



**American Water Works
Association**

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March 13, 2017

Water Docket
Environmental Protection Agency
Mail code: 2822T
1200 Pennsylvania Ave. N.W.
Washington, DC 20460

Re: Comments on EPA's *National Primary Drinking Water Regulations; Announcement of the Results of EPA's Review of Existing Drinking Water Standards and Request for Public Comment and/or Information on Related Issues*. Docket No. EPA-HQ-OW-2016-0627

Dear Sir or Madam:

The American Water Works Association (AWWA) appreciates the opportunity to comment on the Environmental Protection Agency's Federal Register notice, *National Primary Drinking Water Regulations; Announcement of the Results of EPA's Review of Existing Drinking Water Standards and Request for Public Comment and/or Information on Related Issues*. AWWA commends U.S. EPA for a thorough review of the existing drinking water regulations. The Agency review demonstrates that:

1. The current Safe Drinking Water Act regulatory regime is generally sound with existing regulations continuing to meet the requirements set out in Section 1412 of the Act.
2. There are important areas for additional risk management but taking regulatory action will require both additional data gathering and analysis as well as robust stakeholder engagement.
3. The Federal Register notice provides an opportunity for public comment on the analyses and actions envisioned under Section 1412(b)(9).

As AWWA noted in the Association's comments on the Fourth Unregulated Contaminant Monitoring Rule, EPA is thoughtfully integrating the SDWA regulatory development processes under SDWA Section 1412(b)(1)(A) 1413(b)(1)(B) and 1412(b)(9). This integration

is important to efficiently identify meaningful opportunities for additional risk reduction and identify risk balancing challenges when managing multiple contaminants.

In summary, AWWA:

1. Concurs with the Agency that there were neither significant new health effects data nor analytical methods developments that warrant revision of any MCLs for synthetic organic, volatile organic, or inorganic contaminants. The same is true of disinfectant MRDLs.
2. Agrees that there are opportunities to revise risk management expectations for managing microbial risk associated with both source waters and distribution system infrastructure.
3. Strongly agrees that there are numerous complexities associated with changing the microbial / disinfection byproduct regulations that warrant extensive study, dialogue, and careful consideration.
4. Strongly recommends that the USEPA prioritize the potential work areas identified for further analysis by the Six-Year Review process. For example, AWWA views investments in program activities that address outstanding *Legionella* microbial risk and infrastructure integrity as most critical, and further DBP-microbial risk balancing as warranting focused study.
5. Recommends that USEPA consider strategies to improve implementation of existing standards in future regulatory reviews, an area that was lacking in the published review. Revision of the Total Coliform Rule proceeded at least initially based on an opportunity to improve the implementation of an existing rule. As the Agency follows up on this review, effective rule implementation should be a topic to include in the stakeholder discussion.

Because decisions regarding modification of regulatory requirements is a time consuming process, and because the issues identified will require new research and information collection to support regulatory changes, AWWA recommends that the first steps following this Six-Year Review Notice focus on stakeholder discussion. These discussions should be centered around ensuring sound practice is in place to actively meet the spirit and intent of existing regulations and advancing system use of sector best practices. In light of changes in the available budget for EPA since the Agency drafted its Six-Year Review notice, AWWA hopes the following comments and the suggested stakeholder dialogue can help focus Agency actions on the opportunities that will most effectively protect public health.

Attached are more detailed comments on the Agency's Six-Year Review analysis and the requests for comments posed in that notice. AWWA appreciates the opportunity to comment on this important notice. Please feel free to contact myself or Steve Via at AWWA (202-628-8303, svia@awwa.org) if you have any questions regarding these comments.

Respectfully,



G. Tracy Mehan, III
Executive Director of Government Affairs
American Water Works Association

cc: Peter Grevatt – USEPA OGWDW
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About AWWA:

AWWA is an international, nonprofit, scientific and educational society dedicated to providing total water solutions assuring the effective management of water. Founding 1881, the Association is the largest organization of water supply professional in the world. Our membership includes nearly 4,000 utilities that supply roughly 80 percent of the nation's drinking water and treat almost half of the nation's wastewater. Our over 50,000 total memberships represent the full spectrum of the water community: public water and wastewater systems, environmental advocates, scientists, academicians, and others who hold a genuine interest in water, our most important resource. AWWA unites the diverse water community to advance public health, safety, the economy, and the environment.

Attachments: (1)

COMMENTS ON
NATIONAL PRIMARY DRINKING WATER REGULATIONS; ANNOUNCEMENT OF
THE RESULTS OF EPA'S REVIEW OF EXISTING DRINKING WATER STANDARDS
AND REQUEST FOR PUBLIC COMMENT AND/OR INFORMATION ON RELATED
ISSUES

Prepared by
American Water Works Association

Submitted on
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COMMENTS ON
NATIONAL PRIMARY DRINKING WATER REGULATIONS; ANNOUNCEMENT OF THE RESULTS
OF EPA'S REVIEW OF EXISTING DRINKING WATER STANDARDS AND REQUEST FOR PUBLIC
COMMENT AND/OR INFORMATION ON RELATED ISSUES

Introduction

EPA prepared a thorough review of the existing drinking water regulations. AWWA bases this conclusion both on the substance of the Federal Register notice and the associated analyses provided in the docket for this notice. The breadth and depth of the review conducted demonstrate the challenge of preparing a periodic review of existing drinking water standards and the need for sufficient time to conduct the requisite analysis. The notice provides a meaningful opportunity for public comment on the analyses and actions envisioned under Section 1412(b)(9).

The notice clearly illustrates that the current Safe Drinking Water Act regulatory regime is sound with existing regulations continuing to meet the requirements set out in Section 1412 of the Act. The Agency only identified a small fraction of the existing regulations as warranting consideration for further review and potential revision, and all of the items identified had not been reviewed in the two previous Six-Year Reviews. The Agency demonstrated that there were neither significant new health effects data nor analytical methods developments that warrant revision of any of the synthetic organic, volatile organic, inorganic MCLs, nor the disinfectant MRDLs.

The important areas for further evaluation are an extension of a 26-year long progression of seven inter-related regulatory actions focused on microbial-disinfection byproduct risk management (an eighth being the Revised Total Coliform Rule, which was outside the scope of the current review). So the questions posed by this six-year review are, whether to pursue additional risk management in a very carefully balanced set of rules and if so what additional data gathering and analysis will be needed to support the next round of robust stakeholder engagement.

While AWWA's review of the notice found that there are opportunities to revise risk management expectations for managing microbial risk associated with both source waters and distribution system infrastructure, it is important to prioritize the potential work areas identified. For example, investments in program activity that address outstanding microbial risk and infrastructure integrity are likely most critical, particularly with respect to distribution systems. Further reductions in DBPs will entail consideration of DBP-microbial

risk balancing. The complexities associated with changing the microbial / disinfection byproduct regulations warrant extensive study, dialogue, and careful consideration.

There are opportunities to more effectively implement current rules. As the Agency follows up on this review, effective rule implementation should be a topic to include in the stakeholder discussion.

Disinfection Byproducts

Risk Balancing

EPA finds through its analysis that there is additional risk reduction to be achieved primarily through the reduction of brominated DBPs. Currently, DBP risk management is optimized in the context of a number of regulatory and operational constraints, including:

1. Controlling disinfection byproducts from chlorination, chloramination, ozonation, and chlorine dioxide application,
2. Maintaining adequate primary disinfection,
3. Controlling both DBP levels and assuring secondary disinfection is maintained throughout the distribution system,
4. Maintaining a year-round, reliable, chemically and biologically stable water supply in the face of quantity limitations, severe weather, algae and cyanobacteria blooms, while also removing all other regulated contaminants,
5. Financial sustainability in the face of both operational and long-term capital investments,
6. Controlling energy use, off-site disposal costs for treatment residuals, and community sustainability goals, and
7. Operational constraints with respect to system facilities, personnel, and geography.

If the target performance window for system optimization is changed, the health risk reduction benefits realized must be sufficient to warrant re-optimization of all these competing objectives.

Adding new optimization objectives require considering trade-offs. For example, managing nitrosamines could entail oxidation with either ozone or chlorine early in the water treatment plant treatment train, which may lead to higher levels of bromate and chlorinated DBPs respectively. Application of granular activated carbon to reduce total organic carbon and thereby DBP formation, leads to a higher proportion of brominated

DBPs, particularly DBPs with multiple bromines incorporated into the DBP's structure.¹ While there is less data on the formation of iodinated DBPs, a similar trend to that observed for brominated DBPs is found with respect to GAC treatment. Each DBP precursor removal strategy reduces some DBPs but it may also be associated with an increase in another group of DBPs – leading to a risk-risk trade-off. Managing additional groups of DBPs (e.g., nitrosamines) also entails unintended consequences for other unit operations.² For example, nitrosamine control can have impacts on the effectiveness of coagulation and filtration.³ These impacts from managing nitrosamines emphasize the need to holistically evaluate their management in the context of other treatment goals, and highlights the criticality of asking if the potential for meaningful risk reduction exists.⁴

Challenged Water Supplies

Water systems are integrating water supply sources that are challenged, primarily by wastewater influences. Microbial contaminants are probably the most significant risk management concern, but not the only risk. Wastewater contributes organic nitrogen and other precursors impact DBP formation. The impact of these changes on risk balancing should be considered as part of any rule revision.

Risk Reduction Opportunity

The scope of additional risk reduction potential through additional DBP risk management is not clear. There have been a number of well-done epidemiology studies published since the Stage 2 DBPR was promulgated, but the importance for informing regulatory change in the United States is hard to discern:

1. The largest recent bladder cancer risk epidemiological studies, which focus on the risk posed by brominated DBPs associated with chlorination, were conducted in Spain and the associated DBP exposure assessment is challenging to relate to the U.S.
2. There is an extensive history of epidemiology studies exploring the link between DBPs and bladder cancer. Bladder cancer typically expresses itself later in life, thus to establish a correlation between DBPs and bladder cancer

¹ Stuart W. Krasner, Tiffany Chih Fen Lee, Paul Westerhoff, Natalia Fischer, David Hanigan, Tanju Karanfil, Wilson Beita-Sandí, Liz Taylor-Edmonds, and Robert C. Andrews. Granular Activated Carbon Treatment May Result in Higher Predicted Genotoxicity in the Presence of Bromide. *Environ. Sci. Technol.*, 2016a, 50 (17), pp 9583–9591. DOI: 10.1021/acs.est.6b02508.

² Krasner, S.W., Shirkhani, R., Westerhoff, P., Hanigan, D., Mitch, W.A., McCurry, D.L., Chen, C., Skadsen, J., von Gunten, U. (2015) Controlling the Formation of Nitrosamines during Water Treatment, Water Research Foundation: Denver, CO.

³ Russell, Caroline G., Brown, Richard, Porter, Katie, Reckhow, David. (in press) Practical Considerations for Implementing Nitrosamine Control Strategies. *Journal AWWA*.

⁴ Steve E. Hrudey, Richard J. Bull, Joseph A. Cotruvo, Greg Paoli, Margaret Wilson. (2013) Drinking Water as a Proportion of Total Human Exposure to Volatile N-Nitrosamines. *Risk Analysis*. DOI: 10.1111/risa.12070.

requires performing an exposure assessment going back 75 -85 years. Significant DBP sampling only began 35 years ago, leaving 40 -50 years with no DBP data. Exposure assessments with DBP data is difficult enough, but without any DBP data, the assessment is a very rough estimate. Recent regulatory changes have changed the distribution of DBP occurrence further, and there may not have been sufficient time for the impact to be realized in any associated reduction of bladder cancer. Thus the applicability of available epidemiology studies to further modifications to the U.S. regulatory structure is questionable.

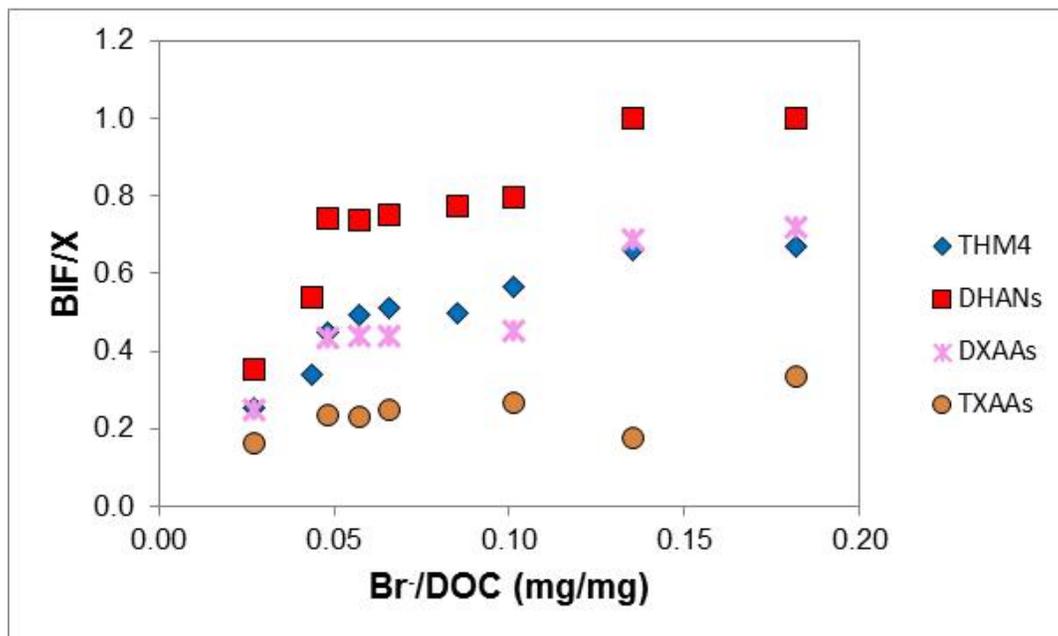
3. A number of epidemiology studies of DBPs and reproductive developmental risk have also been performed and as yet, the weight-of-evidence does not substantiate a causal connection.

The difficulty associated with interpreting the available epidemiology research to support additional revisions to the DBP regulations is substantial.⁵

If brominated DBP species are associated with greater health risk, it is not clear that treatment options like granular activated carbon lead to significant risk reduction. GAC increases the bromine incorporation factor (e.g., forms more of the more brominated and more toxic DBP species for a variety of classes of DBPs) by increasing the relative abundance of bromide to TOC (see Figure 1).

⁵ Hrudey, Steve; Backer, Lorraine; Humpage, Andrew; Krasner, Stuart; Singer, Philip; Stanford, Ben; Michaud, Dominique; Moore, Lee. (2015) Evaluating Evidence for Association of Human Bladder Cancer with Drinking Water Chlorination Disinfection By-Products Journal of Toxicology and Environmental Health, Part B: Critical Reviews.

Figure 1. Impact of bromide (Br-)/DOC ratio on the normalized BIF for a surface water sample treated with F400 GAC (DHANs = dihaloacetonitriles; DXAAs and TXAAs = di- and trihalogenated HAAs).⁶



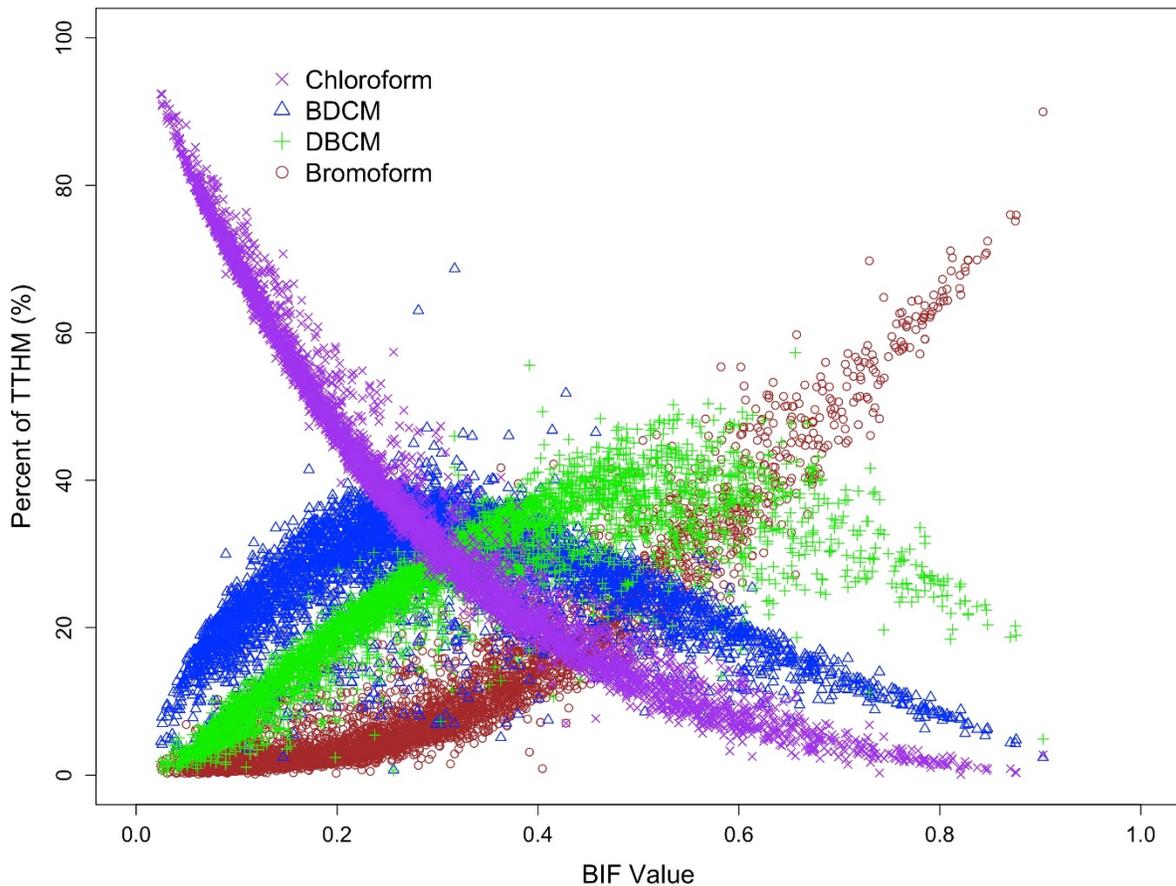
Looking at the TTHM species observed in routine compliance monitoring it is possible to illustrate the shift in brominated DBP species of interest with respect to the TTHM sum. Figure 2 uses compliance data presented by Samson and Seidel (2016) to make this illustration.⁷ Roalson et al. (2003) illustrate how this shift can lead to increased concentrations of brominated DBPs for an individual utility.⁸

⁶ Stuart W. Krasner, Tiffany Chih Fen Lee, Paul Westerhoff, Natalia Fischer, David Hanigan, Tanju Karanfil, Wilson Beita-Sandí, Liz Taylor-Edmonds, and Robert C. Andrews. Granular Activated Carbon Treatment May Result in Higher Predicted Genotoxicity in the Presence of Bromide. *Environ. Sci. Technol.*, 2016a, 50 (17), pp 9583–9591. DOI: 10.1021/acs.est.6b02508.

⁷ Samson, Carleigh and Chad Seidel (2016). Analyzing DBP Speciation and Assessing Source Water Bromide Thresholds for Meeting Current and Potential Future DBPR Regulations. AWWA WQTC. Indianapolis, IN.

⁸ Roalson, S.R., Kweon, Y., Lawler, D.F., Speitel Jr, G.E. (2003). Enhanced Softening: Effects of Lime Dose and Chemical Additions, *JAWWA*, 95:11:97.

Figure 2. Chloroform, Bromodichloromethane (BDCM), dibromochloromethane (DBCM), and bromoform as a function of the normalized bromine incorporation factor



No Small Changes – The TOC Alkalinity Matrix

The M/DBP rules are an interconnected series of requirements that balance competing objectives. They also reflect the need for operational flexibility. Making changes to one element of the rules is very difficult to do without accounting for that change in other ways. The TOC-Alkalinity removal matrix is one such example. The Stage 1 DBPR rulemaking was based on analysis conducted by a stakeholder-EPA staff technical workgroup. In crafting the matrix, the technical workgroup incorporated a safety margin to assure reliable compliance with the matrix and MCLs, while allowing for operational flexibility.⁹

⁹ EPA (2005) Economic Analysis for the Final Stage 2 Disinfectants and Disinfection Byproducts Rule. EPA 815-R-05-010. Page ES-16

It is not surprising to find retrospectively that performance is on average better than must be achieved by the rule – this was planned into the rule’s structure. Modifying the matrix or eliminating alternative compliance criteria would significantly alter the compliance challenge and have impacts beyond those visible through a retrospective analysis of the Six-Year Review data call in. When the TOC removal requirements were developed for the 3x3 matrix, the intent was for 90 percent of systems to be able to comply with the requirements with a 15-percent safety margin. For example, the requirement in the box in the matrix for TOC >4.0-8.0 mg/L and alkalinity >60-120 mg/L is 35.0 percent. The thought was that PWSs would design the coagulation process to achieve a 40 percent removal (the requirement with a 15-percent safety margin). If some of the PWSs in this box were achieving 6-19 percent greater TOC removal than the requirement (i.e., 37.1-41.6 percent), they are removing not more, but exactly what was predicted, when taking into account use of a safety margin. If the requirement in this box was to be increased to that currently being achieved by some (e.g., ~40 percent), then PWSs would need to design for 46 percent TOC removal (which includes a safety margin), which is beyond what was believed reasonably achievable for most systems in this box.

Collaboration

Collaborative efforts are needed to develop the data and analysis required to advance evaluation of M/DBP risk management changes. While EPA has put considerable effort into understanding relevant Unregulated Contaminant Monitoring Rule and Six-Year Review occurrence data, the Water Research Foundation has implemented a multi-year research program focused on the formation, risk, and control of nitrosamines (see Appendix 1. Water Research Foundation Nitrosamine Research Agenda). The resulting research can and should inform policy development as much as EPA’s own UCMR occurrence analysis. WRF already has research programs underway targeting disinfection byproducts and distribution system microbial communities that will inform future rulemakings.

Chlorate / Chlorite

Chlorate in finished drinking water can be a product of disinfection with chlorine dioxide, sodium hypochlorite, or calcium hypochlorite as observed in EPA’s analysis. Hypochlorite is a source of chlorate, but not chlorite. Chlorine dioxide is a source of both chlorite and chlorate.

AWWA compared high levels of chlorate identified in UCMR data with the available data on disinfectants applied as well as maps of chlorite-based pesticides. AWWA was not able to substantiate EPA’s hypothesis that high levels of chlorate associated with free chlorine systems are due to the presence of chlorite-based pesticides or other sources of chlorate in source water. It seems more likely based on the available information, that there is misclassification of water treatment plants in the Agency’s current analysis. That is facilities that are identified as free chlorine and have high levels of chlorate actually have some level of hypochlorite or chlorine dioxide use.

While the exact number of systems is uncertain, the Agency observation that a significant fraction of water systems is now utilizing hypochlorite is correct. This is important in two respects. First, it means that for those systems where sodium hypochlorite is trucked in there are practical measures that can be taken to control chlorate levels in finished water.¹⁰ Secondly, because of concerns about the risks posed by chlorine gas and trucking sodium hypochlorite there is a large and growing number of facilities that generate sodium hypochlorite on-site. Research to-date demonstrates that there is significant chlorate production by on-site generators.¹¹ The exact reason why these generators are prone to elevated chlorate formation and measures that can be used to control formation have not yet been identified.

Lowering the current MCL from 1.0 mg/L would be problematic at water systems where chlorine dioxide is used. Fifty to seventy percent of the chlorine dioxide reacted at any point in time appears as the chlorite ion. Thus, most systems that use this alternative disinfectant, limit the dose of chlorine dioxide (e.g., to ~1.25 mg/L or less) to reliably stay below the chlorite MCL. If the MCL is lowered, many systems will have to lower the chlorine dioxide dose, which may limit the ability to effectively use this disinfectant. While not documented as a widespread practice, some systems utilize chlorite to control nitrification; a low chlorite standard would eliminate this practice for controlling a condition with significant impacts on water quality.¹²

Literature Review

The Agency literature review with respect to DBP occurrence, risk, and treatment failed to include a number of relevant papers. See Appendix 2. References Missing from DBP Literature Review.

Microbial Quality of Source Water

Identifying Microbial Contamination of Ground Water

CDC waterborne disease outbreak data illustrate that *Legionella* and pathogens like it are the most pressing microbial risk associated with potable water. Incidences of outbreaks attributable to waterborne pathogens linked back to source water quality and inadequate

¹⁰ Stanford, Benjamin D.; Pisarenko, Aleksey N.; Snyder, Shane A.; Gordon, Gilbert. Perchlorate, Bromate, and Chlorate in Hypochlorite Solutions: Guidelines for Utilities. Journal – AWWA. 103(6): 71-83. June 2011.

¹¹ Stanford, Benjamin D.; Pisarenko, Aleksey N.; Dryer, Deborah J.; Ziegler-Holady, Janie C.; Gamage, Sujanie; Quinones, Oscar; Vanderford, Brett J.; Dickenson, Eric R.V. Chlorate, perchlorate, and bromate in onsite-generated hypochlorite systems. 105(3):93-E102. March, 2013.

¹² McGuire, Michael J.; Wu, Xueying; Blute, Nicole K.; Askenaizer, Daniel; Qin, Gang (2009) Prevention of Nitrification Using Chlorite Ion: Results of a Demonstration Project in Glendale, California. 101(10):47-59.

drinking water treatment are limited.¹³ The UCMR3 data collection was intended to document pathogen occurrence in highly vulnerable wells and did not find any appreciable occurrence.¹⁴

Under the current Ground Water Rule states are charged with determining if a well is vulnerable to contamination based on its geology. There is an opportunity through the sanitary survey process to identify flaws in well construction, on- / near-site developments that will impact the aquifer, and other shortcomings in a system's facilities that would provide an entry for pathogens. There is a continuum of vulnerability to contamination for groundwater aquifers. Vulnerability is both a function of the aquifer geology and surface activities. While it is unlikely that EPA could determine the number of misclassified GWUDI systems based on (1) waterborne disease outbreak compilations due to inadequacies in the U.S. disease surveillance system, (2) the UCMR3 occurrence data, which only rarely found pathogenic microbes, or (3) national compilations of pre-April 2016 compliance monitoring total coliform detections for which there is no information on the cause of positive observations, it would be prudent for states and systems to review periodically whether current GWUDI status determinations are sound as part of the current GWR and SWTR activity.¹⁵ One data collection strategy that would be informative, is collection of Tier 1 and 2 reports generated under the Revised Total Coliform Rule. With the RTRC's find-and-fix framework, these reports and the success of follow-up actions should provide information on both the occurrence of microbial contaminated wells and distribution system shortcomings that warrant additional regulatory oversight, revised guidance, or new regulatory requirements.

It would be useful to review current state practice identifying water systems as ground water vs ground water under direct influence of surface water. In preparation for this review a summary of the available literature on characterizing ground water as under the influence would be pertinent. There have been some reviews that could be used to inform the Agency's work:

1. Jacangelo, Joseph G. Investigation of criteria for GWUDI determination. AWWRF, 2001.
2. Kuldeep Chaudhary, Bridget Scanlon, Nathan Scheffer, and Steven Walden. Review of the State of Art: Ground Water Under the Direct Influence of Surface Water Programs. August, 2009.
(http://www.beg.utexas.edu/sce/docs/BEG_GWUDI_2009.pdf)

¹³ CDC (2015 and previous). Surveillance Reports for Drinking Water-associated Disease & Outbreaks. Available Feb. 20, 2017 at <https://www.cdc.gov/healthywater/surveillance/drinking-surveillance-reports.html>.

¹⁴ EPA (2017) The Third Unregulated Contaminant Monitoring Rule (UCMR 3): Data Summary, EPA 815-S-17-001.

¹⁵ EPA (2017) UCMR3 (2013-2015) occurrence data. Available February 20, 2017 at <https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule>.

Aerobic spores are a useful indicator of treatment efficacy as demonstrated in implementing the LT2ESWTR microbial toolbox. One failing of aerobic spores is their relatively low concentration in water sources. If aerobic spores were more abundant it is likely that bank filtration and demonstration of performance (DOP) would be able to demonstrate higher levels of log removal. While roughly 80% of the UCMR3 samples had counts of 10 or more aerobic spores, there was no statistical association between aerobic spores and any of the pathogens or fecal indicators tested.¹⁶

It is surprising that 30 percent of samples drawn at more than 790 water systems in UCMR3 were positive for aerobic spores. If these wells were properly constructed, “true” groundwater wells, lower occurrence would be expected. Though it is worthwhile noting that the wells tested were all “located in areas with sensitive aquifers containing fractured or karst bedrock.”¹⁷ These sample sites being representative of the types of wells that both the SWTR and GWR would require removal from service or the addition of treatment prior to use as a source of supply for a PWS. It is not clear from the available UCMR3 documentation why these wells were not already subject to treatment requirements under one of these two rules.

There has been review and revision of both the Microscopic Particulate Test and aerobic spore method since the SWTR and GWR were finalized. As part of reviewing state implementation of current rule provisions, it would be informative to revisit method development and current applications to determine if aerobic spores would be informative for state determinations under these two rules.

Managing Microbial Contamination of Surface Water

Drinking water facilities are currently engaged in the second round of *Cryptosporidium* monitoring under the Long-Term 2 Enhanced Surface Water Treatment Rule. The initial round of monitoring did not identify many facilities facing elevated *Cryptosporidium* treatment challenges. AWWA is currently conducting a survey of water systems engaged in round two monitoring and to-date results are similar, though with the Agency’s interpretation of the rule, as different facilities find *Cryptosporidium* in Round 2, the total number of WTPs in higher treatment bins will likely increase.

Since 2006 when LT2ESWTR was promulgated, U.S. water systems have found it necessary to expand their water supply portfolios. Water scarcity combined with population growth and relocation demands that communities pursue water conservation, water loss control, and other measures including alternative sources of water. Systems are increasingly turning toward (1) lower quality raw water supplies and (2) contemplating reuse of wastewater and stormwater for potable water sources. The same population growth and

¹⁶ EPA (2016) Six-Year Review 3 Technical Support Document for Microbial Contamination Regulations. P. 6-30.

¹⁷ Cadmus (2012) Information Collection Request for the Unregulated Contaminant Monitoring Regulation (UCMR 3). Prepared for EPA.

weather patterns that led to this review of water supply alternatives are also impacting stream flows, lake levels, and aquifer recharge. Studies demonstrate that de facto reuse of wastewater by WTPs have continually increased since 1980.¹⁸ The challenge posed to WTPs varies as a function of flow.¹⁹ There are cost, risk management, and equity questions to be posed as to whether it is more cost effective to manage the quality of wastewater and stormwater at or prior to their release vs at the WTP. AWWA joined with WateReuse, and the Water Environment Federation to fund *Framework for Direct Potable Reuse*, an overview for the policy framework necessary to implement DPR – the elements of this framework are relevant to managing both DPR and de facto reuse.²⁰

States are already addressing microbial risk associated with planned potable reuse through state-specific regulations / regulatory review and approval. As DPR is only being seriously pursued in a limited number of locations and it is an arena where both engineering and regulatory innovation is occurring rapidly, it is not yet ripe for a specific SDWA regulation. The implications for DPR, should not be forgotten as EPA provides more general guidance and revises regulatory requirements for drinking water.

Revision of Virus CT Requirements

At present many utilities have or are continuing to obtain CT at higher pHs on a case by case basis with primacy agencies. EPA should expand the CT tables to at least pH 10. Revision of the virus CT requirements will require careful evaluation (i.e., “EPA identified a potential need to update CT values for virus inactivation by free chlorine or chloramines, particularly for water with a relatively high pH.”).²¹ It is not clear that additional primary disinfection for viruses would lead to a significant reduction in microbial risk. If evolving science were to demonstrate such an opportunity, then there are a number of steps to evaluate related considerations:

1. For virtually all water systems, virus CT is achieved using free chlorine. Consequently, changes to virus CT will have implications for DBP formation, especially for water systems that otherwise use chloramines for primary disinfection. Conventional water treatment plants are now optimized to both achieve existing SWTR disinfection requirements and Stage 2 DBPR TTHM and HAA5 MCLs and many of those with waters that have high levels and or TOC that is recalcitrant to removal with enhanced coagulation rely on a brief period of free chlorine to achieve virus CT prior to converting to chloramines. A

¹⁸ Rice, Jacelyn, Paul Westerhoff, Amber Wutich, Assessment of De Facto Wastewater Reuse across the USA: Trends between 1980 and 2008. *Environmental Science & Technology* 47(19). August 2013

¹⁹ Rice, Jacelyn, Steve Via, Paul Westerhoff. Extent and Impacts of Unplanned Wastewater Reuse in U.S. Rivers. *Journal AWWA* 107(11). November 2015.

²⁰ WateReuse Research Foundation. *Framework for Direct Potable Reuse*. 2015 (<http://www.awwa.org/Portals/0/files/resources/publicaffairs/docs/DPRFrameworkGuide.pdf>).

²¹ 82 FR 3539

regulatory change that would upset this balancing point will have substantial capital consequences for a significant number of systems, consequently it would need to be well justified, given existing conservatism inherent in current regulations covering disinfection practice.

2. Changing the pH of water results in inactivation of some viruses. A change in virus CT should account for both the inactivation by the reacting oxidant species and pH.
3. Require a robust review and include research not currently referenced in this docket including additional work by Benito Marinas, Issam Najm, and other researchers involved in both conducting inactivation studies and evaluating how to use the available inactivation data to inform disinfection practice.
4. Revisit how available inactivation data is used to arrive at a CT requirement (e.g., model fit selection, use of a central tendency estimate, appropriate statistical treatment of dataset variability, selection of relevant safety margins, etc.).

With respect to disinfection at pH levels above 9.0, there are good reasons to provide credit as is currently allowed under federal regulations:^{22, 23, 24}

1. Elevating pH to above 9.5 can, in some waters, be the most effective strategy for managing lead release,
2. Elevating pH above 9.0 allows monochloramine residuals to last longer and there by provide a more lasting benefit throughout the distribution system with less risk of nitrification.
3. Lowering pH for disinfection and then elevating pH prior to distributing finished water can be operationally challenging.

There is research ongoing funded by the Water Research Foundation that is investigating the role of pH on oxidant speciation and inactivation using surrogate organisms.²⁵

Distribution System Microbial Risk Management

Microbial risk management requires a suite of good practices; disinfectant residual practice is not the only important practice. Moreover, secondary disinfectant must be managed in concert with managing DBP risks. Managing distribution system-related risk were

²² 62 Federal Register 59486

²³ EPA (1999) Guidance Manual, Disinfection Profiling and Benchmarking. EPA 815-R-99-013.

²⁴ EPA (2003) Guidance Manual, LT1ESWTR Disinfection Profiling and Benchmarking. EPA 816-R-03-004.

²⁵ WaterRF (2018) Verification of the Effect of pH on the Microbial Inactivation Efficiency of Free Chlorine. In press.

identified as a priority focus area by the EPA in 2006. EPA organized the Total Coliform Rule and Distribution System Federal Advisory Committee which provided recommendations for:

1. Revisions to the Total Coliform Rule (promulgated in 2012 and effective, April, 2016).
2. Initiation of a cohesive, prioritized research and information collection program to support future risk management actions.

The Research and Information Collection Partnership effort was short-lived and inadequately funded.²⁶ The information and research that the effort was intended to gather would serve the Agency well in better managing distribution system related risk.

The RICP research agenda itself was too narrow in scope as it did not include managing water quality within buildings. The role of engineered systems in buildings and the maintenance of those systems has come to the fore in the wake of a National Academy of Sciences report, Centers for Disease Control and Prevention reports, and a number of serious outbreaks in health care and hospitality industry structures.^{27, 28} And most recently, CDC prepared a guide for building owner / operators on assessing and proactively managing building systems to reduce *Legionella* cases.²⁹ The only recently effective RTCR provides a framework for future risk reduction in distribution systems, but there remain significant hurdles to address proliferation of *Legionella* and other opportunistic pathogens in on-premise engineered systems. Barriers include:

1. Absence of a coherent peer-reviewed research literature to support which practices in drinking water distribution systems and in managing premise plumbing that must be changed. This issue is particularly acute when seeking to prevent multiple pathogens from proliferating, each with their own ecological niche and biology.
2. Lack of widespread recognition that buildings, particularly large buildings and campuses composed of multiple buildings that serve immunologically

²⁶ RICP (2010) Final Priorities of the Distribution System Research and Information Collection Partnership. Available Feb. 20, 2017 at <https://www.epa.gov/dwreginfo/research-and-information-collection-partnership-meeting-summary>.

²⁷ National Research Council. (2006) Drinking Water Distribution Systems: Assessing and Reducing Risks. Washington, DC: The National Academies Press. doi:<https://doi.org/10.17226/11728>.

²⁸ Beer KD, Gargano JW, Roberts VA, Hill VR, Garrison LE, Kutty PK, Hilborn ED, Wade TJ, Fullerton KE, Yoder JS. (2015) Surveillance for waterborne disease outbreaks associated with drinking water — United States, 2011–2012. *MMWR Morb Mortal Wkly Rep.* 2015;64(31):842-848.

²⁹ CDC (2016) Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings A Practical Guide to Implementing Industry Standards. Available Feb. 20, 2017 at <https://www.cdc.gov/legionella/downloads/toolkit.pdf>.

compromised individuals, can take steps to significantly reduce conditions that are prone to the proliferation of microbes and avoid aerosolizing water in which large numbers of microbes occur.

AWWA fully supports EPA re-initiating and expanding the RICP to develop a coherent research agenda to support managing risks posed by *Legionella*, *Mycobacteria*, and similar pathogens that are harbored in biofilms and represent a hazard when aerosolized. The Association is also conducting outreach to the sector through its delivery channels (e.g., conferences, publications, sections, etc.) to raise awareness and promote local action building from the CDC guide. The Water Research Foundation identified pathogens associated with biofilm in distribution systems and premise plumbing as a research focus area in 2015 and is actively pursuing a research agenda in this arena.

While research will be necessary to make long-term changes in practice and determine where there are needs for specific regulatory requirements there is a need for near-term actions including:

1. Advancing sound, site-specific distribution system management practice (e.g., AWWA G-200).³⁰
2. Continuing to promote action based on CDC's guide for building owner / operators.
3. Compilation and evaluation of RTCR Tier 1 and 2 assessments for trends that would inform additional risk reduction through directed training, guidance, or regulatory change.

Internationally and in the United States there has been a growing interest in advancing hazard analysis and critical control point management as an umbrella thought process to guide risk management.^{31, 32} The RTCR and the subsequent work of the RICP was in part intended to foster HACCP as a management philosophy with respect to distribution systems. Going forward EPA faces four central challenges:

1. The RTCR has only been in effect for one year, consequently it is not clear what impact the find-and-fix framework is having on water system practice or how completely the sector is adopting the practices reflected in AWWA G-200.

³⁰ AWWA (2010) G200-09 Distribution Systems Operation and Management.

<http://dx.doi.org/10.12999/AWWA.G200.09>

³¹ WHO (2011) Guidelines for drinking-water quality, fourth edition. Available Feb. 20, 2017 at

http://www.who.int/water_sanitation_health/publications/dwg-guidelines-4/en/

³² NSF (in development) NSF 444: Prevention of Injury and Disease Associated with Building Water Systems. Information available Feb. 20, 2017 at <http://www.nsf.org/newsroom/nsf-international-and-ashrae-sign-agreement-to-advance-knowledge-of-buildin>.

2. Limited state resources, large numbers of small systems to manage, and increasing pressure for simple metrics that can be tracked in available data systems are leading to simple regulatory requirements that are easy to monitor but are inherently conservative so as to force a set of actions that are not explicitly required. Such regulatory frameworks lead to misconstruing cause and effect relationships (e.g., a chlorine residual of x will protect against *Legionella*), and thereby missed risk reduction opportunities (e.g., regular removal of accumulated sediment in distribution piping and storage, management of water age, etc.).
3. A tendency toward a one-size-fits-all solution (e.g., all systems should have a disinfectant residual of x mg/L, TOC in finished water should be below y mg/L, etc.) that forces water systems to meet a regulatory criterion rather than having a solution that addresses the issues that could present a health hazard (e.g., a ground water applying a minimum level of disinfectant when abandoning a well or installing conventional treatment is more appropriate).
4. The absence of a cohesive structure for risk management, when water quality degradation occurring in buildings is central to managing risk.

There is growing anxiety about *Legionella* that must be addressed in a constructive fashion. EPA's literature review demonstrates that disinfectant residual alone is not a viable solution.³³ CDC's experience as well as the *Legionella* control efforts in other countries demonstrate the need to address proliferation in buildings. As EPA looks to lessons learned from RTCR implementation, the Agency should initiate a stakeholder dialogue on when will a water system-building owner partnership work and when buildings should be managed as public water systems. Such a discussion may identify opportunities for organizing a more cohesive risk management framework.

AWWA organized a multi-stakeholder facilitated discussion focused on water systems maintaining a disinfectant residual in 2015. The participants identified the following topics for further exploration:³⁴

- “• Detection limits – uncertainty in the performance of the analytical methods in the field should be further explored ..., particularly at low levels approaching the limits of detection.
- Organic chloramines ... There is no EPA-approved analytical method for organic chloramines, or for monochloramine; ...

³³ EPA (2016) Technologies for Legionella Control in Premise Plumbing Systems: Scientific Literature Review. EPA 810-R-16-001. Information available Mar. 3, 2017 at <https://www.epa.gov/ground-water-and-drinking-water/technologies-legionella-control-premise-plumbing-systems> .

³⁴ AWWA (2015) Correspondence to Peter Grevatt RE: Disinfectant Residual and the Third Six-Year Review.

- Science-based sampling – ... the need to develop a robust monitoring framework ... for both the RTCR and disinfectant residuals.”

EPA’s notice also identifies detection limits for disinfection residuals as an area for further study and evaluation. EPA explores in detail the correlation of chlorine residual and coliform bacteria. As the Agency and stakeholders determined in the TCRDSAC dialogue that resulted in the RTCR, there is not a basis to conclude that a residual in the range of interest is protective against the occurrence of coliform bacteria. In the TCRDSAC process the use of disinfectant residual as a surrogate for monitoring coliform bacteria was explicitly not pursued, at least in part because (1) the absence of chlorine cannot be demonstrated to be causally linked (e.g., available data does not document the presence or absence of defects that lead to the occurrence of coliforms), and (2) there are instances where coliforms are present at high levels in the presence of a chlorine residual. In both the GWR and RTCR policy discussion there was an explicit concern that application of a disinfectant can mask more significant sources of risk and it was more important to find and address the underlying sanitary defect.

The RTCR also illustrates the challenge of structuring a rule with an embedded philosophy of encouraging progressive system activity and also establishing “bright line criteria.” In taking primacy individual states are reducing the rule structure to a list of items that can be readily documented and tracked in automated compliance monitoring systems. As a consequence, measures intended to promote more water quality modeling and better problem evaluation like flexible upstream-downstream repeat provision in the RTCR are not being implemented. With this experience in mind, a stakeholder discussion on how to transition states and systems, especially smaller systems and consecutive systems to good distribution system management practice would be a productive Agency investment. Such a discussion should be coordinated with refining current operator certification requirements.

Producing and maintaining biologically stable water is an active area of research at the Water Research Foundation that has not received sufficient attention. Particularly in light of the renewed focus on stability of water with respect to corrosion, now is a useful time to expand the ongoing research program to better understand maintaining water stability across multiple objectives.

Elevated Free Chlorine Periods

The EPA analysis explores the concept of requiring DBP compliance monitoring in chloraminated distribution systems during periods of elevated free chlorine. Both our understanding of DBP formation and anecdotal reports indicate that DBP formation can be above 80 and 60 µg/L for TTHMs and HAAs respectively during such events.

These periods of elevated free chlorine were understood to occur when Stage 1 and Stage 2 DBPR were developed and finalized. Both the use of chloramination and exercising

limited periods of elevated DBP formation with free chlorine application were anticipated aspects of both rule frameworks:

1. TTHMs and HAA5 are regulated based on a cancer end point or continuous (chronic) exposure over an extended period of time, not within short periods of time, is the basis for risk management.
2. Elevated free chlorine periods are specifically recognized in EPA guidance on operational excursions under the Stage 2 DBPR.

After the Stage 2 DBPR rule had entered implementation, stakeholders worked with EPA to develop the revised Total Coliform Rule. In this latest rulemaking which took effect in 2016, there is a strong emphasis on “find and fix” and the rulemaking benefit-cost analysis reflects the application of elevated chlorine to remedy elevated coliform levels. What was probably less explicitly addressed in these rulemakings was the unique nature of free chlorine periods as the only demonstrated, effective strategy for ending a nitrification episode if nitrification gets out of control.

Assimilable Organic Carbon

The notice also asked for comment on the use of AOC to control biological activity in the distribution system citing the Dutch experience with not using a secondary disinfectant. Adopting an AOC standard would be similar to having a biological oxygen demand standard. By the time the results are back the water is long gone. There are emerging tools that maybe helpful. The biofiltration literature includes efforts to utilize adenosine triphosphate assays as one example that could be explored. Before guidance can be developed or analytical tools selected, a concerted effort will be need to define what is biologically stable water. And, that task will be difficult. Biofilms are composed of a diverse assembly of organisms and control strategies have different effects on subsets of that assembly. As one example, the nitrifiers are chemolithoautotrophs; they rely on an inorganic carbon source. A biologically stable water for heterotrophs, which use an organic carbon source, will select for a nitrifying population. This concept requires a thorough exploration prior to developing guidance as the potential for unintended consequences are significant.

Research Needs

Practice is already changing, unless constrained by state law, to utilize alternatives to regular free chlorine periods. Considerable focus is given to nitrification plans and managing water quality in order to avoid episodes that exhaust total chlorine residuals and have other negative impacts on water quality. Benchtop studies and validated modelling will suffice to demonstrate DBP formation under these conditions, but a substantial research program geared toward practices to resolve low disinfectant residual, eliminate nitrification episodes that do occur, and other uses of elevated free chlorine is essential prior to revising current policy on monitoring during these periods for DBPs.

Appendix 1. Water Research Foundation Nitrosamine Research Agenda

Occurrence	Precursors	Treatment	Others	2012				2013				2014				2015				2016				2017				2018				2019			
				Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
	X		X	Development of a bench-scale test to predict the formation of nitrosamines - 4180																															
	X	X	X					Investigating Alternative Coagulant Aids to PolyDADMAC - 4452																											
X	X							Nitrosamine Occurrence Survey -4461																											
X	X	X	X									Unintended Consequences of Implementing Nitrosamine Control Strategies 4491																							
X		X														Relative Importance and Contribution of Anthropogenic and Natural Sources of Nitrosamine Precursors - 4499																			
X	X	X	X													Effect of GAC on the Removal of DBPs of Health Concern - 4560																			
	X	X	X													Understanding the Source and Fate of Polymer-Derived Nitrosamine Precursors - 4622																			

Appendix 2. References Missing from DBP Literature Review

Data to support revising the MCLG for bromate to reflect nongenotoxic modes of action (If these hypotheses are confirmed, linear extrapolation of risk from low doses of BrO₃⁻ is inappropriate (Bull and Cotruvo, 2013)).

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Bull, Richard J.; Cotruvo, Joseph A. Nongenotoxic mechanisms involved in bromate-induced cancer in rats. *Journal - American Water Works Association*, 2013, 105 (12), E709-E720. DOI: <http://dx.doi.org/10.5942/jawwa.2013.105.0155>

Cotruvo, J.A.; Bull, R.J.; Cummings, B.S.; Delker, D.; Guo, Z.; Fisher, J.; Quiñones, O.; Snyder, S.A.; & Ong, C.N. 2012. Bromate Disposition and Mechanisms of Toxicity at High and Low Doses. Water Research Foundation, Denver.

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Zhang, X.; De Silva, D.; Sun, B.; Fisher, J.; Bull, R.J.; Cotruvo, J.A.; & Cummings, B.S. 2010. Cellular and Molecular Mechanisms of Bromate-Induced Cytotoxicity in Human and Rat Kidney Cells. *Toxicology*, 269:1:13. <http://dx.doi.org/10.1016/j.tox.2010.01.002>.

[Addressing Issues with EPA Method 521\(Nitrosamines\)](#)

Various researchers have identified issues with the EPA-approved method (521) for nitrosamines. An alternative method, which resolves these issues, is in Standard Methods.

APHA, AWWA, and WEF. 2008. Standard Methods for the Examination of Water and Wastewater. 6450 Nitrosamines.

Lee, C. F. T., et al. 2014. Performance of Alternative Nitrosamine Analytical Methods. Proc. 2014 AWWA WQTC. Denver, Colo.: AWWA.

[Potential approaches that provide enhanced protection from health risks posed by nitrosamines in drinking water systems.](#)

Both iodinated DBPs and NDMA are preferentially formed by chloramines. Both classes of these DBPs can be controlled with appropriate pre-oxidation. Free chlorine or ozone can convert iodide to iodate, a sink for iodide. Both of these oxidants can destroy (transform) NDMA precursors. The efficacy of using free chlorine as a pre-oxidant for either class of DBPs was improved with increased free chlorine contact time. However, use of free chlorine or ozone will form regulated and other emerging DBPs. Thus, there is a need to risk/risk balance the control of iodinated DBPs and NDMA with the formation of other DBPs.

Bichsel, Y. & von Gunten, U. 2000. Formation of iodo-trihalomethanes during disinfection and oxidation of iodide-containing waters. Environ. Sci. Technol. 34, 2784-2791. (doi:10.1021/es9914590)

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Krasner, S.W., R. Shirkhani, P. Westerhoff, D. Hanigan, W.A. Mitch, D.L. McCurry, C. Chen, J. Skadsen, and U. von Gunten. 2015. Controlling the Formation of Nitrosamines During Water Treatment. Denver, Colo.: Water Research Foundation.

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