APPENDIX B. TECHNICAL MEMORANDUM -- AWWA WITAF 054 M/DBP TECHNICAL SUPPORT TASK 1: ENHANCED ANALYSIS OF TOTAL ORGANIC CARBON (TOC) REMOVAL COMPLIANCE CHALLENGES

CORONA | ENVIRONMENTAL CONSULTING

AWWA WITAF 054 MDBP Technical Support

Task 1: Enhanced Analysis of Total Organic Carbon (TOC) Removal Compliance Challenges

Technical Memorandum

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Prepared by Corona Environmental Consulting, LLC

Overview

The objective of this memorandum is to define and characterize impacts and challenges associated with potentially enhanced total organic carbon (TOC) removal requirements under the Surface Water Treatment Rule (SWTR). The National Drinking Water Advisory Council (NDWAC) Microbial and Disinfection Byproduct (MDBP) Rule Revisions Working Group recommended to EPA that MDBP Rule revisions include "multi-benefit precursor control" in their November 2023 report[1]. Recommendation 4 in the report states:

Establish a public water system (PWS) source water evaluation screening requirement and, under defined conditions, provide additional mandatory treatment to reduce disinfection byproduct (DBP) formation and disinfectant demand.

- *Part 1: Evaluate options for a source water vulnerability screening requirement to identify those systems with a higher risk of DBP formation*
- *Part 2: Evaluate options for an enhanced precursor control treatment requirement in response to elevated precursor conditions characterized through the vulnerability screening.*
    - *Examine role additional monitoring can play to create baseline for treatment technique (TT) requirement*
    - *Examine range of approaches to establish method(s) to determine performance requirement*
    - *Examine and seek to include range of options of how covered systems must operate to achieve performance levels indicated by TT performance requirement*

Available data from EPA's Fourth Six Year Review (SYR4) are used to evaluate TOC removal performance and finished water TOC levels and to generate a target list of systems that are likely to be currently facing challenges complying with the removal requirements or likely to face challenges with enhanced requirements. Due to limited data availability, a survey was also conducted to solicit more information from utilities on the target list, as well as other utilities for which data were not available. Follow up technical discussions were conducted with a subset of systems that completed the survey to learn more about source water quality, treatment processes, TOC removal, finished water and distribution system water quality, current challenges, and anticipated actions in the case that more stringent TOC removal are to be included in MDBP rule revisions.

Regulatory Overview

The removal of organic matter, measured as TOC, was included in the Stage 1 Disinfectant and Disinfection Byproduct Rule (DBPR) for the purpose of reducing public exposure to disinfection byproducts (DBPs). A requirement for public water systems (PWSs) to remove TOC was implemented to help control the formation of both regulated, i.e., total trihalomethane (TTHM) and the sum of five haloacetic acids (HAA5), as well as unregulated and even unknown DBPs that may pose risks to human health. Under the Stage 1 Disinfectant and Disinfection Byproduct Rule (DBPR), the U.S. Environmental

[1] National Drinking Water Advisory Council (NDWAC) 2023. Report of the Microbial and Disinfection Byproducts Rule Revisions Working Group. November 13, 2023. https://www.epa.gov/system/files/documents/2023-11/report-of-the-mdbp-rule-revisions-working-group-to-the-ndwac-november-2023_0.pdf.

Protection Agency (EPA), which applies to community water systems (CWSs), non-transient non-community water systems (NTNCWSs) and transient community water systems (TNCWSs) that use chlorine dioxide, requires all Subpart H systems using conventional treatment, regardless of size, to meet an enhanced coagulation or softening treatment technique (TT) requirement. Subpart H systems are defined as systems with surface water or groundwater under the influence of surface water as their source. This TT requirement can be met in one of two steps. The first step, **Step 1**, of this requirement includes a specific **percent TOC removal** based on a system's source water TOC and alkalinity concentrations (Table 1).

Table 1 The Stage 1 DBPR enhanced coagulation and softening Step 1 3x3 matrix defining TOC removal requirements

Source Water TOC (mg/L)	Source Water Alkalinity, mg/L as $CaCO_3$		
	0 - 60	**> 60 - 120**	**> 120**
> 2.0 to 4.0	35.0%	25.0%	15.0%
> 4.0 to 8.0	45.0%	35.0%	25.0%
> 8.0	50.0%	40.0%	30.0%

Standard monitoring for the Step 1 enhanced coagulation/enhanced softening TT requirement includes one monthly paired TOC and alkalinity sample from the source water prior to any treatment and one TOC sample no later than the point of combined filter effluent turbidity monitoring and representative of filtered water. Reduced monitoring, if allowed, is on a quarterly basis. Compliance with the Step 1 requirement is based on a running annual average (RAA) of removal ratios. Removal ratios are calculated by taking the percent of TOC removal achieved and dividing by the required TOC removal based on the source water TOC and alkalinity concentrations (Table 1). The RAA of the removal ratios must be equal to or greater than 1.00 for the system to be in compliance with the Step 1 TOC percent removal requirements.

There are three footnotes to the 3x3 matrix shown in Table 1 based on alternative compliance criteria:

(a) Systems meeting at least one of the conditions in Section 141.135(a)(2) (i)-(vi) of the rule are not required to meet the removals in this table
(b) Softening systems meeting one of the two alternative compliance criteria in Section 141.135(a)(3) of the rule are not required to meet the removals in this table.
(c) Systems practicing softening must meet the TOC removal requirements in the last column to the right.

The **alternative compliance criteria (ACC)** referenced in footnote (a) include the following:

1. The system's source water TOC is <2.0 mg/L, calculated quarterly as a RAA.
2. The system's treated water TOC is <2.0 mg/L, calculated quarterly as a RAA.

3. The system's source water TOC <4.0 mg/L, calculated quarterly as a RAA, its source water alkalinity is >60 mg/L (as $CaCO_3$), calculated quarterly as a RAA, and the system is achieving TTHM <40 µg/L and HAA5 <30 µg/L (or prior to Stage 1 DBPR compliance dates, the system has made a clear and irrevocable financial commitment to technologies that will meet the TTHM and HAA level).
4. The system's TTHM RAA is <40 µg/L, HAA5 RAA <30 µg/L, and only chlorine is used for primary disinfection and maintenance of a distribution system residual.
5. The system's source water specific ultraviolet absorbance (SUVA) prior to any treatment, measured monthly, is $\leq$2.0 L/mg-m, calculated quarterly as a RAA.
6. The system's treated water SUVA, measured monthly, is <2.0 L/mg-m, calculated quarterly as a RAA.

The additional **ACC** for softening systems referenced in footnote (b) include the following:

7. Softening that results in lowering the treated water alkalinity to less than 60 mg/L (as $CaCO_3$), measured monthly, and calculated quarterly as a RAA.
8. Softening that results in removing at least 10 mg/L of magnesium hardness (as $CaCO_3$), measured monthly, and calculated quarterly as a RAA.

The Stage 1 DBPR also includes a **Step 2 performance criteria** when it is technically infeasible for systems to meet the TOC removal requirements. The alternative TOC removal using Step 2 is determined by performing jar tests on at least a quarterly basis for one year. The jar tests will identify a point of diminishing returns (PODR) for TOC removal based on coagulant dose, and the PODR is used to set the alternative TOC removal percentage. If there is no PODR, based on the Stage 1 DBPR definitions, the water is considered not amenable to enhanced coagulation and TOC removal is not required if the system requests, and is granted, a waiver from the enhanced coagulation requirements by the State.

It is possible for a system to have some months in which they comply with the TOC removal requirement based on the Step 1 3x3 matrix and other months in which they meet an ACC. For months in which a system meets an alternative compliance or performance criteria, a monthly value of 1.0 is used in place of the ratio of percent TOC removal achieved to the required percent TOC removal, which is then used to calculate the RAA for compliance.

Assessment of National Data

Assessment of National Data: TOC Removal

An assessment of nationally available data was performed to gain an understanding for the extent to which systems are complying with the Stage 1 DBPR enhanced coagulation / enhanced softening TT and how systems are meeting compliance. The assessment outcomes were also intended to inform the extent to which a regulatory change focused on either increasing the TOC removal requirement or establishing a finished water TOC maximum contaminant level (MCL) would impact water utilities nationwide.

The EPA's Fourth Six Year Review (SYR4) data set (2012-2019) includes source water and finished water TOC data, paired source water TOC and alkalinity data, and TOC removal percents. The analysis showed that these data are available for only a small subset of Subpart H systems subject to the Stage 1 DBPR.

Focusing on CWSs and NTNCWSs and using the EPA's Safe Drinking Water Information System (SDWIS) Water System Detail Report as of the fourth quarter of 2019 to define the inventory of active public water systems (PWSs), 9.5% of active Subpart H CWSs and NTNCWSs, 1,172 systems in total, have sufficient available data to assess TOC removal achieved relative to TOC removal required. For this study, sufficient available data is defined as a PWS having results for paired source water TOC and alkalinity and finished water TOC in the SYR4 data set. Data availability is shown geographically and by system size in Figure 1 and Figure 2, respectively.

Figure 1 Map of Subpart H CWSs and NTNCWSs with sufficient available data in SYR4 (2012-2019) for assessing TOC removal achieved versus TOC removal required

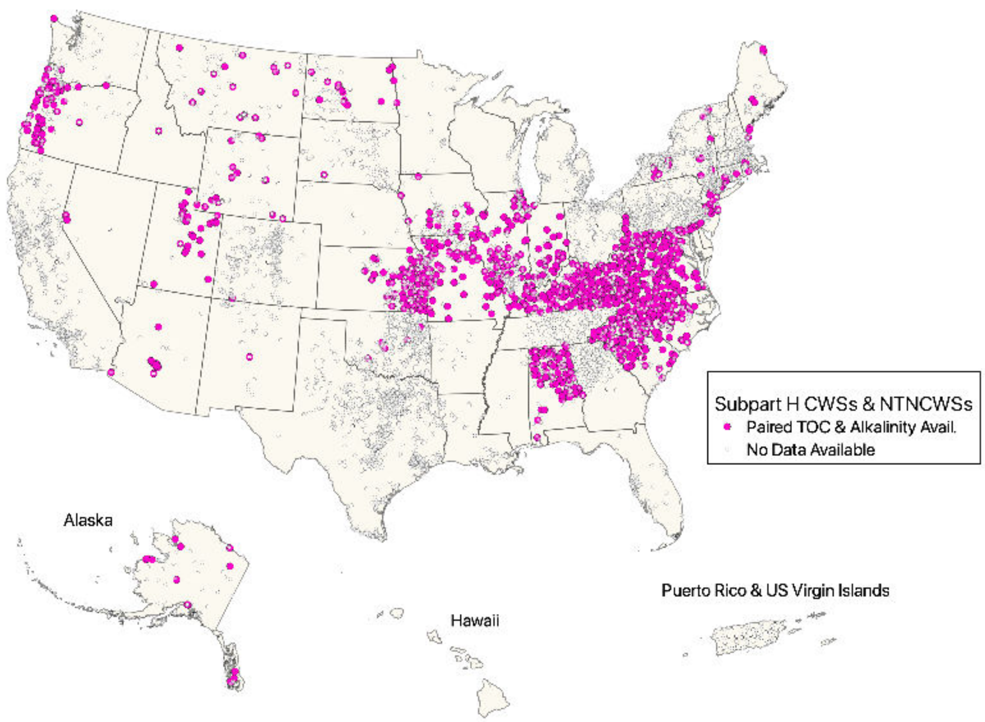
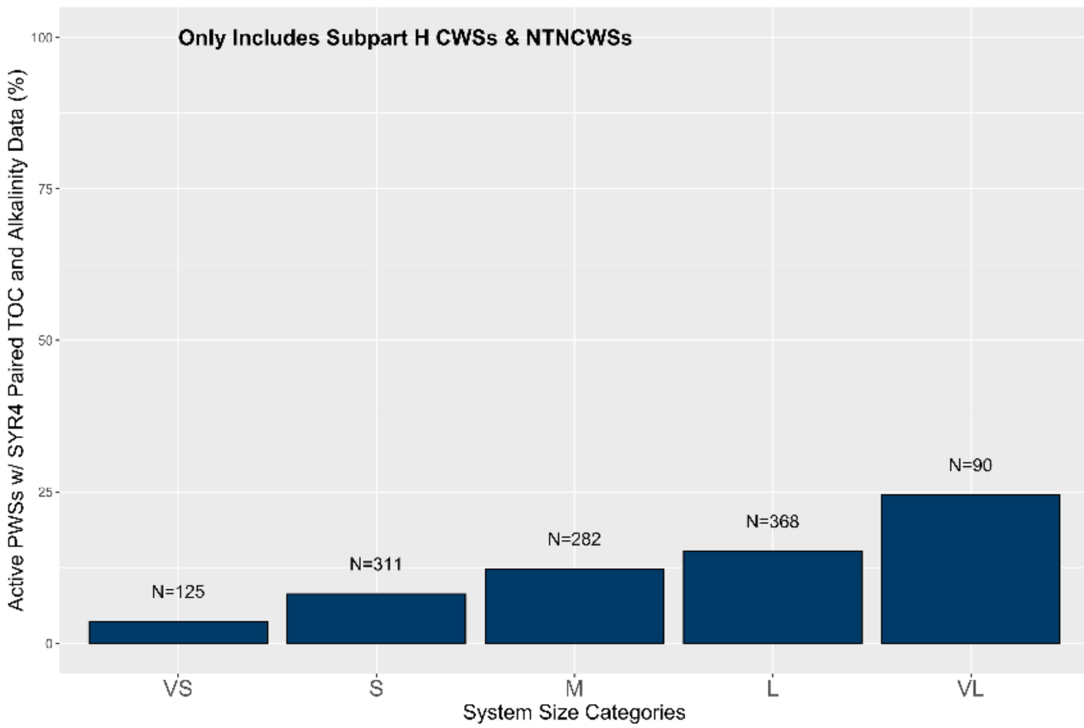


Figure 2 Barplots showing number and percent of active PWSs (subpart H CWSs and NTNCWSs only) with paired source water TOC and alkalinity and finished water TOC data in the SYR4 data set by system size category



Of these 1,172 systems with available data, 774 systems (66%) have at least one month in which the required TOC removal was not met. For compliance purposes, there are 339 systems (29%) which have at least one month's removal ratio RAA that does not meet the requirement. In addition to the current TOC removal requirement, potential regulatory scenarios requiring an additional 5%, 10%, and 15% TOC removal were investigated. To describe both the percent of surface water treatment facilities and the percent of time in months that these facilities do not meet the removal requirement, the percent of unique facility-months where the TOC removal ratio RAA is less than the requirement were also summarized for the current regulatory scenario and under scenarios requiring an additional 5%, 10%, and 15% TOC removal. Similarly, results were also summarized on a PWS-quarter basis. The percent of facility-months not meeting compliance ranged from 12% under the current regulatory scenario to 29% based on a requirement for an additional 15% TOC removal. The percent of PWS-quarters not meeting compliance ranged from 11% under the current regulatory scenario to 26% based on an additional 15% TOC removal requirement. Results are summarized in Table 2.

Table 2 Summary of PWSs challenged to meet current and potential TOC removal regulatory scenarios (2012-2019)

Regulatory Scenario	PWSs with at least one month not meeting percent TOC removal requirement	PWSs with at least one month's RAA of TOC removal ratio < 1.00	Percent of facility-months with RAAs of TOC removal ratio < 1.00	Percent of PWS-quarters with RAAs of TOC removal ratio < 1.00
Current Scenario	698 (60%)	339 (29%)	12%	11%
Additional 5% Removal Required	790 (67%)	433 (37%)	16%	14%
Additional 10% Removal Required	860 (73%)	532 (45%)	22%	20%
Additional 15% Removal Required	925 (79%)	642 (55%)	29%	26%

The results shown in Table 2 account for ACC 1 by assigning a removal ratio of 1.0 for systems in months when source water TOC is less than 2.0 mg/L. This criterion exempts the system from a percent TOC removal requirement based on the 3x3 matrix. The results do not account for systems meeting compliance with the ACC 2-8, the Step 2 performance criteria, or for the 3 alternative performance criteria. National data are not available to identify systems meeting compliance with the Step 2 performance criteria or the 3 alternative performance criteria, but an effort was made to identify systems meeting ACC 1-8 using SYR4 data, where possible. Table 3 summarizes the data required to identify systems that may have qualified for each ACC and number and percent of active subpart H CWSs and NTNCWSs with the required data in the SYR4 data set. The outcomes of the ACC analysis are presented in Table 4 on a PWS-basis and a facility-basis for ACC 1, 2, 5, and 6; ACC 3 relies on quarterly distribution system DBP data and thus, can only be determined on a PWS-quarter basis.

Table 3 Summary of TOC removal ACCs, data required to assess a system's eligibility, and the number and percent of systems with the required data from the SYR4 data set

Alternative Compliance Criteria (ACC)	**Data required to assess eligibility[1]**	**Number and percent of active CWSs and NTNCWSs with data required from SYR4**
1. The system's source water TOC is <2.0 mg/L	Source water TOC	3,336 (27%)
2. The system's treated water TOC is <2.0 mg/L	Finished water TOC	2,533 (20%)
3. The system's source water TOC <4.0 mg/L, its source water alkalinity >60 mg/L as $CaCO_3$, and the system is achieving TTHM <40 µg/L and HAA5 <30 µg/L[2]	Paired source water TOC and alkalinity, distribution system TTHM and HAA5	1,827 (15%)
4. The system's TTHM <40 µg/L, HAA5 <30 µg/L, and only chlorine is used for primary disinfection and maintenance of a distribution system residual	Distribution system TTHM and HAA5, primary and secondary disinfection type	Not assessed due to lack of reliable primary and secondary disinfection type data
5. The system's source water SUVA prior to any treatment is ≤2.0 L/mg-m	Source water SUVA	28 (0.2%)
6. The system's treated water SUVA is <2.0 L/mg-m.	Finished water SUVA	50 (0.4%)
7. Softening that results in lowering the treated water alkalinity to less than 60 mg/L (as $CaCO_3$), measured monthly, and calculated quarterly as a RAA	Treatment data, finished water total alkalinity data	Not assessed due to lack of reliable treatment data
8. Softening that results in removing at least 10 mg/L of magnesium hardness (as $CaCO_3$), measured monthly, and calculated quarterly as a RAA	Treatment data, source and finished water magnesium hardness data	Not assessed due to lack of reliable treatment data

[1]ACC 1, 2, 5, and 6 are determined based on monthly monitoring calculated quarterly as a RAA of all measurements. ACC 3 is based on monthly monitoring for TOC and alkalinity or quarterly monitoring for TTHM and HAA5, calculated quarterly as a RAA of all measurements. ACC 4 is determined based on monitoring for TTHM and HAA5, calculated quarter as a RAA of all measurements.

[2]The part of ACC 3 that includes systems that have made a clear and irrevocable financial commitment to technologies that will meet the TTHM and HAA level is not included here due to lack of data to identify systems meeting this criterion.

Table 4 Summary of ACC analysis using available SYR4 data (2012-2019)

ACC	Count of PWSs with data	Count of facilities with data	Percent of PWSs meeting ACC at least 1 month (quarter for ACC 3)	Percent of facilities meeting ACC at least 1 month	Percent of facility-months meeting ACC
1	3,336	8,025	54%	56%	28%
2	2,533	3,156	80%	71%	51%
3	1,827	N/A	29%	N/A	12% of PWS-quarters
5	28	37	32%	27%	9%
6	50	65	94%	95%	92%

The outcomes of the ACC analysis (Table 4) offer little information on their own due to the limited number of systems with data available to evaluate each ACC. Coupling the ACC analysis with the enhanced coagulation TOC removal analysis (Table 2) does provide a better understanding of the extent to which, and how, systems are meeting compliance. As show in Table 2, 339 PWSs for which data were available did not meet the TOC removal requirements as specified in the 3x3 matrix based on the TOC removal ratio RAA for at least one month and based on a PWS-quarter basis, the data suggested a rate of 11% non-compliance. Once the ACC data were accounted for, it was determined that 114 PWSs had at least month not meeting either the 3x3 matrix removal requirement. This means that 66% of systems that did not meet the TOC removal requirement did still meet compliance based on an ACC. From a PWS-quarter basis, the inclusion of the ACC data reduced the rate of non-compliance with TOC removal requirements from 11% to 5%. It’s important to note that the ACC analysis did not account for ACC 4, 7, or 8, the Step 2 performance criteria, or the 3 alternative performance criteria. Therefore, based on the SYR4 data set, there is a non-compliance rate less than 5%, and less than 4% of PWSs that are required to meet the enhanced coagulation TOC removal requirements have been out of compliance in 2012 through 2019.

Assessment of National Data: Finished Water TOC

Finished water TOC concentrations were assessed to understand the impact of a potential regulatory change inclusive of a finished water TOC MCL, i.e., 2 mg/L, 3 mg/L, or 4 mg/L. Finished water TOC data were available for 21% of active Subpart H CWSs and NTNCWSs, 2,747 in total, and 0.3% of groundwater systems, 151 in total. As a result, data were only available for 4% of all CWSs and NTNCWSs due to the lack of data for groundwater systems. Data availability is shown geographically and by system size in Figure 3 and Figure 4, respectively.

Figure 3 Map of CWSs and NTNCWSs with finished water TOC data in SYR4 (2012-2019)

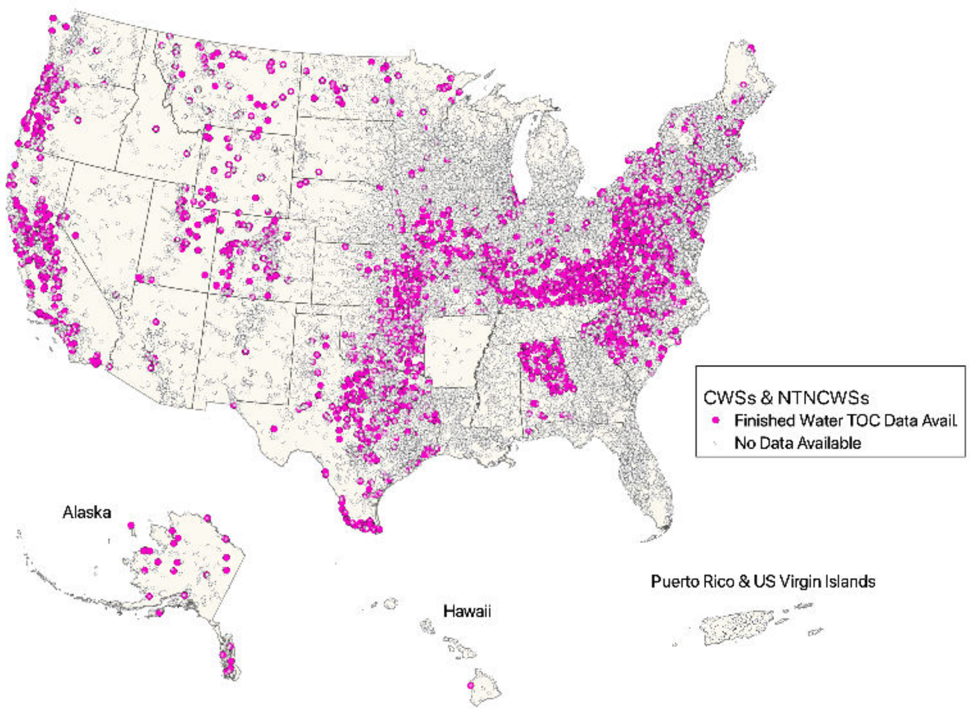
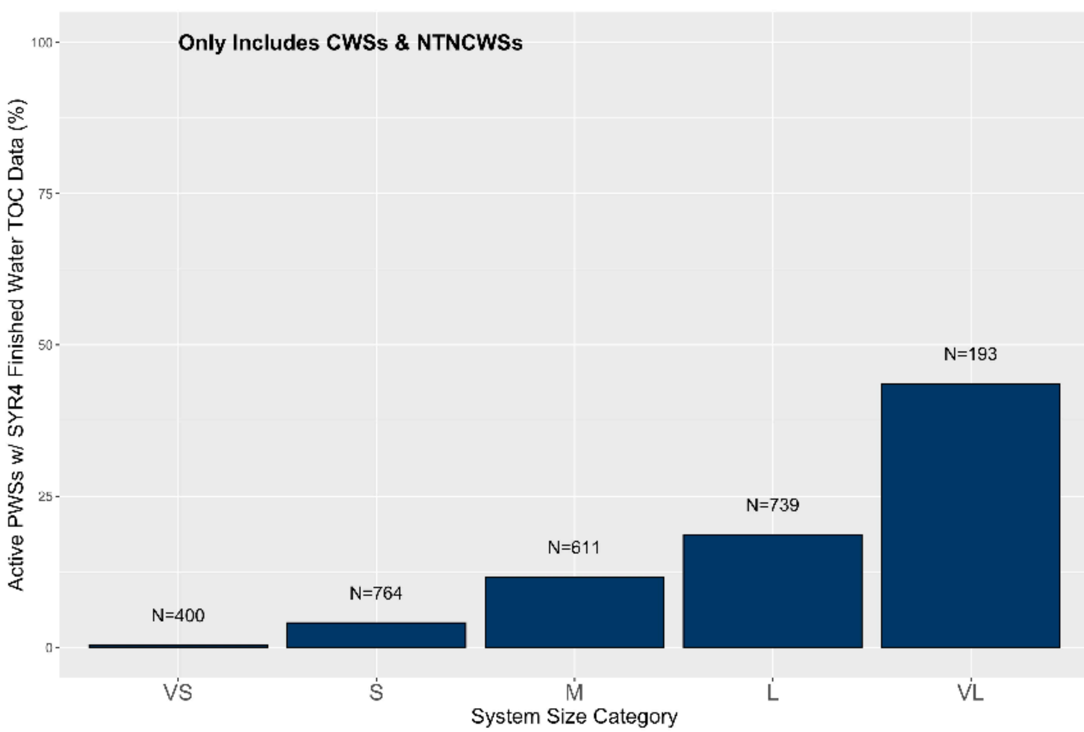
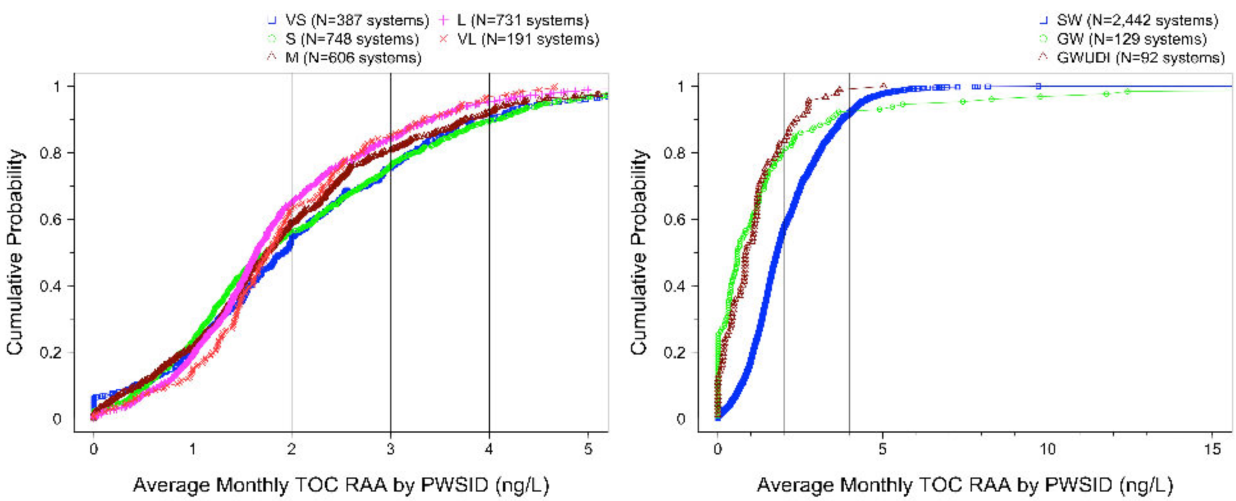


Figure 4 Barplots showing number and percent of active PWSs (CWSs and NTNCWSs only) with finished water TOC data in the SYR4 data set by system size category



The SYR4 data set of finished water TOC data were used to calculate monthly finished water TOC RAAs. Sufficient data for calculating these monthly RAAs were available for 2,562 PWSs. The monthly RAAs indicate that the percent of systems that would have exceeded a finished water TOC MCL during 2012 – 2019 of 2 mg/L, 3 mg/L, and 4 mg/L are 40%, 20%, and 8%, respectively. Cumulative distribution plots based by system size and primary source water type are shown in Figure 5. The results show that smaller systems serving less than 3,300 have the highest rate of PWSs that exceeded a hypothetical finished water TOC MCL in the range of 2 mg/L to 4 mg/L, and while a higher percent of surface water systems would have exceeded a finished water TOC MCL in the range of 2 mg/L to 3 mg/L, an equal percent of surface water systems and groundwater systems would have exceeded a finished water TOC MCL of 4 mg/L. It is important to note that very few groundwater systems are represented in these data and the data are likely biased by the fact these groundwater systems were reporting TOC data.

Figure 5 Cumulative distributions of average monthly finished water TOC RAAs for each PWS with available SYR4 data (2012-2019) by system size (on left) and primary source water type (on right)



TOC Removal Survey and Technical Discussions

Overview

Following the assessment of national data, a survey was developed to gather more information from systems regarding their compliance with the Stage 1 DBPR enhanced coagulation/ enhanced softening TT. The survey (Appendix A) asks about sources of water, source water TOC and alkalinity levels, treatment processes, typical percent TOC removal achieved, finished water TOC levels, disinfectant residual type, environmental justice status, and if a contact from the system is willing to participate in a follow up technical discussion. The objective for the survey was to receive feedback from a representative sample of drinking water systems across the country, while also targeting feedback specifically from systems that are challenged to meet current or potential future TOC removal requirements.

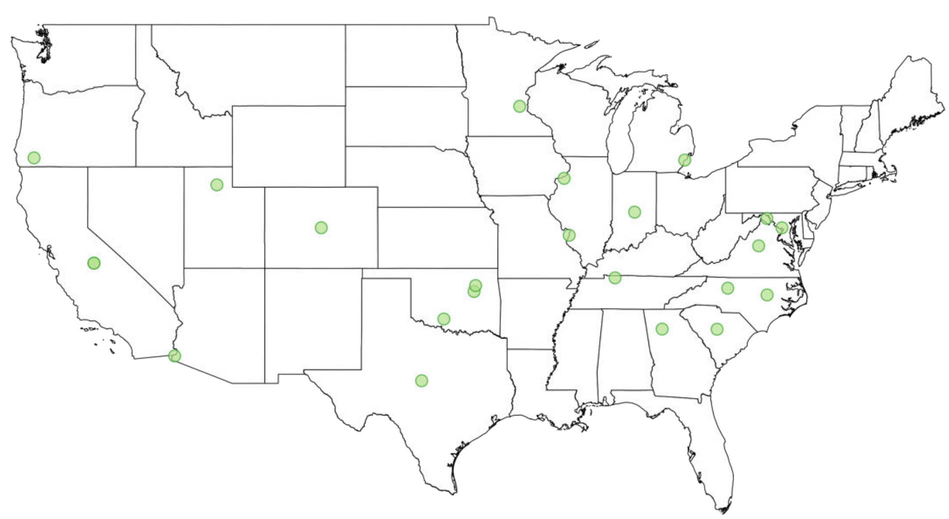
A list of target systems was developed using the outcomes of the national SYR4 data assessment. The target systems were identified as having at least one month not meeting the TOC removal ratio RAA based on the Step 1 3x3 matrix. Publicly available contact information, including a contact name and email address, for each target system was gathered from SDWIS, where available. It is understood that contact information in SDWIS may be out of date, but no other publicly available national database containing PWS contact information has been identified. A request for completing the survey with a link to the survey was emailed to all available contacts for the target systems by American Water Works Association (AWWA) Regulatory Technical Manager Chris Moody on April 18, 2024. To solicit responses from the water utility community at large, the Water Insider email sent out by AWWA Public Affairs on May 10, 2024 includes a section describing the survey and its purpose along with a link to the survey.

The survey received twenty-three completed responses. Twenty of the 23 respondents indicated that they were willing to participate in a follow-up technical discussion. The nineteen respondents that submitted their survey response by May 24, 2024 and indicated that were willing to participate in a follow-up technical discussion were contacted to schedule a follow-up discussion. Technical discussions were held with eleven utilities and completed on June 7, 2024.

Survey Respondents and Results

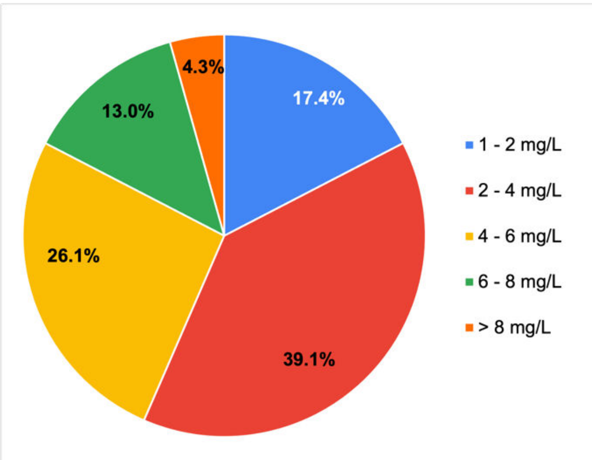
The systems that responded to the survey are all surface water systems, relatively well distributed geographically across the country. The 23 systems are located in 8 of the 10 EPA Regions (only Regions 1 and 2 were not represented) and 19 of the 50 US states. Approximate locations of the respondents are shown in Figure 6. Four of the systems are strictly wholesalers with a service population of zero, one system is a small system (serving greater than 500 and less than or equal to 3,300), five systems are large (serving greater than 10,000 and less than or equal to 100,000), and thirteen systems are very large (serving more than 100,000). All systems that completed the survey are surface water systems, and they all identified a surface water source as their most controlling source in terms of TOC removal requirements.

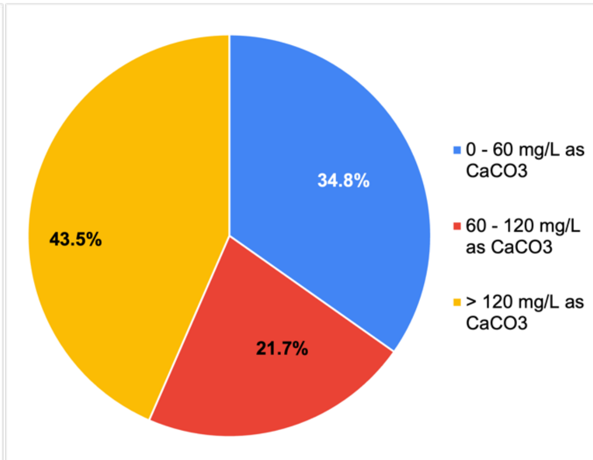
Figure 6 Map showing approximate locations of utilities that responded to the TOC Removal Survey



For the most controlling source for each of the responding systems, average source water TOC levels ranged from less than 2 mg/L to above 8 mg/L. Approximately 65% of the systems have an average source water TOC between 2 to 6 mg/L. Average source water alkalinities ranged from less than 60 mg/L as $CaCO_3$ to above 120 mg/L as $CaCO_3$ across these systems.

Figure 7 Pie charts showing average source water quality for survey respondents. Average source water TOC shown on the left and average source water alkalinity on the right.



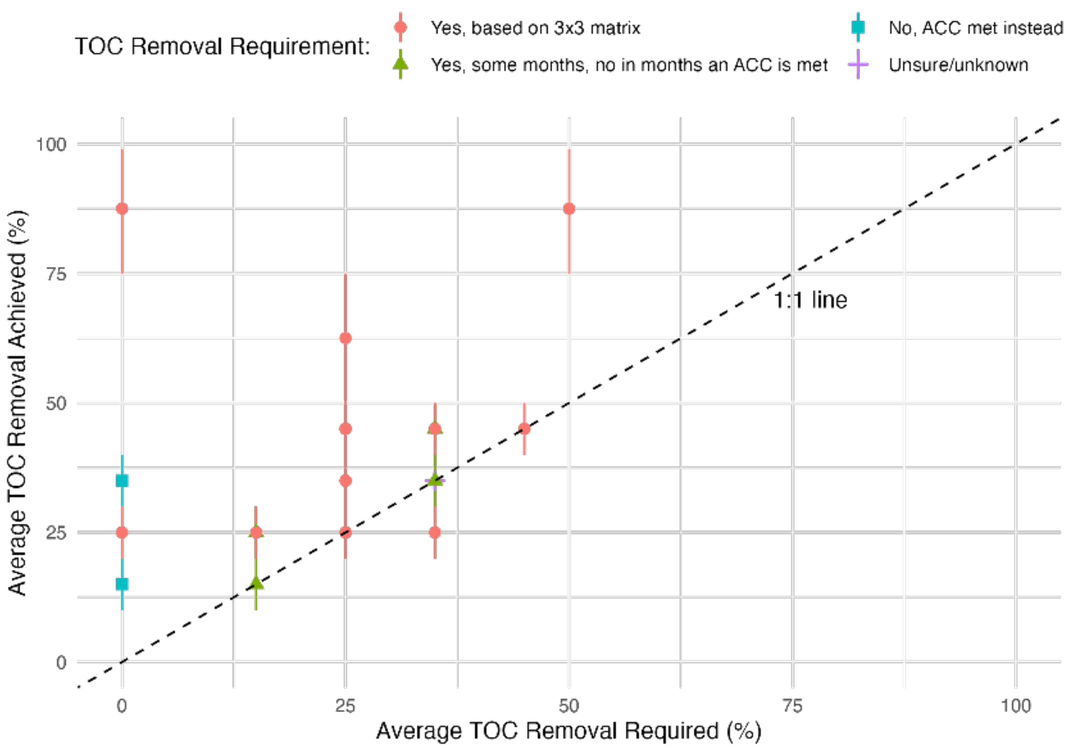


Based on the reported average source water TOC and alkalinity ranges, an average percent TOC removal requirement was assigned to each survey respondent's most controlling source water based on the 3x3 matrix requirement. The percent of survey respondents that fell into each removal requirement category is shown in Table 5. The table is color-coded where the shades of green are increasingly darker for a higher percent of respondents. Thirty percent of respondents are required to remove 25% of their source water TOC; for all systems except one this was based on source water alkalinity greater than 120 mg/L as $CaCO_3$ and source water TOC between 4 mg/L and 8 mg/L. Four survey respondents (17.4%) reported an average source water TOC level below 2 mg/L, so these systems are not required to remove a certain percent TOC.

Table 5 Percent of survey respondents based on their average TOC removal requirement in the enhanced coagulation 3x3 matrix

Source Water TOC (mg/L)	Source Water Alkalinity, mg/L as $CaCO_3$		
	0 - 60	> 60 - 120	> 120
> 2.0 to 4.0	35% removal required 17.4% of respondents	25% removal required 4.4% of respondents	15% removal required 17.4% of respondents
> 4.0 to 8.0	45% removal required 4.4% of respondents	35% removal required 8.7% of respondents	25% removal required 26% of respondents
> 8.0	50% removal required 4.4% of respondents	40% removal required 0% of respondents	30% removal required 0% of respondents

Figure 8 Scatterplot showing average TOC removal required versus achieved for survey respondents



The average percent TOC removal required for each respondent's most controlling source was then compared to the average range of TOC removal achieved as reported by each respondent (Figure 8). The range of TOC removal is indicated by a vertical line and the midpoint of the range is shown as a point in the figure. The results are grouped based on each respondent's response to whether they were required to meet a TOC removal requirement. A 1:1 line is included in the figure for reference to determine when systems are meeting a higher TOC removal than required versus a lower TOC removal than required. More than half of the respondents exceed their required TOC removal requirement by less than 15%, with over 12% of systems achieving their exact required removal plus or minus 5%. The results suggest that these systems would need to increase their TOC removal to meet compliance if the EPA was to increase the TOC removal requirements. Four systems indicated that they have source water TOC levels below 2 mg/L, which should exclude them from a required TOC removal according to ACC 1. Two of the 4 systems identified that they do in fact meet an ACC, while the other two indicated that they are required meet a percent TOC removal based on the 3x3 matrix. It is unclear why these systems would not qualify for ACC 1.

Average finished water TOC levels among the survey respondents ranged from 0.5 – 1 mg/L up to 4 – 6 mg/L, with no systems reporting finished water TOC levels above 6 mg/L. Approximately half of the respondents have typical finished water TOC levels between 2 to 3 mg/L, with 70% of systems reporting finished water TOC levels above 2 mg/L. The relationship between reported average finished water TOC concentrations for each system's most controlling source and available DBP data in the SYR4 data set were investigated. TTHM and HAA5 data were available for 18 of the 23 survey respondents. Data collected directly from state regulatory agencies were used to supplement the SYR4 data. The state data included TTHM data for an additional 2 survey respondents and HAA5 data for an additional 3 survey respondents. Figure 10 and Figure 11 show the distribution of TTHM and HAA5 data, respectively, as boxplots grouped by the reported average finished water TOC level for each system's most controlling source.

Figure 9 Pie chart of average finished water TOC levels for survey respondents

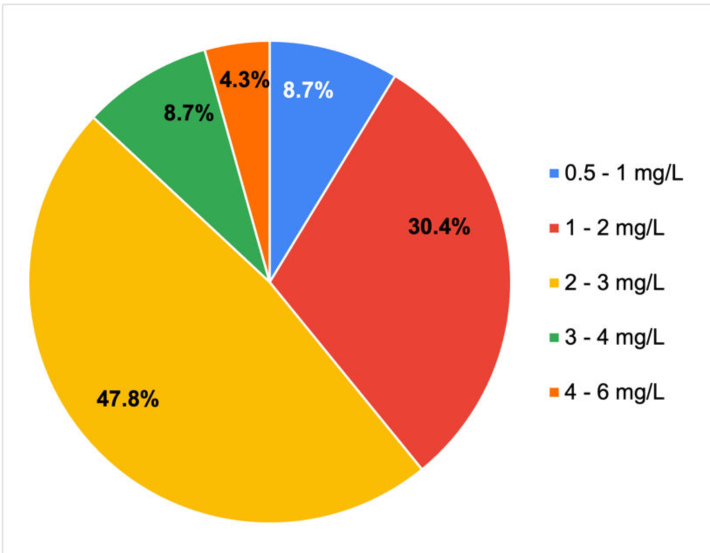


Figure 10 Boxplots of TTHM concentration data in the SYR4 data set (2012-2019) for survey respondents grouped by average finished water TOC levels. A legend describing the boxplots is shown on the right.

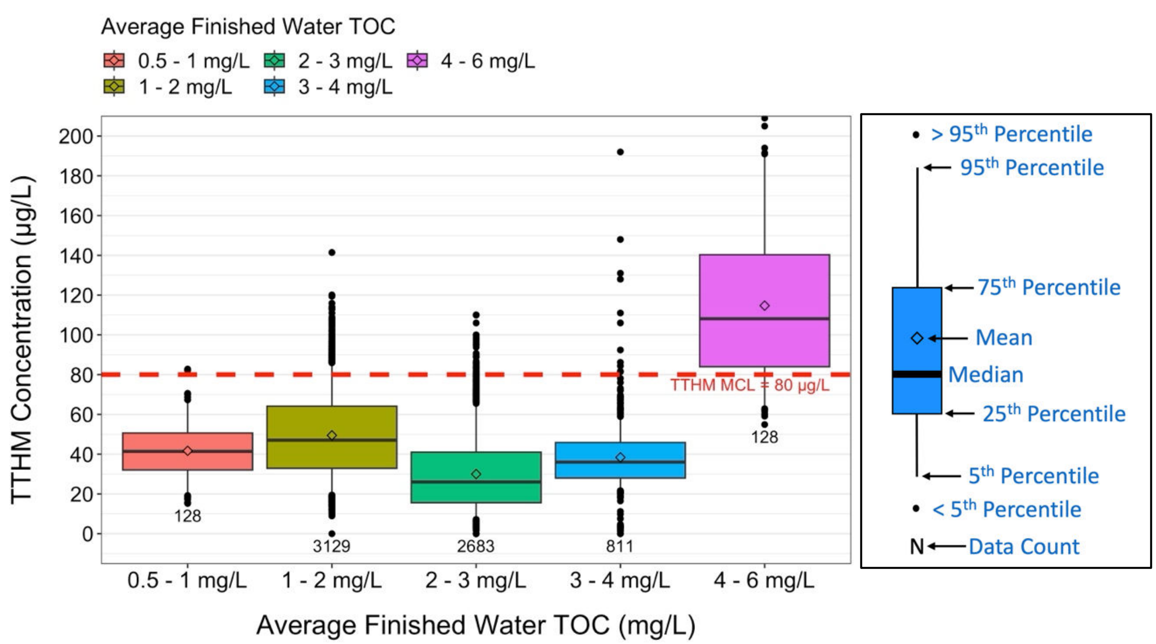
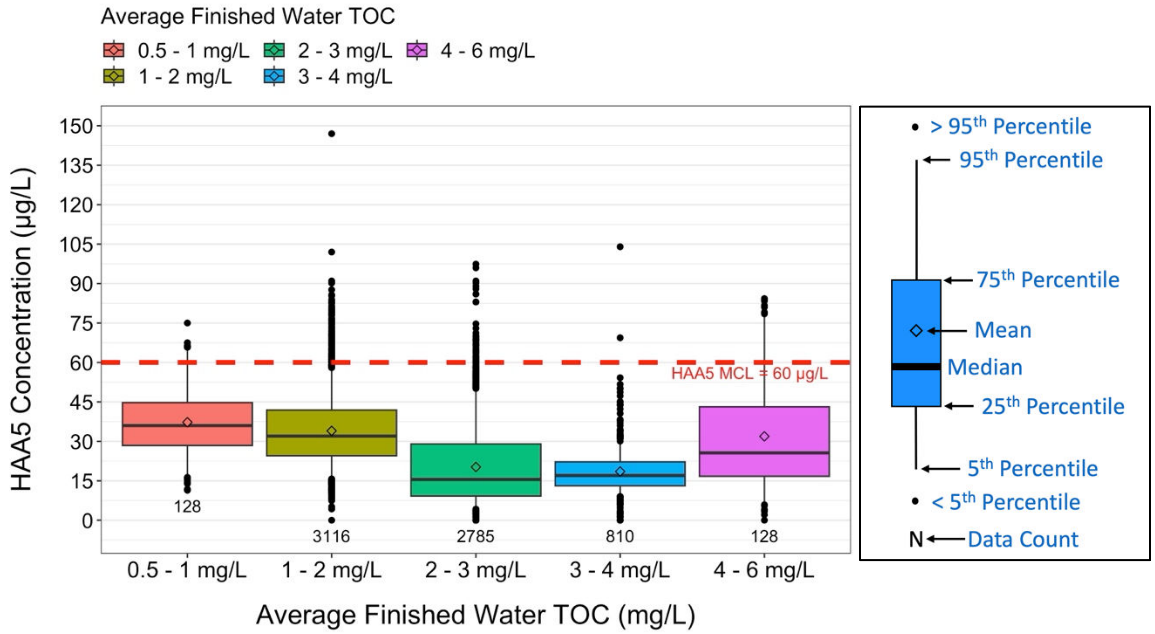
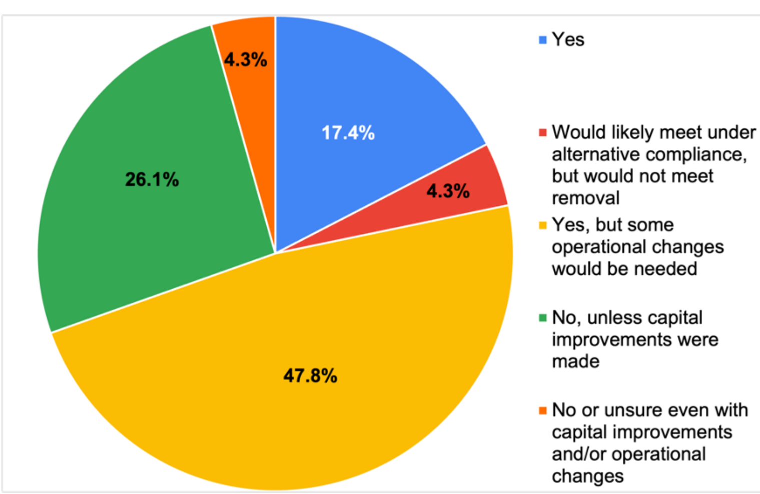


Figure 11 Boxplots of HAA5 concentration data in the SYR4 data set (2012-2019) for survey respondents grouped by average finished water TOC levels. A legend describing the boxplots is shown on the right.



For the 18 systems included in the analysis, finished water TOC levels less than 4 mg/L do not appear to have a strong correlation with the system's TTHM or HAA5 levels. There are many factors that are not considered in this analysis, such as how many other sources of water a system has available or how their distribution system and water age are managed. The one system that reported finished water TOC levels over 4 mg/L has historically high DBP levels, especially TTHM levels.

Figure 12 Pie chart showing if survey respondents felt they would be able to meet regulations requiring either a higher percent TOC removal in the range of 5-15% or a finished water TOC MCL in the range of 2-4 mg/L



The survey asked systems if they would be able to meet regulations requiring either a higher percent TOC removal, in the range of 5-15%, or a finished water TOC MCL, in the range of 2-4 mg/L. Responses are summarized in Figure 12. Less than 25% of the respondents felt that they would be able to meet increased requirements based on their current treatment and operations as well as the ACC. Approximately half of the respondents identified that operational changes would be needed, and 30% of respondents answered that they would need capital improvements to comply. One system responded that they still might not be able to comply even with capital improvements. Another system responded that they would be able to comply with a finished water TOC MCL in the range of 2-4 mg/L, but they would not be able to meet an increased percent TOC removal requirement due to low levels of TOC that is not amenable to removal. Capital improvements can be a substantial, and in some cases unsurmountable, financial burden on a system. Even changes in operations can represent a challenging hurdle based on both budget and resources available. One-third of respondents identified as serving an environmental justice community, while another third responded that they were unsure if they served an environmental justice community. If environmental justice status is based on economic indicators, i.e., median household income, water affordability can become a serious concern if capital improvements and/or operational changes are necessary for a water system to meet compliance.

Follow-up Technical Discussions

Follow-up technical discussions were conducted with 11 utility contacts following their completion of the TOC Removal Survey. The conversations covered such topics as sources of water and source water quality, treatment plants and their processes, disinfection practices, TOC removal required and/or alternative compliance, TOC removal achieved and challenges, distribution system DBP and residual levels. The conversations brought into question the intended outcomes for a potentially more stringent TOC removal requirement and/or TOC MCL and the cost at which these outcomes could be achieved. More specifically, different utilities must take different approaches to most effectively meet one single objective. Furthermore, current TOC removal requirements apply to conventional surface water treatment plants. Water treatment plants that include ultrafiltration (UF) or direct filtration plants are not required to meet the enhanced coagulation requirements, although in several instances, utility contacts pointed out these treatment plants may have the highest DBP levels leaving the plant.

The MDBP Working Group recommendation suggest a water evaluation screening to identify systems with a higher risk of DBP formation and for those systems identified, consider additional monitoring, establishing a performance requirement, and a determination of how these systems “must operate” to meet the TT performance requirement. The responsibilities for these screenings, if included in future MDBP rule revisions, would likely fall upon state regulatory agencies. While a collaborative partnership between the state and utilities that need support in meeting current TOC removal requirements, minimum disinfectant residual levels, and DBP regulations could be extremely beneficial, states need the resources to work with these systems, especially on an individual level as needed. Recommendation 11 from the NDWAC MDBP Working Group Report addresses this by recommending to EPA that they “address SDWA Primacy Agency capacity needs associated with the new demands anticipated from MDBP rule revisions”. There are examples of successful state support bringing systems into compliance with MDBP challenges, i.e., via Area-Wide Optimization Program (AWOP). On the other hand, universal rules applied based on parameters such as TOC, alkalinity, and DBP concentrations do not account for the wide range of organic matter characteristics and other source water quality conditions that impact TOC removal. An important question is whether the TOC removal requirement is intended to control regulated parameters DBPs or if it is to control unregulated and even unknown DBPs. If the focus is on regulated DBPs, as well as reducing chlorine demand, it can be argued that the regulatory construct should focus on DBP and chlorine levels in the distribution system and allow systems to meet those regulations through processes optimized for their system. If the focus is on unregulated or unknown DBPs, it can be argued that there is no sufficient evidence that real health benefits will be realized. The follow-up discussions illustrated many different water qualities, challenges, and approaches for meeting regulatory compliance. Most utilities voiced concerns about increased requirement for precursor removal that may provide no real health benefits but would lead to significant cost burdens. The discussions further demonstrated how there is no universal approach, i.e., increased percent TOC removal requirement or a finished water TOC MCL, that will accomplish the same goal for all drinking water systems.

Table 6 provides a summary of the follow-up discussions with the 11 utilities, including their sources of water, how the comply with the Stage 1 DBPR enhanced coagulation TT requirement, their biggest challenges in meeting compliance with enhanced coagulation and other MDBP rules, and anticipated actions that would be needed to comply if TOC removal requirements were increased in future MDBP rule revisions. More detailed summaries for each participating utility follows the table.

Table 6 Summary of TOC Removal Survey follow-up discussions

Utility	Sources / Source Water Quality	Enhanced Coagulation/ Precursor Control Compliance Method	Biggest Challenges	If Future Regulations Require Increased TOC Removal…
City of Thornton, CO	South Platte River and Lower Clear Creek via the West Gravel Lakes – lower TOC Upper Clear Creek via Standley Lake South Platte River via East Gravel Lakes – wastewater plant effluent impacts	Wes Brown Plant – UF membranes – no TOC removal required Thornton Plant – meet 3x3 matrix removal requirement with conventional treatment and activated carbon biofilters	Concerns if TOC removal requirement went up to 50%; lake turnover can upset activated carbon biofilters	Comfortable with current treatment process unless requirement increases to 50% TOC removal – operational changes would be need
City of Minneapolis, MN	Mississippi River: high, flashy TOC, spikes from rain events, correlates well with UV254, almost all dissolved (DOC ≈ TOC), high alkalinity but drops during spring runoff	UF membranes at one plant – no TOC removal required Conventional treatment with lime softening at second plant to meet 3x3 matrix removal requirement	No concerns regarding MDBP rule revisions as long as utilities are able to treat as needed	Continued operation or potentially adjust operations as needed
City of Columbia/ Columbia Water, SC	Lake Murray Broad River Canal – flashy turbidity and TOC, high spikes from rain events	Conventional surface water treatment with aluminum sulfate coagulant, seasonal use of polymer and flocculation aid to meet 3x3 matrix removal requirement	During turbidity events, TOC can be more difficult to remove and DBPs can be an issue; seasonal challenges for disinfectant residuals during times of high chlorine demand and high temperature; challenging to meet requirements based on recent rain events	Optimizing and adjusting operations to meet increased TOC removal levels would be increasingly more challenging, especially with rain events that negatively impact source water alkalinity. Managing chlorine demand while minimizing DBP formation potential will also be challenging.

Utility	Sources / Source Water Quality	Enhanced Coagulation/ Precursor Control Compliance Method	Biggest Challenges	If Future Regulations Require Increased TOC Removal…
City of Clarksville, TN	Cumberland River – low TOC, moderate alkalinity	Conventional surface water treatment with ACH, membrane filtration to meet 3x3 matrix removal requirement	Meeting TOC removal due to low levels of TOC that is not amenable to removal	Optimize operations or pursue compliance with ACC
East Bay Municipal Utility District, CA	Mokelumne River via reservoirs – moderate levels of TOC and alkalinity	Direct filtration plants – exempt from TOC removal requirement Conventional surface water treatment plants – meet 3x3 matrix removal requirement	Distribution reservoirs are oversized and not in ideal locations, need to cycle reservoirs for control DBP formation, disinfectant residuals, and fight nitrification	Increased TOC removal requirements could result in capital improvements and would not be useful – it would be more productive to alter DBP MCLs/disinfectant residual requirements and allow utility to figure out how to comply
Water System 1 (chose to remain anonymous)	Two large turbid rivers subject to significant swings in water quality due to rainstorm events and drought	Some months meet ACC (treated water TOC <2 mg/L); some months meet 3x3 matrix removal requirement with conventional treatment (with ferric sulfate coagulant and polymer) and lime softening	TOC difficult to remove, especially when TOC levels are low; experience issues with nitrification; alkalinity impacted by storm and drought events affecting pH control	If a higher percent TOC removal was required, different treatment process and capital improvements could be needed
Water System 2 (chose to remain anonymous)	River source – flashier TOC impacted by rain/runoff events, moderate alkalinity levels Reservoir fed by a river – impacted by biological growth and algal blooms, lower TOC levels, low alkalinity	Some months meet ACC (treated water TOC <2 mg/L); some months meet 3x3 matrix removal requirements with conventional treatment	Maintaining DBP LRAAs at 80% of MCL; building water systems not well managed that impact total coliform rule (TCR) monitoring locations	Increased TOC removal requirements would force capital improvement evaluations

Utility	Sources / Source Water Quality	Enhanced Coagulation/ Precursor Control Compliance Method	Biggest Challenges	If Future Regulations Require Increased TOC Removal…
City of Yuma (Yuma), AZ	Colorado River – low TOC, high alkalinity	Some months meet ACC (raw water <2 mg/L or SUVA ≤2.0 L/mg-m), some months meet 3x3 matrix removal requirement with conventional treatment	Challenges with DBPs, low disinfectant residual levels in some areas, water age especially during times of low demand that occur during the hottest time of the year; water conservation efforts limit flushing abilities	Concerns for changes in regulation, would require change in treatment process/ capital improvements
Duncan Public Utilities Authority (Duncan), OK	Fuqua Lake – high TOC, amenable to remove Humphreys Lake – highest TOC, most amenable to remove Waurika Lake – most voluminous, useful for droughts, lowest TOC but most difficult to remove	Meet 3x3 matrix removal requirement with conventional treatment; violation received in 2024 for noncompliance	Challenges removing TOC and meeting removal requirement, higher TOC in last few years, high DBP levels in distribution system, challenge with meeting DBP regulations	Challenges with noncompliance with current regulations, more stringent regulations require TOC removal optimization and likely capital improvements
Cobb County – Marietta Water Authority (CCMWA)	Chattahoochee River – low TOC but spikes with rain events, Lake Allatoona – seasonally impacted by biological growth and algal blooms	Some months meet ACC (treated water <2.0 mg/L), some months meet 3x3 matrix removal requirement with conventional surface water treatment and GAC	Support customer systems that have older areas of their system and dead ends that must flush to manage DBPs	Would rely more heavily on GAC
Helix Water District (Helix)	Colorado River and California State Water Project blend purchased from Metropolitan Water District Local water resources supplement purchased water – higher TOC, easier to remove	Some months meet ACC (raw water SUVA ≤2.0 L/mg-m or TOC <4, alkalinity > 60 mg/L as $CaCO_3$, TTHM < 40 µg/L and HAA5 < 30 µg/L), some months meet 3x3 matrix removal requirement with conventional treatment and ozone	Purchase most of their water from Metropolitan Water District, blend of water changes and they don't have any control – must treat varying source water quality; high water rates	Would likely meet ACC if still an option under rule revisions, but would not meet increased percent TOC removal – would need capital improvements

Based on the discussions, these 11 utilities were divided into several groups:

Group 1: Capacity for additional TOC removal and/or meeting a TOC MCL

Four utilities were grouped together based on their capacity to meet current and future MDBP regulations, i.e., the enhanced coagulation requirements. These utilities include the City of Thornton (Thornton) in Colorado, the City of Minneapolis (Minneapolis) in Minnesota, and City of Columbia (Columbia), South Carolina, and Clarksville Water System (Clarksville) in Clarksville, Tennessee.

Thornton treats water from the South Platte River and Lower Clear Creek via the West Gravel Lakes at their Wes Brown water treatment plant (WTP) and water from Upper Clear Creek via Standley Lake and the South Platte River via East Gravel Lakes at the Thornton WTP. The Wes Brown WTP includes UF membranes, so this WTP does not need to meet TOC removal requirements. Average source water TOC levels at the Thornton WTP are in the range of 4-6 mg/L with spikes or extended periods with levels above 6 mg/L. Alkalinity levels typically greater than 120 mg/L as $CaCO_3$. The Thornton WTP includes conventional treatment followed by ozonation, activated carbon biofilters, and then sand filtration, disinfection, and distribution. Based on the enhanced coagulation 3x3 matrix, the Thornton WTP is typically required to meet 25-35% removal and achieves 40-50% removal. Finished water TOC concentrations for the Thornton WTP range between 1.0 – 3.5 mg/L. Thornton uses chloramines for a secondary disinfection residual with an average total chlorine residual level of 2.38 mg/L and minimum measured level of 0.55 mg/L[2]. Regulated DBPs are well-maintained with TTHM locational running annual averages (LRAAs) between 32.9 – 40.9 µg/L and HAA5 LRAAs between 7.1 – 10.0 µg/L. Based on current operation the City of Thornton would likely be capable of meeting increased TOC removal requirements up to 40% without significantly altering their operations. The plant could be challenged by a finished water TOC MCL in the range of 2 -3 mg/L or a TOC removal requirement of up to 50%. Thornton plans to install PFAS removal treatment in the near future, which may improve TOC removal, and future plans for treating water from the Poudre River may also impact TOC removal. Since regulated DBPs are already low and disinfectant residuals are well-maintained, increased precursor removal would likely not achieve its objective unless the goal was specific to unregulated or unknown DBPs for which data are not available.

Minneapolis treats water from the Mississippi River with high organic levels. The source water TOC concentrations are typically in the range of 7 mg/L but can spike up to 20 mg/L with rain events. There are two WTPs, one of which has UF membranes and does not need to meet a TOC removal requirement and one of which uses conventional treatment. Excess lime softening is used to reduce the high levels of organic material. Required TOC removal is typically in the range of 25-30%, due to source water alkalinity greater than 120 mg/L, and typically 50-70% removal is achieved with approximately an average of 60% removal[3]. In the spring during runoff events, alkalinity drops to around 100 mg/L as $CaCO_3$ and Minneapolis relies on their polymer for organics removal due to less effective softening. Minneapolis has also found a strong correlation between their TOC and UV254, allowing them to set goals for UV254 levels, which can be faster and easy to measure. Chloramines are used for a secondary disinfectant residual and maintains distribution system residual levels above 2.5 mg/L. Flushing is

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[2] City of Thornton. 2024 Water Quality Report: Covering Data for Calendar Year 2023. https://www.thorntonco.gov/media/file/water-quality-report-2024.

[3] Minneapolis Public Works. 2023 Water Quality Report. https://www2.minneapolismn.gov/media/content-assets/www2-documents/residents/2023-CCR-FINAL.pdf

conducted if residual levels are found to be lower than 2.5 mg/L. Regulated DBP levels are low with TTHM levels in the range of 8.7 µg/L to 42.6 µg/L with an average of 32.9 µg/L and HAA5 levels in the range of 1.5 µg/L to 29.3 µg/L with an average of 23.5 µg/L in 2023. Minneapolis has capacity to meet higher TOC removal requirements, comfortably up to 45-50%, but a finished water TOC MCL less than 4 mg/L could present some challenge based on current operation. The same conclusion that was made for Thornton applies here; since regulated DBPs are already low and disinfectant residuals are well-maintained, increased precursor removal would likely not achieve its objective unless the goal was specific to unregulated or unknown DBPs for which data are not available.

Colombia operates two surface WTP, one which treats Lake Murray water and one which treats Broad River Canal water. The canal is subject to higher turbidity and TOC variability caused by rain events. Typical source water TOC levels are in the range of 3-5 mg/L but can spike up to 10-15 mg/L. Source water alkalinity levels are low, typically in the 15-35 mg/L as $CaCO_3$ with an average of approximately 25 mg/L as $CaCO_3$. Based on source water TOC and alkalinity, typical TOC removal requirements are 35-45%. The WTPs use conventional treatment with an aluminum sulfate coagulant and seasonal use of polymer and flocculation aid. Generally, the plants get more TOC removal than required, although TOC can be more difficult to remove during turbidity events in the canal requiring adjustments to the sodium hydroxide and coagulant dose. In the distribution system, chloramines are used to maintain a disinfectant residual. Detected chloramine levels in 2023 ranged from 0.01 to 4.3 mg/L[4] showing challenges in maintaining the residual throughout the distribution system especially in high temperatures and events with high chlorine demand. DBPs meet regulatory compliance with average LRAAs in 2023 for 37 µg/L for TTHM and 33 µg/L for HAA5, but HAA5 levels were detected as high as 86 µg/L showing a greater challenge with HAAs than TTHM. If future regulations were to require more TOC removal, Colombia may be able to comply based on operational adjustments alone, and increased TOC removal could help to lower DBP levels and chlorine demand. In this case, the objectives for revisions to the precursor removal requirement may be achieved.

Clarksville treats Cumberland River water using conventional surface water treatment followed by membrane filtration. Currently, there is one active WTP, the South Clarksville WTP, although the North Clarksville WTP is anticipated to be operational by 2026. The river has low TOC and moderate levels of alkalinity, with reported source water TOC levels typically less than 2 mg/L (average source water TOC from UCMR4 was 1.8 mg/L), and source water alkalinity levels are between 90– 120 mg/L as $CaCO_3$. It is unclear why Clarksville does not typically qualify for an ACC based on an average source water or treated water TOC less than 2 mg/L. Contacts indicated they are required to remove 25% TOC and this TOC removal is challenging when source water levels are so low. While the system will be able to comply if a finished water TOC MCL is set in the range of 2-4 mg/L, it would be challenging to meet a higher percent TOC removal requirement. The system uses free chlorine for secondary disinfection and maintain the residual throughout the system with the lowest detected chlorine level in 2023 equal to 0.8 mg/L. Clarksville implements flushing to maintain their residual, and they have also conducted a water age study and identified areas in their distribution systems with dead ends and low usage. They also comply with DBP MCLs, with average LRAAs in 2023 of 53 µg/L for TTHM and 39 µg/L for HAA5[5].

[4] Columbia Water. City of Columbia 2023 Water Quality Report. https://issuu.com/columbiascwater/docs/2023_columbia_water_consumer_confidence_report.

[5] City of Clarksville. Annual Drinking Water Quality Report. https://www.clarksvilletn.gov/ArchiveCenter/ViewFile/Item/1184.

Detected TTHM and HAA5 levels reach 81 µg/L and 57 µg/L, respectively. If MDBP rule revisions include increased TOC removal requirements, Clarksville may need to further optimize their operations or pursue ACC options. If optimized operations are able to achieve increased TOC removal, it is possible that Clarksville may also achieve some decrease in regulated DBPs levels as well.

Group 2: Capital improvements needed for additional TOC removal and/or meeting a TOC MCL

Five utilities were grouped together based on their capacity to meet current and future MDBP regulations, i.e., the enhanced coagulation requirements. These utilities include East Bay Municipal Utility District (MUD), the City of Yuma (Yuma), Arizona, Duncan Public Utilities Authority (Duncan) in Duncan, Oklahoma, and two utilities that wish to remain anonymous – Water System 1 and Water System 2.

East Bay MUD serves over a million people in Alameda and Contra Costa Counties in California, with roughly 90% of its water coming from the Mokelumne River. Some Mokelumne River water is stored in local reservoirs before treatment, and these local reservoir also capture local runoff. The utility operates six WTPs, half of which are direct filtration plants that are not required to meet a TOC removal requirement and half are conventional surface water treatment plants which are subject to the requirement. Source water TOC levels after local reservoir storage are typically in the range of 4-6 mg/L and source water alkalinity levels are typically in the 60-120 mg/L as CaCO3 range, often resulting in a required TOC removal of 35%. Some months the conventional WTPs meet the TOC removal required by the 3x3 matrix, but other months they may use an alternate method of compliance, including the Step 2 performance criteria jar testing, due to challenges with removing TOC. East Bay MUD uses chloramine for secondary disinfection and have well controlled DBP levels in the distribution system. The highest TTHM levels detected in 2023 were found in areas of the distribution system served by direct filtration plants, which are not required to meet the enhanced coagulation rule. DBPs have been found to be more strongly correlated with contact time with free chlorine, as opposed to TOC levels. Additionally, both DBPs and disinfectant residual level maintenance are challenged by the system's distribution system reservoirs being oversized and not in effective locations. East Bay MUD exercises several approaches to control DBP formation, i.e., addressing water age through actions such as cycling reservoirs, and can lower pH through the conventional WTPs if needed. The utility can use these alternative controls, which are less costly than increased TOC removal, to limit DBP formation. If increased TOC removal requirements are to be included in MDBP rule revisions, East Bay MUD may be forced to implement capital improvements which would have significant cost consequences. They do serve environmental justice communities, specifically defined in California as disadvantaged communities (DAC), which could be impacted by the need for capital improvements. If instead of requiring increased TOC removal, other objectives or requirements were provided to utilities (i.e., different DBP regulations, disinfectant residual requirements), the utility could determine the most effective way of meeting these objectives which is unlikely to be increasing TOC removal.

Water System 1 treats water from two large turbid rivers at two conventional surface WTPs. Source water TOC levels are typically in the range of 2-5 mg/L and source water alkalinity is typically greater than 120 mg/L as $CaCO_3$. The source waters are subject to large swings in water quality and source water TOC levels are impacted by rain, floods, and drought. At the time of the discussion, TOC levels were described higher than normal due to drought conditions following a flood stage. Alkalinity is also affected by storm and drought conditions. During flood events, alkalinity drops affecting pH buffering capacity and coagulation conditions. Both WTPs are required to remove 15% TOC based on the enhanced coagulation 3x3 matrix and the annual average percent removal has been in the range of 25-30% over the last ten years, with approximately 25% removal in the last two years. Ferric sulfate and polymer are used for TOC removal along with lime softening. The system has found that the coagulants don't work as well in the winter, while the lime softening has been the most cost effective for TOC removal. Echoing challenges described by Clarksville, Water System 1 has the most concern with meeting TOC removal requirements when source water TOC levels are the lowest. In the distribution system, Water System 1 maintains a disinfectant residual with chloramines, which are well maintained with a detected range of 2.4 – 3.2 mg/L in 2023. Regulated DBP levels are low in the distribution system, with a maximum measured TTHM concentration of 25.6 µg/L and maximum HAA5 concentration of 34.1 µg/L. DBPs can actually be higher in the winter due to longer free chlorine contact time to meet CT requirements, leading to greater DBP formation. The system does have wholesale customers, and the connection to one of these customers is located within a quarter mile from one of the WTPs so this wholesale customer receives water with lower DBPs and higher disinfectant residuals than the population Water System 1 serves directly. The city served by the system has decreased in population over time leaving the system oversized for its current operations. Though the cause is different, the challenge of an oversized system has similar consequences for managing MDBP parameters as those that East Bay MUD faces with oversized reservoirs. To combat nitrification and water age challenges, the system monitors nitrate weekly and more frequently in the summer, proactively flushes, and cycles reservoirs. They do not implement free chlorine periods as many chloramine systems do and have not had microbial issues. In terms of current regulations, the system meets all regulations with for DBPs, disinfectant residuals, and microbiology. While the system does typically exceed the required TOC removal requirement, there is concern about meeting any increased requirement because of challenges when source water TOC levels are low, and therefore feel that capital improvements would be necessary if the requirements became more stringent. This would be a significant cost burden for a system with well-maintained disinfectant residuals and low regulated DBPs.

Water System 2 is a very large system serving over a million people with water from two river sources. One WTP draws directly from the river, and second WTP draws water from two reservoirs served by the second river. Its larger WTP treats the river water and has enhanced coagulation abilities, i.e., can lower the pH, can switch to an alternate coagulant if needed. The WTP treating the reservoir water does not have these abilities. The reservoir typically has TOC levels in the range of 2-4.5 mg/L and alkalinity in the range of 20-35 mg/L as $CaCO_3$, typically requiring 35% TOC removal and sometimes up to 45% removal. TOC levels and organic characteristics are seasonally driven and impacted by algae growth. The river has TOC levels generally between 2-7 mg/L with spikes up to 10 mg/L caused by runoff events. The WTP that treats river water must typically remove 25-35% TOC. Some months, the WTPs may qualify for an ACC based on treated water TOC levels below 2 mg/L, while other months they meet the removal percents based on the 3x3 matrix. At the reservoir WTP, they generally remove 40-50% TOC, while the river WTP can see TOC removal between 10-80% due to the flashier nature of the river water. The system uses free chlorine for secondary disinfection and reported a range of 0.09 – 3.0 mg/L residual chlorine in their distribution system in 2023. DBPs are managed such that the LRAA levels do not exceed 80% of the MCLs. In 2023, TTHM samples ranged from 16-104 µg/L, with a maximum LRAA of 68 µg/L and HAA5 samples ranged from 19-62 µg/L with a maximum LRAA of 46 µg/L. Temperature is a controlling factor with DBP formation, and the highest DBP levels are observed in the warmest time of the year. Water System 2 would evaluate capital improvement alternatives if the future MDBP rule revisions required increased TOC removal, which could have a significant cost implication. The system does serve environmental justice communities that would be impacted by these costs. Water System 2 shared similar sentiments as East Bay MUD in its ability to meet distribution system objectives (i.e., DBPs levels, disinfectant residuals levels) through determine the most effective methods and brought up concerns with potentially being required to increase TOC removal or meet a TOC MCL, which may not achieve the intended health outcomes but will impose a great cost burden.

Yuma operates two WTPs and treats surface water from the Colorado River from two canal intakes. One WTP operates Zenon Pressure membrane UF and thus is not required to meet enhanced coagulation despite higher TTM levels leaving this plant. The second WTP uses conventional water treatment and is now required to meet TOC removal based on the 3x3 matrix. For a 17-year period, the system was given a waiver from the state based on low DBP levels but DBPs have increased in recent years and thus the waiver was revoked. The source water is high in alkalinity, roughly 140-150 mg/L as $CaCO_3$, and TOC is typically between 2-3 mg/L, requiring a 15% TOC removal. In some months, an ACC can be met due to raw water TOC less than 2 mg/L, and since 2022, Yuma collects SUVA data and can meet an ACC based on SUVA in some months. In the remaining months, Yuma is challenged with meeting the required TOC removal and has found some improved removal using an aluminum chlorohydrate (ACH) polymer. In the distribution system, Yuma maintains a free chlorine disinfectant residual with detected levels ranging from 0.01-1.01 mg/L in 2023[6]. DBP levels meet regulatory requirements with the highest LRAA for TTHM at 66 µg/L and for HAA5 at 14 µg/L. The summer months are the most challenging for distribution system management as much of the population travels during the hottest time of the year, decreasing water demand. Yuma relies on flushing to keep water moving and reduce water age, although they have reduced their flushing in recent years to meet water conservation goals. Increased TTHM levels have been observed since flushing has been decreased. Potential revisions to the MDBP rules that might include a required numeric minimum disinfectant residual level and increased TOC removal requirements would force Yuma to evaluate capital improvements to meet compliance.

Duncan has two side-by-side conventional treatment plants that treat surface water from three lakes, Fuqua, Humphreys, and Waurika, with the ability to pull from each source and blend as needed based on water quality and drought conditions. Humphreys has the highest TOC, followed by Fuqua, both of which are amenable to removal. Waurika is the most voluminous lake of the three, useful in drought conditions, and has the lowest level but most difficult to remove TOC. Since 2015, average influent TOC has been 5.8 mg/L, with a range of 4.6-10.2 mg/L. Since the start of 2023, influent TOC levels have been elevated, with an average of 6.7 mg/L, possibly due to drought conditions. Source water alkalinity is high, on average 160 mg/L as $CaCO_3$ and ranging between 120-220 mg/L as $CaCO_3$. Duncan is typically required to remove 25% TOC, and since 2020, only one month requiring 30% removal was an exception. Actual TOC removal achieved has ranged from 16% to 67% with an average removal of 30%. In 2024, Duncan received a TT violation for TOC removal due to the RAA of the removal ratio being less than 1. Finished water TOC levels ranged from 2.1-8.5 mg/L in samples collected since 2015 with an average of 4.0 mg/L, although since 2023, finished water TOC levels have averaged 5.0 mg/L. For disinfection, Duncan applies free chlorine for primary and uses chloramines to maintain a disinfectant residual in the distribution system. They conduct free chlorine conversion periods that vary seasonally and in length of

[6] City of Yuma. Water Quality Report 2023. https://www.yumaaz.gov/home/showpublisheddocument/8061/638491235520300000.

duration. TTHM concentrations in the distribution system since 2015 have ranged between 40-226 µg/L and LRAAs have ranged from 54-174 µg/L with an average of 98.6 µg/L. Duncan received MCL violations for TTHM in 2023 and in 2012-2020. Duncan received a MCL violation for HAA5 in 2016 and 2017, and available SYR4 data indicate a spike in HAA5 levels during those years followed by a subsequent decrease. The average reported HAA5 concentration in 2019 was 11 µg/L and Duncan reported HAA5 levels to now be below detection. Duncan is currently in need of an optimization study and operational adjustments to meet current Stage 1 and 2 DBPRs. They have worked with consultants to experiment with high levels of polymer to increase TOC removal and decrease TTHM but have not found a solution that works. The potential of a new MDBP rule that includes increased TOC removal requirements will further challenge their ability to meet compliance. It is unlikely they would comply with a more stringent regulation without serious changes including capital improvements.

Group 3: Perspectives from a Wholesaler and a Consecutive System

Cobb County – Marietta Water Authority (CCMWA) is a wholesale utility that treats surface water from the Chattahoochee River and Lake Allatoona, as well as groundwater from 2 wells. The Chattahoochee River has upstream wastewater treatment plants and turbidity and TOC spikes with rainstorm events. This water is treated at the Quarles WTP, where influent TOC levels are generally in the range of 2-2.5 mg/L. After conventional surface water treatment, the finished water TOC is roughly 0.9 mg/L, which qualifies this plant for ACC 2 based on treated water TOC less than 2.0 mg/L. Lake Allatoona is impacted by biological growth and algal blooms, especially in the summer, and high TOC events up 8 mg/L typically last a long time as compared to the flashy spikes seen in the river from rain events. Rain has little impact on the lake TOC levels. The Wyckoff WTP treats the lake water with an average source water TOC between 3-3.5 mg/L. This plant is required to meet 25% TOC removal and after conventional treatment, finished water TOC levels are typically 1.7-1.8 mg/L with high TTHM formation potential. In summer months, CCMWA operates GAC contactors at the Wyckoff WTP which further reduces TOC to 1.3-1.4 mg/L. The burden of Stage 2 DBPR compliance falls on their 11 customers systems, although CCMWA works with the customer systems and provides laboratory analysis and sampling. Customer systems that have high demand and manage water age effectively have no issues complying with DBP regulations. Other customer systems that have older areas of their distribution system with dead ends do have monitoring sites with high TTHM occurrence and must flush to meet compliance. If more stringent requirements for TOC removal were included in future MDBP rule revisions CCMWA would take steps to optimize operations and increase the use of their GAC contactors.

Helix Water District (Helix) purchases roughly 80% of its water from Metropolitan Water District of Southern California (MWD) and supplies additional water from local water resources. The purchased water sources include the Colorado River and the California State Water Project (SWP) that includes a collection of canals, pipelines, and reservoirs. The blend of source water provided by the MWD changes constantly based on rainfall and allocations outside of Helix's control. The Colorado River water has lower TOC and higher alkalinity compared to the SWP water and is less amenable to TOC removal. Helix is usually able to comply with enhanced coagulation via ACC 5, which specifies that the RAA of source water SUVA prior to any treatment is $\leq$2.0 L/mg-m. In the case of Helix, the use of ACC 5 is based on a state approval caveat. Due to concerns regarding quagga mussels, MWD applies chlorine to the water ahead of it reaching Helix's system. The state and EPA Region 9 allows compliance with ACC 5 as long as the chlorine residual is less than 0.5 mg/L. In other months, Helix qualifies for ACC 3 based on source water TOC <4.0 mg/L, source water alkalinity is >60 mg/L as $CaCO_3$, TTHM < 40 µg/L, and HAA5 < 30 µg/L or the Step 2 performance criteria based on performing jar tests to identify points of diminishing return. In some months when local water resources are used to supplement the purchased supply, Helix does have a required percent TOC removal, often 35%, but the local water is also amenable to TOC removal and Helix can remove the required percent. To enable the juggling act of constantly changing source water quality and compliance mechanisms, Helix collects and tracks all relevant data and uses the data effectively to inform compliance strategies. In the distribution system, DBPs are generally low with TTHM levels of 20 µg/L and HAA5 levels of 10 µg/L on average. Chloramines are used to maintain disinfectant residual levels with a tight range of 1.8-2.4 mg/L detected in the distribution system in 2023[7]. While Helix meets current regulatory compliance comfortably, they do not control their sources of water and must make the best of the water quality available to them. They have also noticed a big reduction in water demand due to conservation efforts which has led to higher water age in their system. If regulations became more stringent, Helix could meet compliance, but if operational adjustments are needed to do so it would come at a cost. Southern California has some of the highest water rates in the country and Helix serves environmental justice communities that would be impacted. Since DBP levels are already low and disinfectant residuals are well maintained, it is not clear what goal increased precursor reduction would meet.

[7] Helix Water District. Water Quality Report: Calendar Year 2023 Water Quality Data. Published June 2024. https://www.hwd.com/DocumentCenter/View/2561/2023-Water-Quality-Data-PDF?bidId=.

Appendix A: TOC Removal Survey