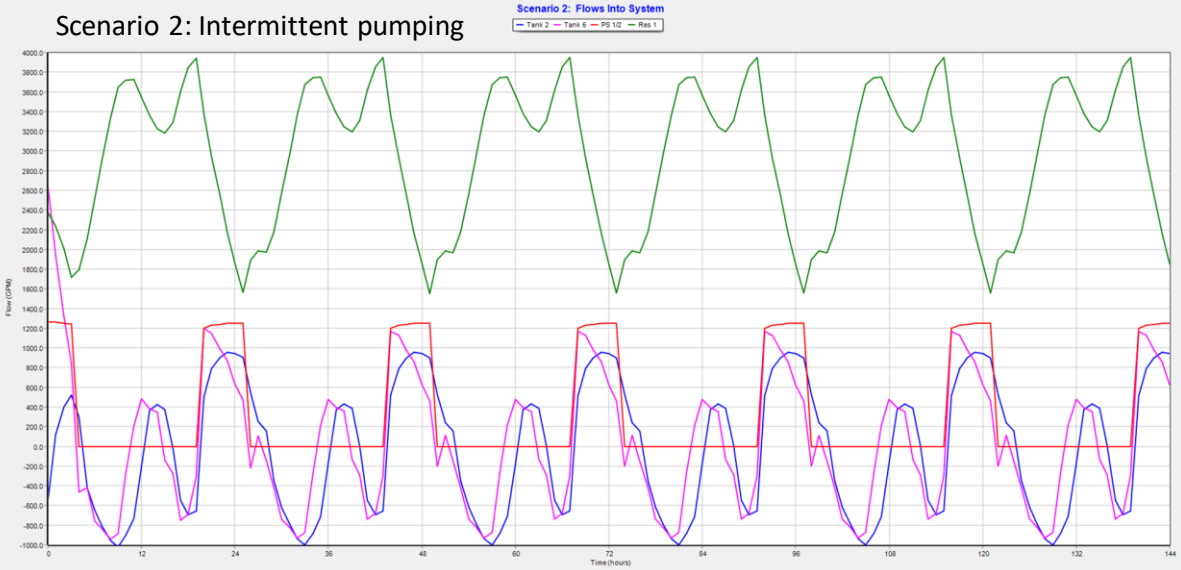
Scenario 1: Constant pumping PS 1/2

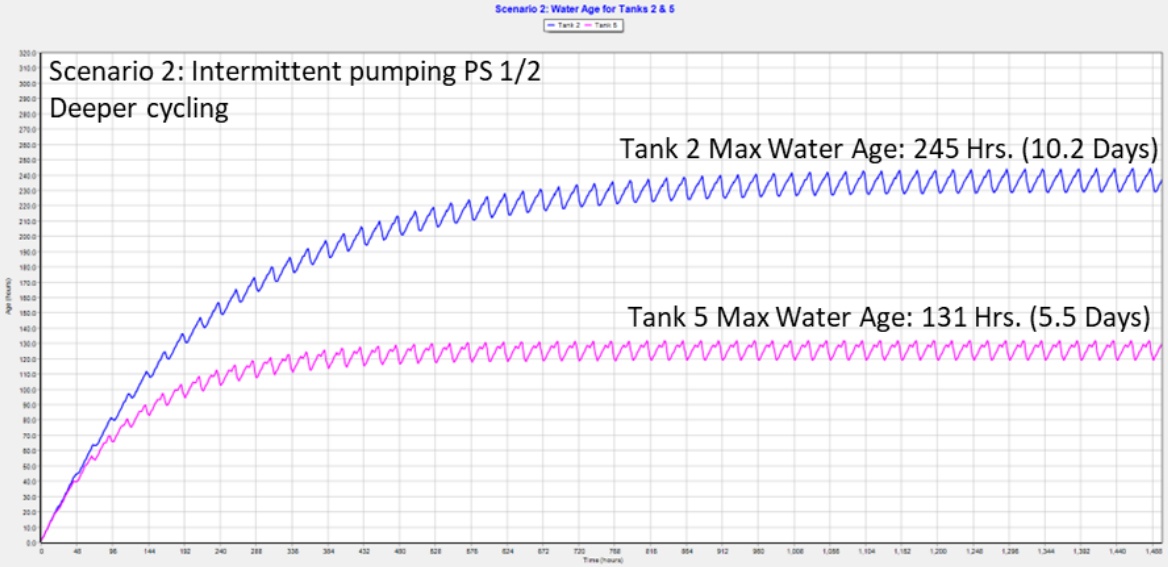


Scenario 1: Constant pumping PS 1/2



Scenario 2: Intermittent pumping





https://www.usatoday.com/in-depth/news/investigations/2021/05/21/infrastructure-neglect-water-towers-add-millions-illnesses/6769259002/

Finished Water Storage Tank Inspection & Cleaning

"Inspecting…storage tanks and…developing good sanitary policies and practices for repair work are ways to improve the distribution water quality."[1]

> Based on surveys of tank inspection firms, State primacy agencies and utilities, Kirmeyer et al. (1999) concluded that many storage facilities in the U.S. are not ever inspected, and many facilities are inspected less frequently than the three-year frequency recommended by AWWA.[2]

"However, as responsible water utility personnel know, regular inspection and tank cleaning are critical to improving water quality and reducing treatment costs…"[3]

[1]Ruda, T. Microbial Regrowth and Distribution System Management. *OPFLOW* August 1997

[2]Friedman, M. et al. 2005 Development of Distribution System Water Quality Optimization Plans. *AWWA Water Research Foundation, Denver CO.*

[3]Cashion, B & J Peters. Clean Tanks Deliver Quality Water, *OPFLOW* December 2013

Finished Water Tank being vacuum cleaned – 1.5" Sediment

Finished Water Storage Tank Inspection & Cleaning

Daily to Weekly (Risk profiles vary):

- Inspect site security – vandalism, intact locks, gunshot wounds
- Visually inspect the places where bad things can enter (screens, overflows, hatches, level measurement cable penetrations) Use a Drone if need be

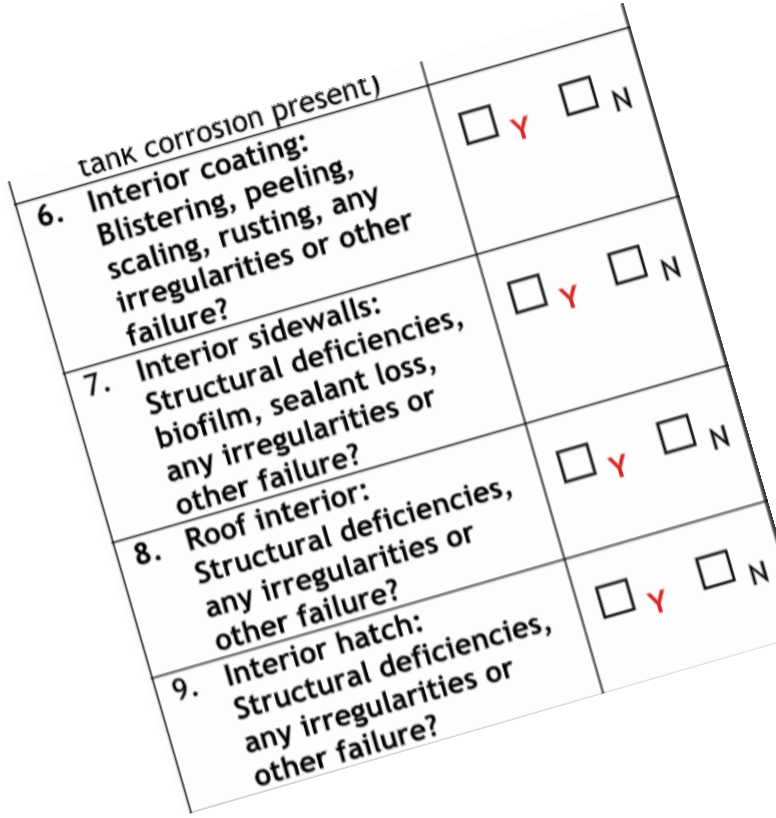
Seasonally:

- Look inside – and don't forget to look up – bird, insect, bat etc. intrusions

Every 3-5 Years:

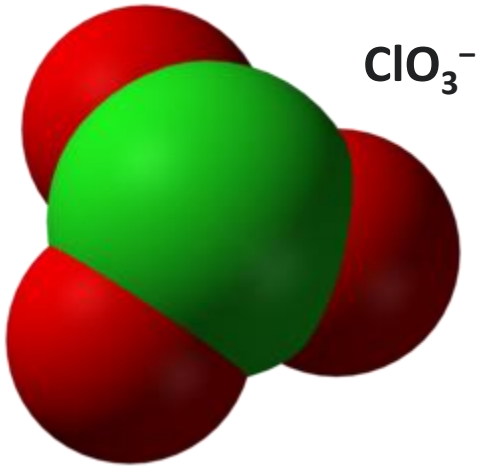
- Drain (or dive), thoroughly clean & inspect coatings
  - Biofilm or inorganic deposits
  - Detailed review of internal coating system, wall and floor penetrations

Keep Good Records!



Resources:
Colorado Storage Tank Rule: https://cdphe.colorado.gov/dwtank (Checklist ideas, etc.)
WDOH O&M Guidance: https://doh.wa.gov/sites/default/files/legacy/Documents/Pubs/331-351.pdf

What to do about Chlorate?



ClO_3^-

Exhibit 5.3: National Estimates of Sample Locations and Associated Population Served with Locational Average Chlorate Concentrations Greater than Threshold Values (Based on UCMR 3 Data)

Threshold Concentration	National Estimate of Number of Sample Locations with Locational Average Concentration > Threshold (Percent[1])	National Estimate (in million) Population Served by Sample Locations with Locational Average Concentration > Threshold (Percent[1])
> HRL (210 µg/L)	24,868 (16.59%)	52 (17.43%)
> 2xHRL (420 µg/L)	10,168 (6.78%)	15 (5.06%)
> 3xHRL (630 µg/L)	5,124 (3.42%)	6 (2.00%)

https://www.epa.gov/sites/default/files/2016-12/documents/810r16013.pdf

EPA Health Reference Level: 210 µg/L (2016)

https://www.epa.gov/sites/default/files/2016-12/documents/810r16012.pdf

Health Canada Max Allowable Concentration: 1,000 µg/L (2008)
https://www.canada.ca/content/dam/canada/health-canada/migration/healthy-canadians/publications/healthy-living-vie-saine/water-chlorite-chlorate-eau/alt/water-chlorite-chlorate-eau-eng.pdf

EU Maximum value: 250 µg/L; 700 µg/L allowed if using chlorine dioxide (2020)

https://eur-lex.europa.eu/eli/dir/2020/2184/oj

WHO Provisional Guideline value: 700 µg/L (2005)

https://cdn.who.int/media/docs/default-source/wash-documents/wash-chemicals/chlorateandchlorite0505.pdf

Chlorate Management Best Practices

- Assess the quality of hypochlorite stock upon receipt (or request in the Certificate of Analysis)
  - Hypochlorite strength
  - Chlorate concentrations
  - pH (maintain in the range of 11–13)
- Dilute hypochlorite solutions upon receipt
- Maintain hypochlorite solutions at low temperature
- Avoiding exposure of hypochlorite solution to sunlight
- Avoiding extended storage times for hypochlorite
- Transition metals (e.g. iron, nickel, copper, zinc, chromium, and manganese) concentration should be kept low

Rules are coming –
They don’t need to hit you like an AI generated freight train

Check on your distribution system disinfectant residuals

- Any problem areas?
- Evaluate and Inspect your storage
  - Water age & mixing ?
  - Tank maintenance & integrity?
- Distribution system maintenance?

How do those Disinfection Byproducts look?

- Any levels close to regulated DBP MCLs?
  - Are you still looking in the right places (has your system changed)?
- Ever tested for chlorate?

Consider Communication with large building customers – do they have a Water Safety Plan?

Proactive, Investigative sampling & evaluation work is just that

THANK YOU!

source
treatment
distribution
tap

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ENGINEERING GROUP LLC

American Water Works Association
Pacific Northwest Section
PNWS Annual Conference
May 7-9, 2025, Boise, ID

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