ASSOCIATION OF METROPOLITAN WATER AGENCIES

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May 30, 3023

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

Via electronic submission

Re: Docket ID #: EPA-HQ-OW-2022-0114; PFAS National Primary Drinking Water Regulation Rulemaking

Dear Administrator Regan,

The Association of Metropolitan Water Agencies (AMWA), an organization representing the largest publicly owned drinking water utilities in the United States, welcomes the opportunity to provide comments on the proposed National Primary Drinking Water Regulation of PFOA, PFOS, PFBS, HFPO-DA and its ammonium salts (known as GenX), PFNA, and PFHxS. AMWA strongly supports policies that protect public health and economic vitality via safe, affordable, and sustainable drinking water. AMWA appreciates the opportunity to lay out its concerns with elements of the rulemaking – particularly related to costs/affordability and compliance timeline, among many others.

Although AMWA supports regulating PFOA and PFOS in drinking water, AMWA disagrees with EPA's choice to place the lion's share of the financial burden of PFAS removal from drinking water on the American public rather than those producing and manufacturing these chemicals. EPA should be pursuing a polluter pays principle, where polluters are responsible for PFAS pollution prevention and remediation. EPA could mitigate these costs without compromising protection of public health by prioritizing water systems with the highest concentrations of PFAS. By doing so, these systems would gain expedited access to essential project resources including supplies, labor, and funding.

EPA's cost analysis vastly underestimates the real-world costs that this rulemaking will impose on public water systems, and ratepayers will bear those costs. Even worse, those costs will disproportionately affect economically disadvantaged and underserved communities. As EPA

continues to work toward addressing environmental justice, the agency should be working to reduce burdens on these communities, not imposing further financial stresses.
Given the numerous pressing priorities that public water systems are already grappling with, including challenges posed by aging infrastructure, compliance with various regulations, the impacts of climate change, and the current difficulties stemming from inflation, labor shortages, and disruptions in the supply chain, it is evident that more time than what is proposed in this rulemaking will be necessary for the implementation of PFAS treatment technologies. Projects of this magnitude can rarely be done in three years, but with the certainty of additional time, many water systems will be able to come into compliance by the deadline.

The association was able to provide the following comments to EPA in the short, 60-day comment period that was given for such an intricate and consequential rulemaking. In addition to real-world data and information AMWA collected from members who have explored or are currently exploring PFAS treatment, the association commissioned a report on the additional benefits and disbenefits of this proposed rule. This report can help EPA further explore the costs and benefits of its final rulemaking.

AMWA welcomes the opportunity to engage in continued dialogue regarding the effective implementation of this proposed rulemaking, with the overarching objective of enhancing public health protections in a manner that is financially feasible and accessible to all. If you have any additional questions, please contact Brian Redder (Redder@amwa.net), AMWA's Manager of Regulatory and Scientific Affairs.

Sincerely,

Tom Dobbins
Chief Executive Officer

Attachments

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ASSOCIATION OF
METROPOLITAN WATER AGENCIES

Comments on
Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation
Docket ID No. EPA-HQ-OW-2022-0114

May 30, 2023

Comments on behalf the Association of Metropolitan Water Agencies
Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation
Docket ID No. EPA-HQ-OW-2022-0114

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Section 1: Overarching comments

AMWA continues its strong support of regulation based on sound science that is protective of human health. Due to the significant risks of severe health effects and their persistent nature, AMWA agreed with EPA's 2021 final determination to regulate perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) in drinking water. Public water systems (PWSs) and EPA share the same goal of ensuring the delivery of clean, safe drinking water to the public, and AMWA welcomes continued dialogue with EPA on the best ways to accomplish this goal.

PWSs provide an important and valuable service to the public, and the burdens of pollution remediation should not be solely placed on these systems and their ratepayers. Foremost, EPA should focus its resources on incentivizing pollution prevention and regulating per- and polyfluoroalkyl substances (PFAS) pollution where it is manufactured and/or used, rather than putting the entirety of burdens on passive receivers. It is much easier and more cost effective to prevent chemical discharges from entering the nation's waterways than trying to remediate pollution downstream. EPA must do more to hold polluters accountable and implement the "polluter pays" principle, where those causing pollution are responsible for the cost of clean-up. Relying solely on PWS ratepayers to finance the removal of contaminants shifts this responsibility to a "community pays" model, where the burdens of pollution removal are unfairly placed on the public.

AMWA recommends EPA take actions to better identify sources of PFAS in the environment and work to limit these discharges. The agency has recognized the persistent nature of these chemicals; therefore, it should be working toward prevention, as disposal is not a viable long-term option. AMWA appreciates efforts already being made, like the addition of certain PFAS to the Toxics Release Inventory and urges the agency to do more to track and reduce PFAS discharges. Knowing the source of PFAS will allow EPA and PWSs to work to address it at the source and hold those polluters accountable.

AMWA also recommends EPA Office of Ground Water and Drinking Water (OGWDW) work with other line offices and federal agencies to address other routes of public exposures to PFAS. PFAS are in food and food packaging, household and personal care products, fire extinguishing foam, and many other items that the public encounters[1]. EPA and other agencies must work to reduce these exposures and better communicate the risks associated with them. Regulating drinking water should only be one part of a larger, holistic approach to addressing the public's exposure to PFAS.

[1] EPA. (2023, March 16). *Our Current Understanding of the Human Health and Environmental Risks of PFAS*. https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas.

Section 2: Maximum Contaminant Level Goal

EPA is proposing an individual Maximum Contaminant Level Goal (MCLG) for PFOA and PFOS and a separate MCLG for PFNA, PFHxS, GenX, and PFBS as a mixture. The MCLG is the level at which no known health effects are known to occur and allows for an adequate margin of safety. EPA conducted its analysis and consulted with the EPA Science Advisory Board (SAB) to determine the MCLGs for these chemicals.

Section 2.1: PFOA and PFOS

EPA is proposing MCLGs of zero for both PFOA and PFOS. These MCLGs stem from EPA designating PFOA and PFOS as "likely to be carcinogenic to humans," which historically has resulted in an MCLG of zero. The SAB supported this determination for PFOA, and EPA states that it "expects to conduct a final literature search update before the final rule is promulgated."

AMWA recommends one way to strengthen this determination would be for EPA to go further in its analysis to compare PFAS-linked health effect outcomes to population statistics. Such analysis should clearly present information to show the effects PFAS has on the national population by looking at health trends over time, particularly in relation to cancer rates. This will serve to strengthen the MCLG analysis and would work to link PFAS exposure with certain health outcomes. Additionally, EPA should show that geographic areas with PFAS concentrations higher than the proposed MCLGs/MCLs see higher rates locally of certain PFAS-linked health risks.

This addition is important as it will affect the cost-benefit analysis. PFAS are persistent and bioaccumulative; therefore, one would expect to see national trends of associated adverse health conditions and potentially a steady decrease in life expectancy in areas of high PFAS exposure. There are, of course, other factors that would be associated with adverse health impacts and earlier life expectancy, specifically the COVID-19 pandemic and other events affecting the health of the public, but this analysis will strengthen the overall approach EPA has made in this determination.

Section 2.2: PFAS mixture of PFBS, PFNA, GenX, PFHxS

AMWA recognizes the difficulty of addressing a class of compounds that includes thousands of chemicals with many uncertainties. PFOA and PFOS, being some of the most studied and well-known of the PFAS class, have individual proposed MCLGs while the additional four PFAS are proposed to be addressed as a mixture. EPA has proposed using a hazard index (HI) approach for PFBS, PFNA, GenX, and PFHxS, with an HI of 1.0 for the MCLG.

There have been past rulemakings when EPA has used the sum of certain chemicals in regulation. For example, in the Stage 2 Disinfectants and Disinfection Byproducts Rule, trihalomethanes (THMs) and haloacetic acids (HAA5) have an MCL for the sum of certain chemicals in these groups. The HI proposed by EPA is slightly different, as it uses a quotient of

measured concentration in drinking water over a Health Based Water Concentration (HBWC). EPA proposes this measure to address the additive noncancer health effects of these compounds in a mixture. EPA declined to implement individual MCLGs for each compound, which AMWA is supportive of, as more data is needed for these chemicals to proceed with individual MCLGs.

AMWA has some concerns with the proposed HI approach, some of which will be addressed later in these comments, but such a novel approach warrants longer than a 60-day comment period. Regulating groups or classes of PFAS will set a precedent unlike one seen in the past; therefore, EPA should be consulting with stakeholders on the best way to do so before making Regulatory Determinations and proposing regulations in such a rapid and expedited manner. SDWA is very clear on not allowing backward sliding in regulation, so it is paramount that the agency make well-informed decisions that include feedback from stakeholders and use up-to-date data.

Section 3: Maximum Contaminant Level

Like the MCLGs, EPA is proposing individual Maximum Contaminant Levels (MCLs) for PFOA and PFOS, and an MCL for PFNA, PFHxS, GenX, and PFBS as a mixture. Under section 1412(b)(4)(B) of SDWA, EPA must establish an enforceable MCL, "which is as close to the [MCLG] as is feasible." Section 1412(b)(4)(D) subsequently defines "feasible" to mean "feasible with the use of the best technology, treatment techniques and other means which the Administrator finds … are available (*taking cost into consideration*)."

Section 3.1: PFOA and PFOS

EPA has proposed individual MCLs of 4.0 parts per trillion (ppt) each for PFOA and PFOS. EPA also explored the costs of potentially proposing 5.0 ppt and 10.0 ppt, individually. EPA determined the Best Available Technologies (BATs) have the *capability* to bring PFAS levels down below the proposed 4.0 ppt MCL, which AMWA believes is true. However, the costs, supply chain, and labor challenges affecting the compliance timeline, and current and future simultaneous compliance challenges, invite questions as to whether this standard is actually *feasible* under SDWA, as defined in Section 1412(b)(4)(D).

EPA creates some confusion when it states in the preamble, "Measuring PFOA and PFOS results below the practical quantification level (PQL) may not be achievable from all laboratories and may not have the same precision as higher-level measurements, *nor does EPA believe it is appropriate to make potentially costly compliance decisions based on such lower-level measurements*." However, EPA also states that it assumes water systems will treat to 80% of the proposed MCL to include "a margin of safety." Installing these treatment techniques will take several years, so a utility risks being in noncompliance at any moment if it is approaching detection at the proposed 4.0 ppt MCL, even though EPA has expressed that it is not "appropriate" to make costly decisions on these low-level measurements. Therefore, water systems with 3.2-4.0 ppt samples whose running annual average (RAA) is below 4.0 ppt will have to decide to install treatment in case there is seasonal variability or spikes that may put

them out of compliance, potentially costing them, and therefore ratepayers, millions of dollars to get under this margin of safety that cannot be reliably measured.

Several AMWA members have detected PFOA and PFOS in the 3.0-5.0 ppt range and will have to make decisions on how to address PFAS (see Attachments 2, 3, and 4). Source control is an effective way for some water systems detecting PFOS and PFAS at these levels; however, it takes significant time to both identify the source and address the issue, and for levels to decrease in response to the action. Not only will source control save money for ratepayers in these service areas, but it will ease supply chain and labor demands for water systems with higher levels of PFAS that are a greater risk to public health. Source control will also address the problem of PFAS accumulation in the environment. PFAS are known as "forever chemicals" and are very persistent, so preventing PFAS pollution is more responsible and protective of public health than treating after PFAS are released into source waters.

Several states and countries have implemented regulatory limitations of certain PFAS that differ significantly with EPA proposed limits. Some examples are Michigan, New Jersey, New Hampshire, Massachusetts, and Vermont, among several others. States must go through rigorous and thorough reviews of the science and data available to propose and finalize PFAS regulation. EPA's proposed MCLs are significantly lower than every state that has regulated PFOA and PFOS by at least half. This discrepancy makes it difficult to communicate whether water treated to these existing state standards is currently safe, and AMWA asks EPA to further explain why these states' cost-benefit analyses supported their respective levels and why EPA's analysis is different. Water systems must be able to explain to ratepayers why they are paying more for water after the implementation of this NPDWR, and having these differences complicates that task.

Other countries, such as Australia and Japan, as well as the United Kingdom (UK) and European Union (EU), have also approved limits on PFAS in drinking water that are higher than those the EPA has proposed. EPA's proposed limits are still much lower than every one of these. These countries have access to the same research that EPA does. In the UK, samples above 10 ppt require more investigation if actions are needed, while samples over 100 ppt require immediate action[2]. Japan sets a provisional target of less than 50 ppt for PFOA and PFOS combined[3]. Australia similarly sets guidelines at 70 ppt for PFOA and PFOS combined[4]. AMWA supports regulation based on sound science and data and asks EPA to further explain how it came to

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[2] Drinking Water Inspectorate. (2022, July 7). *Water Supply (Water Quality) Regulations 2016 (2018 in Wales) for Poly and Perfluorinated Alkyl Substances (PFAS).* https://dwi-content.s3.eu-west-2.amazonaws.com/wp-content/uploads/2023/01/13123351/IL_03-2022_PFAS_Guidance-4-1.pdf.

[3] The Mainichi. (2023 February 4). *Japan must grasp full picture of chemical pollution amid PFAS detection.* https://mainichi.jp/english/articles/20230204/p2a/00m/0op/008000c#:~:text=Since%202010%2C%20Japan%20has%20also,each%20of%20PFOS%20and%20PFOA.

[4] Australian Government National Health and Medical Research Council. (2023, April 28). *Australian Drinking Water Guidelines*. https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines.

different conclusions than every other state and country currently addressing PFAS in drinking water.

In the preamble, EPA refers to other regulations that have been set at the PQL, specifically the phase 1 Volatile Organic Carbon (VOC) rule. AMWA would like to point out that the levels proposed for PFAS are in the ppt range, while the VOC rule includes compounds like Benzene, which has an MCL in the parts per billion range. When dealing with levels of parts per trillion of ubiquitous chemicals like PFAS, there is significant sensitivity and variability in analytical capabilities. Additionally, at such small concentrations, any sample container, and the handling and transport of samples, create the opportunity for interference or contamination.

It is also worth mentioning that EPA methods 533 and 537.1 allow for variability in sample and spike duplicates[5] and could have significant consequences for water systems' compliance. For samples measured below twice the MRL (i.e., below 8.0 ppt), the accepted relative percent difference (RPD) is 50% or less. To illustrate, suppose a sample is analyzed and found to have a concentration of 5.0 ppt. If the same sample is then reanalyzed and found to have a concentration of 3.0 ppt, the RPD calculation would be 50%, indicating that the laboratory's results are within the acceptable range. If a water sample can yield measurements of 5.0 ppt and 3.0 ppt, the difference between one drop of PFAS in 10 Olympic-sized swimming pools[6], it demonstrates the variation allowed in results that can significantly impact a water system's compliance status. This distinction is crucial because it can determine whether a water system would need to implement costly treatment techniques (5.0 ppt) or require no immediate action as it falls below the MCL with a reasonable margin of safety (3.0 ppt).

The greatest health risks from PFAS in drinking water will come from systems with the highest concentrations, not those at the margins of compliance with EPA's proposal. EPA should work to address these systems first to protect individuals in those service areas. EPA's proposal estimates approximately 4,300 PWSs will be impacted by this rule[7]. AMWA emphasizes that the upcoming implementation of UCMR 5 will provide more accurate estimations of the impacted systems' PFAS levels. Any system with levels above the proposed MCLs must promptly initiate planning and execute interventions to address PFAS contamination once this rule is finalized. It is important to anticipate that this substantial demand will exert significant pressure on supply chains and the labor market. Meanwhile, EPA estimates around 3,300 PWSs would be impacted if MCLs were implemented at 5.0 ppt and about 1,300 PWSs with MCLs set to 10.0 ppt. These 1,300 PWSs with PFOA and/or PFOS above 10.0 ppt should be prioritized, as greater demands in GAC, materials, and labor could prevent these systems from quickly remediating the issue, potentially exposing the public in these service areas to higher concentrations of PFAS for a longer period.

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[5] EPA. (2020, June 6). *Method 537.1*. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=343042&Lab=NERL

[6] Missouri Department of Natural Resources. (2023). *Understanding data.* https://dnr.mo.gov/monitoring/understanding-data

[7] EPA Economic Analysis, (USEPA, 2023j)

If EPA chooses to rush through finalizing this rulemaking before the September 2024 statutory deadline, it would be advantageous to finalize an MCL that is both feasible for PWSs to achieve and meaningfully protects public health. EPA should initially require PWSs with high levels of PFAS – those greater than 10 ppt – to implement actions to reduce PFAS exposure at these PWSs first. Then, EPA can use UCMR 5 and other up-to-date research to further explore lowering that threshold. The agency would still be protecting public health and would simultaneously be alleviating the strains, demands, and increased costs for labor, materials, and construction. This would also allow PWSs with lower concentrations to explore other, less costly, measures to reduce exposures to PFAS, yielding both fiscal and health-related advantages for the public.

Section 3.2: PFAS mixture of PFBS, PFNA, GenX, PFHxS

EPA is proposing a HI of 1.0, equal to the MCLG, for the mixture of PFBS, PFNA, GenX, and PFHxS. Each PFAS in this mixture has a proposed HBWC: 10 ppt for GenX, 2000 ppt for PFBS, 10 ppt for PFNA, and 9 ppt for PFHxS. EPA proposed this action to account for dose-additive health impacts of these chemicals in co-occurrence.

As mentioned earlier, EPA has limited occurrence data for these additional PFAS and is in the process of developing a human health toxicity assessment for PFNA and PFHxS. The human health toxicity assessment should be done *before* a Regulatory Determination, and certainly before a proposed regulation, as this is paramount to assessing the impact on public health. In contrast, EPA in 2022 used a toxicity assessment from 2021 to develop a drinking water health advisory for PFBS, which is currently the basis for its HBWC. EPA should be using the same method to create the HBWC if it plans to group these PFAS into a HI.

AMWA is concerned that this proposed HI would serve as a de-facto MCL for systems that have detected only one of the PFAS chemicals present in their system. These de-facto MCLs are equal to the HBWC EPA has proposed, but the agency is not officially proposing them as individual MCLs, an action AMWA supports. If EPA is addressing the issues these chemicals cause as a mixture and when they co-occur, then it would make sense that a water system would need to have a mixture and co-occurrence (more than one) present to do this calculation.

AMWA seeks further evidence on EPA's claim that HI PFAS have additive adverse health effects and recommends EPA consider grouping these, and any future PFAS chemicals, based on similar health endpoints with the greatest support from data and science. EPA's reasoning for grouping these chemicals was that they had additive health impacts. In Table 42 of the preamble, EPA details the health outcomes associated with the HI PFAS compounds. The only row that indicates the potential health effects of all four PFAS is birth weight, but two of the four chemicals have the subscript "5" which signifies that "evidence of the relationship between PFAS compound and the health outcome is not conclusive."

AMWA is concerned that once there is a holistic view of PFAS occurrence from UCMR 5 data, it will become clear the HI approach may not have been the most appropriate. The addition of

more PFAS to this HI will decrease the quotient threshold each quotient is allowed, without being more protective of public health. For example, right now each PFAS chemical can have a quotient of 0.25 (0.25+0.25+0.25+0.25=1), a value of ¼ of the HBWC and/or health advisories and still be compliant, but if one more PFAS chemical is added to make five, that quotient reduces to 0.2. At some point, the HI of 1.0 will not be attainable with additional PFAS, and EPA will have to evaluate its options on how to group and separate certain PFAS.

Several AMWA utilities, based on their current monitoring data for PFAS, would be in noncompliance based solely on one or more of these PFAS chemicals in the HI. EPA assumes PFOA and PFOS will be the driving force in costs and decisions, but many utilities will have to make decisions primarily on the chemicals included in this HI. This is why EPA must have the best data and information necessary to make the most informed and science-supported decisions.

Section 3.3: Simultaneous compliance

A major issue facing PWSs is simultaneous compliance. Water treatment is an extremely delicate process, and even the slightest change in the treatment train can have dramatic effects on water quality. Water utility managers are facing many challenges unique to their PWSs and are the most qualified individuals to make decisions on what is a priority for that system. Water systems must balance risk-risk tradeoffs to ensure maximum compliance and minimum risks of health effects.

PFAS is just one of many concerns water systems must navigate. PWSs are also addressing lead service line replacement requirements, where some are running into issues with funding and costs both on the public and private side of the service lines. Utilities across the country are working to prioritize the repair and replacement of aging infrastructure. The nation's headlines have shown the consequences of ignored infrastructure maintenance, and with limited resources, many projects must be put on the backburner to ensure compliance with regulations like the one proposed in this NPDWR. Many PWSs are extremely concerned about water scarcity and climate change impacts, which will require new and creative solutions that will likely come at high costs. These examples do not diminish the impact PFAS can have on public health but highlight the demand for resources and difficult decisions water systems must weigh to keep water both affordable and safe.

Water systems also must comply with the many current and future regulations. Even the smallest change in treatment can have negative impacts on other regulated and unregulated contaminants. The type and concentration of a contaminant to be treated with a new technology is extremely important information to have before designing and implementing a new treatment process as these variables affect the size and components of the new system. Therefore, a treatment technique may be applicable to many contaminants, but the effectiveness of removing each of the contaminants can be dependent on how the process was developed. As EPA continues to revise or create new rules, water systems will have to make adjustments that could require more labor and increased costs than EPA originally assumed while drafting NPDWRs.

Section 4: Regulatory Determinations for Additional PFAS

EPA has proposed issuing a regulatory determination for four additional PFAS concurrently with a proposed NPDWR for the same chemicals. Those additional PFAS are perfluorohexane sulfonic acid (PFHxS), hexafluoropropylene oxide dimer acid (HFPO-DA) and its ammonium salt (also known as a GenX chemicals), perfluorononanoic acid (PFNA), and perfluorobutane sulfonic acid (PFBS).

To make this determination, EPA used older data from the Unregulated Contaminant Monitoring Rule (UCMR) 3 and more recent data from states as of August 2021. Some of these states where data was collected have gone through the process of promulgating their regulation for certain PFAS that are included in this determination. For example, Michigan, a state included in Table 1, regulated PFHxS, PFNA, PFBS, and GenX in 2020[8]. This regulation would likely change the percent of samples with detections in those states as utilities presumably would have taken actions to address these detections and stay in compliance. Similarly, New Jersey regulated PFNA in 2018[9]. New Hampshire[10] and Massachusetts[11] regulated PFHxS and PFNA in 2020, while Vermont regulated them in 2019[12]. Each of these states is included in Tables 1 and 2 of the preamble and has implemented measures to reduce concentrations and occurrence of specific PFAS.

An important part of Regulatory Determinations is having a holistic view of occurrence, or nonoccurrence, of these chemicals regionally and nationwide. While EPA does have some older data on occurrence, this data may no longer be accurate as a result of recently promulgated state regulations. Additionally, data from many states is still missing. Fortunately, over the next two years, UCMR 5 will provide EPA with a large portion of data that will be able to fill in these gaps in the understanding of occurrence of these four PFAS chemicals, including data from all systems serving 3,300 people or more, and 800 representative public water systems serving fewer than 3,300 people[13]. This dataset is invaluable in assessing the occurrence of chemicals in the nation's water systems. All four of these proposed additional PFAS are included in UCMR 5.

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[8] Michigan PFAS Action Response Team. (2023). *Maximum Contaminant Levels.* https://www.michigan.gov/pfasresponse/drinking-water/mcl

[9] New Jersey Department of Health. (2022, July). *Per- and polyfluoroalkyl substances in drinking water.* https://www.nj.gov/health/ceohs/documents/pfas_drinking%20water.pdf.

[10] New Hampshire Department of Environmental Services. (2023). *Drinking water.* https://www.pfas.des.nh.gov/drinking-water.

[11] Massachusetts Department of Environmental Protection. (2020). *Massachusetts PFAS Drinking Water Standard (MCL).* https://www.mass.gov/lists/massachusetts-pfas-drinking-water-standard-mcl#massachusetts-pfas-standard-for-public-drinking-water-supplies-

[12] Vermont Department of Environmental Conservation. (2023). *PFAS & Drinking Water.* https://dec.vermont.gov/water/drinking-water/water-quality-monitoring/pfas

[13] EPA. (2021, December 7). UCMR 5. https://www.epa.gov/dwucmr/fifth-unregulated-contaminant-monitoring-rule

EPA should wait until it has the first year of UCMR 5 data to better assess the occurrence of the four HI chemicals in drinking water systems at current achievable analytical levels. AMWA understands EPA's urgency in regulating PFOA and PFOS, and the association strongly supports regulation based on sound science and up-to-date data. That is why AMWA believes at least the first year of UCMR data will be crucial to giving the agency a better understanding of occurrence of these four additional PFAS. With this additional occurrence information, EPA will have the ability to include this information in a cost-benefit analysis that uses the most current data to calculate the number of systems impacted and any additional health benefits associated with these chemicals at levels *known to occur*.

To reiterate, AMWA was and is extremely supportive of the Regulatory Determination to regulate PFOA and PFOS. EPA has the option to move forward with the PFOA and PFOS rulemaking, as the statutory deadline of that Regulatory Determination only applies to those two contaminants based on the timeline outlined under SDWA. EPA can still choose to regulate these four additional PFAS in an expedited manner after a Regulatory Determination is finalized utilizing UCMR 5 data, but AMWA stresses the importance of the UCMR 5 data EPA will soon receive. This UCMR 5 dataset will also fill in some gaps in the cost-benefit analysis regarding this determination and proposal, which is currently missing. Additionally, as the decision in *NRDC v. Michael Regan*[14] demonstrated, once a positive determination is made, even if the UCMR 5 data later show very little to no occurrence, EPA cannot "backslide" or reverse its decision to regulate the contaminant(s). AMWA wants EPA to make the best decision possible on these four chemicals to protect the public's health by ensuring its decisions are well-informed and that the public does not incur unnecessary costs.

AMWA supports EPA in protecting public health by ensuring safe, clean drinking water to the public at an affordable rate. This is why it is crucial EPA is using all the resources available to make these decisions that will have such profound financial implications for the public. EPA always has the authority to strengthen drinking water standards when new data or science presents itself, but the agency is not able to walk back previously finalized standards if subsequently obtained data demonstrates that the occurrence of a contaminant is not as widespread as had been believed. This means that water system ratepayers would be permanently saddled with monitoring and treatment costs related to these low-occurrence contaminants – funding that may be put to better use addressing improving infrastructure or addressing widespread contaminants that do pose broad threats to public health.

AMWA also understands that PFAS are a unique set of substances and that there are challenges in addressing dozens, hundreds, or even thousands of these substances, and as a result, these challenges may need creative solutions. The association has stated before (Attachment 5) that if EPA determines that regulatory action is needed beyond PFOA and PFOS, the agency should use the Negotiated Rulemaking Procedure ("Reg-Neg"). To implement a "Reg-Neg", the agency must decide there is a need for a rule, determine that there are a limited number of identifiable

[14] *NRDC v. Michael Regan*. No. 20-1335. U.S. Court of Appeals. (2023, May 9). https://www.cadc.uscourts.gov/internet/opinions.nsf/E8EC4867311BA7BA852589AA0052854F/$file/20-1335-1998466.pdf

interests that will be significantly affected by the rule, and conclude that there is a reasonable likelihood that a committee could be convened which would consist of a balanced representation of the interests involved.

Due to the unique circumstances surrounding PFAS as a family, AMWA believes regulating additional PFAS would meet the criteria for a "Reg-Neg" and would save the agency time as all key stakeholder concerns would be discussed during a process that would bring those stakeholders into a risk-risk tradeoff discussion to help the agency come to a proposal with a higher likelihood of success. Throughout any regulatory process to address additional PFAS, the agency must consider any future actions within the context that whatever path EPA chooses will set the stage for how the agency addresses other PFAS and other emerging contaminants going forward.

Section 5: Monitoring and Compliance Requirements

Section 5.1: Monitoring

EPA has requested comments on several pieces related to monitoring requirements. The agency has proposed a monitoring regime based on the Standard Monitoring Framework (SMF) for Synthetic Organic Contaminants (SOC). AMWA has been and still is supportive of using this framework to ensure uniformity among rules covering similar compounds (Attachment 5). AMWA also strongly supports maximum flexibilities in monitoring that will reduce burdens on PWSs and still be protective of public health, as EPA has done with other chemicals with chronic health risks.

AMWA is pleased EPA has considered situations in which reduced monitoring is appropriate. However, the agency is proposing a trigger level well below the Practical Quantification Level (PQL) for PFOA and PFOS. Under this proposal, a PWS qualifies for reduce monitoring if its RAA is below the trigger level of 1.3 ppt for PFOA and PFOS and a 0.33 HI for the additional PFAS. This allows water systems to sample once or twice in a three-year period, depending on system size. Because the health effects of PFAS are chronic, AMWA recommends EPA make this reduced monitoring uniform and require all systems, regardless of size, to sample once in the three-year period under this reduced monitoring framework. This would allow for further reduction in burdens on utilities while also not compromising public health.

AMWA has strong concerns with EPA proposing a trigger level below the PQL. As defined in the preamble, the PQL is "the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions." For EPA to consider using values below this would mean using unreliable and potentially inaccurate data to make monitoring decisions. This could lead to costly monitoring requirements at a system that in reality meets these conditions, but laboratory results do not reflect that due to inaccuracy.

PWSs may encounter many difficulties acquiring sampling results required by this proposed rule. Several AMWA members currently have contracts with commercial labs that provide information down to 4.0 ppt, or in some instances 2.0 ppt, depending on the contract details and lab. For those labs to provide any more information, many PWSs would have to amend or renegotiate their established contracts, likely adding costs. Labs are also not always willing to provide information they deem unreliable or inaccurate, meaning values below the lab's own PQL may not be available to many water systems. A prominent commercial lab used by many PWSs has told AMWA members that if they are on UCMR 5 contract and want to see results below 4.0 ppt, they would need an entirely separate sampling event due to quality assurance and quality control (QAQC) differences between UCMR 5 methods and regular EPA methods 537.1 and 533. This would require water systems to sample twice and pay twice to still only be able to see results between 2.0 and 4.0 ppt.

Because of the difficulties associated with a proposed 1.3 ppt trigger level, if EPA moves forward with a 4.0 ppt MCL, then AMWA recommends EPA set the trigger level at 50% of the MCL, or 2.0 ppt individually for PFOA and PFOS, and 0.5 for the HI PFAS. Water systems that qualify for reduced monitoring based on RAAs from UCMR 5 will still need to show they are below 2.0 ppt to continue the reduced monitoring schedule. While this would alleviate some of the burdens for PWSs that do receive sample information below 1.3 ppt, the proposed trigger level, the association stresses that this level is not readily available to all PWSs, particularly those with fewer resources and limited budgets.

AMWA urges EPA to reconsider its decision to not grant monitoring waivers or reduced monitoring based on reduced risks and watershed characteristics, such as proximity to contaminant sources or previous uses within the watershed. Omitting this is inconsistent with other contaminants with chronic health impacts and introduces unnecessary costs. Furthermore, a PWS that cannot prove it is below the trigger level due to lab reporting constraints would never be able to stay in the reduced monitoring schedule. This is because once a system qualifies for reduced monitoring based on its RAA, if it cannot prove it maintains concentrations below the trigger level, the system is automatically thrown back into quarterly monitoring. This can result in systems repeatedly going back and forth between monitoring schedules with no option for providing stability in monitoring timelines unless the system chooses to stick to quarterly monitoring, increasing total costs and resources.

Allowing systems to use watershed characteristics and demonstrations of reduced risk to qualify for reduced monitoring or monitoring waivers would still be protective of the chronic health risks of PFAS. Utilities could demonstrate their reduced risk through a growing abundance of resources and tools. For example, EPA released its PFAS Analytic Tools to bring together multiple sources of information on PFAS sources in one spot with mapping, charting, and filtering functions[15]. Another tool by Azimuth provides information on PFAS-contaminated sites throughout the country that could be used to show a system is not located in these risk areas[16].

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[15] EPA. (2023, May 22). *PFAS Analytic Tools*. https://echo.epa.gov/trends/pfas-tools.

[16] Azimuth. (2021, April 07). *How data science provides a new view into PFAS contaminated sites.* https://www.azimuth1.com/blog/pfas

Additionally, more data continues to be available on PFAS occurrence as EPA takes actions to identify and report PFAS industrial discharges and sources. A PWS would still be sampling at a reduced rate to check for detections of PFAS but will lessen the burdens and confusion of qualifying for reduced monitoring based on RAA and then being disqualified for an individual sample they cannot accurately demonstrate is below the trigger level.

AMWA appreciates EPA's consideration of reducing burdens on PWSs in the proposed rule and believes the above recommendations will achieve that goal without compromising any health benefits. Allowing PWSs with lower concentrations and risks to have a reduced monitoring schedule will ease burdens of costs and labor on the utility while still requiring the system to show continued low concentrations and risks.

Section 5.2: Individual entry point compliance monitoring

EPA seeks comment on allowing water systems to potentially have entry points to the distribution system (EPTDS) on different monitoring schedules. This would allow a system with multiple entry points to potentially be required to monitor quarterly at one entry point and qualify for reduced monitoring at another. AMWA agrees with this decision and believes that this reduction in sampling will save valuable resources for PWSs with more than one entry point that may have different RAAs for the proposed PFAS. It is important to note that it is also not mandatory that a water system participates in reduced monitoring if it qualifies, so a system does have the option to keep all its EPTDS on the same sampling schedule.

If EPA were to mandate a uniform monitoring schedule for all EPTDS, it would result in significantly more samples that utilities must collect, analyze, and report. However, this uniformity would not enhance public health protection if a particular entry point qualifies for reduced monitoring. The potential consequences of such a requirement, including increased costs and strain on laboratory capacity, lend substantial support to EPA's proposition of allowing different monitoring schedules based on individual EPTDS circumstances.

Section 5.3: Initial compliance monitoring

EPA is proposing to allow PWSs to use previously acquired monitoring data from UCMR 5, state-led, or other applicable monitoring programs using EPA Methods 533 or 537.1 as the initial monitoring data for determining compliance. AMWA strongly agrees with this decision and recognizes the initial monitoring burdens this approach will erase for systems that would have been required to conduct a separate sampling campaign. AMWA supports the utilization of UCMR and other monitoring data whenever possible, as this will help with lab capacity and sample analysis costs.

Section 5.4: Compliance calculation

EPA is proposing a RAA approach to compliance calculation. PWSs must take quarterly samples, a minimum of 4 per year per EPTDS, and use the average of the four. This is consistent with other regulation and would provide stability and familiarity with sampling calculations.

AMWA also strongly supports EPA's proposal to report values below the PQL as 0 to calculate the RAA. An alternate approach EPA considered in the proposal is using the trigger level (1/3 of the PQL), as the value when concentrations are below the PQL. If EPA were to adopt this version, no water system would be able to qualify for reduced monitoring. If a utility has all quarterly samples below 4.0 ppt, the proposed method will give them a RAA of 0, and they would be below the trigger level and qualify for reduced monitoring. That same utility under EPA's alternative approach would have a RAA of 1.3 ppt. The preamble states that water systems qualify for reduced monitoring if they "do not detect regulated PFAS in their system **at or above the rule trigger level**," so being at the trigger level does not qualify a system for reduced monitoring.

Section 5.5: Lab capacity

EPA is requesting comment on the underlying assumptions: that sufficient laboratory capacity will be available with the MCLs set at 4.0 ppt; that demand will be sufficiently distributed during rule implementation to allow for laboratory capacity; and on the cost estimates related to these assumptions. AMWA has serious concerns over the ability of certified labs to not only reliably process the number of samples this rule will require, but also to evaluate the number of additional samples water systems will take for their own system evaluation purposes. While EPA has proposed some possible avenues to reduce the number of samples required under this proposed rule, the agency should also consider the number of samples beyond general compliance that will be generated due to the proposal.

AMWA members are currently underway with UCMR 5 sampling. UCMR 5 includes all six PFAS included under this proposed regulation. PWSs are already experiencing issues with getting data back in a timely manner, in addition to increased costs of sampling, sample transport, sample analysis, and even mishaps at labs where samples are thrown out before they can be retested. Many AMWA members rely on one commercial lab for PFAS analysis due to costs, availability, and access. Currently, AMWA members are waiting between one and three months for PFAS sample results. These issues are being seen during implementation of UCMR 5, even before other systems will have to start their initial monitoring.

One additional unintended consequence of this delay in results is the current proposed revisions to the Consumer Confidence Report (CCR) Rule. The proposed revisions would require a PWS to update its CCR later in the year after delivery of the first if new UCMR data is received after delivery of the first report. With continued and worsened delays in receiving PFAS results, utilities who typically finalize reports in February or March before a quarterly billing cycle will have to update their CCR later in the year, delaying the delivery of results to customers by up to

12 months. The alternative would be to spend additional resources sending out the CCR separately from quarterly billing, which is neither efficient nor cost-effective.

In the months following the promulgation of the rule, utilities with PFAS near or above the finalized MCLs will start the sprint toward treatment. Pilot studies will need to be conducted to determine the best treatment approach, how the treatment will affect other regulated and non-regulated contaminants, and the total efficacy of the treatment. As the investment in this treatment will be extremely significant, utilities need to be sure they are making the right long-term decision. This will result in many more samples being taken to assess what route a utility should take and what effect this will have on other elements of the treatment process.

Due to the cost compared to the other options and the success of granular activated carbon (GAC) and Ion Exchange (IX) at removing PFAS from drinking water, these will likely be options that many utilities choose. For these treatment techniques, water flows through a media that removes the PFAS from the water, leaving it in the media. While the media remove certain PFAS, media will become spent, requiring replacement or reactivation.

In the proposed rule, EPA estimates PWSs serving over 3,300 people will, at most, sample quarterly for initial and long-term compliance. While that timeline may be what EPA requires to show compliance, it is not the reality for many water systems. Because a water system needs to know how often it needs to replace its media, water systems will have to perform sampling throughout the column or bed to ensure PFAS is still being removed from the water and the media is still performing adequately. This will significantly increase the number of samples water systems have to take and, therefore, get analyzed by a lab. For example, one specific member serving over 2 million people has been consulting on the potential treatment they will need to comply with the rule. This system would have to install concrete 24 gravity contactors – 12 lead and 12 lag – that include four sample ports at different depths to assess GAC performance. This water system's sampling protocol to assess the efficacy of the GAC and switch between lead/lag arrangement would result in (12x4) + 12 = 60 samples per month on average, or 720 samples a year. That is significantly more than the four per year per entry point required under the rule, is not unique to this singular utility, and is less than other utilities are projecting.

Another PWS, serving almost one million people, indicates that it plans on carrying out biweekly sampling of raw and finished water at all treatment plants for operational control and treatment performance, totaling approximately 415 samples per year. Additional testing for other aspects of treatment, such as developing dosage curves with specific carbon under varying water-quality conditions, carbon-type testing for procurement, and more uses, could result in around 50 more samples a year. Adding these to general compliance sampling, this PWS will have to process about 500 samples a year using EPA methods 537.1 or 533, or in some cases both. A final AMWA member serving around 400,000 people estimates that between UCMR/NPDWR samples, source water investigation (2-3 years), rapid small-scale column tests and pilot (2-3 years), and full-scale treatment applications, it will have to analyze at least 168 samples per year through 2026 at least, with only 8 of those being compliance/UCMR 5 monitoring samples.

EPA states in the proposal that 54 laboratories submitted applications for EPA approval to analyze PFOA and PFOS under UCMR 5. While more labs can become certified in the future once the rule is promulgated, the initial demand for sample analysis will be overwhelming. Using EPA's estimated number of systems, a mean of about 4,300, without factoring in required compliance monitoring, leads to an additional 258,000 samples a month. Split between 54 approved labs, each of them would have to process approximately 4,700 samples a month. Add in UCMR 5 and required monitoring under this proposal for *every* PWS, and that number increases. This is a back-of-the-envelope calculation, but these are additional strains EPA may not have considered and will be the reality for many water systems trying to get data back in a timely manner. This estimate also does not account for other wastewater and/or biosolids samples that will likely be competing for lab analysis.

Several AMWA members are looking into the creation of an in-house or affiliate lab to avoid the issues they currently or may face with limited lab capacity for PFAS samples. In-house labs are extremely costly to startup and require extensive operational and maintenance costs. Utilities who have explored this option, typically mid- and large-sized utilities, have seen a minimum equipment cost of $0.5 million, $400,000 for analytical instruments, and $100,000 for the autosampler and extraction system. This does not include space procurement, labor, and maintenance costs, which would likely be greater than the equipment cost. Additionally, the certification process can be time-consuming and tedious. Even with high start-up costs, PWSs are still considering it due to the ongoing issues with other labs and concerns about being held non-compliant for actions outside their control.

Section 5.6: Compliance timeline

EPA is proposing a three-year compliance time from the promulgation of the rule. A state or EPA may grant up to a two-year extension if it is determined that an individual system needs additional time for capital improvements, giving up to five years **if** the state or EPA grants the extension. Additionally, EPA or the primacy agency may grant an extension of three additional years beyond the five for systems meeting specific demands criteria explained in SDWA § 1416. Small systems have the option to apply for a series of three, two-year extensions beyond this total of eight provided to medium and large systems. This is the compliance schedule laid out in the SDWA.

AMWA cannot stress enough that the three-year compliance deadline will not be enough time for many water systems impacted by the proposal to complete capital improvement projects to address PFAS. AMWA members have indicated that a project of this magnitude would take a minimum of five years if this project was the only utility priority and there were no delays or issues that arise from the supply chain, labor, or permitting and procurement processes. Others have estimated 10+ years. While SDWA does allow for a two-year extension and potentially a three-year exemption, these are not guaranteed **and** are at the discretion of the primacy agency or EPA.

The process for a PWS to complete a project of this magnitude is long and tedious. While each water system is different, there are similarities in the process that most must follow, and some unique pieces that are worth consideration. AMWA members are publicly owned and must go through certain channels for approvals at each step of the process. There are deeper considerations that some must address when it comes to rate increases, permitting, and general budgeting for improvement projects. Many of these steps must be approved by boards, councils, and/or elected officials.

Some examples of PWS timelines for specific utilities are included in Attachments 2, 3, and 4. Typically, approvals need to be granted for a project this size, which can take months based on scheduling and other priorities within a municipality. Water systems will then need to design and conduct pilot studies to determine the best approach to treatment, assess impacts on other aspects of treatment, determine the specific needs of the water system, and determine the efficacy of the chosen treatment. Design and building of these pilots can take 18 months to three years. These pilots would also need to capture seasonal variability in source waters, so this process can take about 12 months.

Many utilities must go through local land use or zoning processes to obtain approval to construct any facilities. This process can take six to eighteen months, preceded by at least six months of preliminary engineering and development of other application materials including an alternatives analysis. The zoning process is separate from and a prerequisite to obtaining site plans and building permits, processes that can take another six to twelve months. In between zoning and site permitting, the detailed design and development of bid documents would occur, a process that can take twelve to eighteen months depending on the complexity of the selected treatment process.

Public utilities are also subject to public procurement regulations. These processes add additional time to the design and construction process. Development of a request for proposals for project design services, receipt and review of proposals, the consultant selection and negotiation process, and contract award typically take six months or more. The process for receiving bids for construction and awarding those contracts will take another three to six months. While some public utilities may be able to employ alternative procurement methods, not all are able to do so, and even alternative methods will only shorten timeframes associated with the design and construction phase.

Construction of the treatment alternatives noted in the rule (GAC, IX, RO) would be additional treatment trains. Construction phasing to maintain plant operations and ensure an adequate supply of drinking water to the public is critical. Tie-ins to existing infrastructure will be necessary and must occur during low-demand periods (often wintertime or other low-use time based on location) to ensure sufficient water production capacity to meet community needs. These construction staging intricacies will further lengthen the time to construct PFAS treatment improvements. Construction and commissioning timeframes will be project and site-specific but could in some cases take three years.

PWSs and other sectors across the country are currently experiencing increased pricing of goods and services, supply chain disruptions, and labor shortages. The proposed compliance period would be impossible for many utilities to meet without extensions. EPA needs to include considerations for how the increased demand for contractors, materials, equipment, and other labor will prolong projects and drastically increase prices, costs that eventually must be passed on to ratepayers and impact a utility's ability to provide affordable water to the public. Currently, even before this rule is finalized, some GAC suppliers have advised that the lead time for GAC vessels for PFAS treatment is eighteen months. This is not a unique situation, and many utilities must prepare for the situation to worsen if this rule is finalized as is.

While AMWA supports the proposal's overall goal of protecting public health by delivering safe, clean, and affordable drinking water to the public, a compliance period of three years will simply be impossible for many PWSs to meet. There are several options EPA could pursue to alleviate burdens on public systems while still implementing feasible actions that will ultimately be more protective of public health from the chronic conditions attributed to PFAS exposure.

In the proposed rule preamble, the agency states "EPA does not intend to provide a two-year extension nationwide." AMWA urges EPA to reconsider this decision. While states may provide an extension on a case-by-case basis, there is no guarantee that the extension will be granted. Many other social and political factors may pressure a state's primacy agency to not grant any extensions even when it is warranted and justified. EPA could provide some relief to water systems by providing this blanket extension nationwide and could potentially ease the immediate impacts on labor markets and supply chains. Additionally, EPA could provide guidance to states on when is appropriate to provide a three-year exemption, particularly when a utility is acting diligently to implement treatment, but constraints out of its control have prevented completion in the five-year period.

EPA could also take a similar approach it did with the arsenic rule (see table below), where systems were eligible for an exemption based on contaminant concentrations[17]. Water systems would still get five years for compliance but would be eligible for the three-year exemption based on the concentrations of PFAS in their system. A potential option would be using over or under 10.0 ppt, as EPA already explored the option of a 10.0 ppt MCL and approximates 1,300 systems would be impacted. These 1,300 systems would need to be in compliance in the 5 years, but those under 10.0 ppt would have a little more time to explore other options or to spread out the demand for materials and labor.

[17] EPA. (2002, August). *Implementation Guidance for the Arsenic Rule*. https://www.epa.gov/sites/default/files/2015-09/documents/2005_11_10_arsenic_ars_final_app_g.pdf

Table 1: Exemption Eligibility Based on "Unreasonable Risk to Health" Criteria

Systems Serving	Total Compliance Time after 01/22/2001	Exemption Periods Available	Would an exemption be granted for these arsenic concentrations?				
			> 35 ppb	> 30 ppb but ≤ 35 ppb	> 25 ppb but ≤ 30 ppb	>20 ppb but ≤ 25 ppb	≤ 20 ppb
> 3,300 persons	8 years	3 years (2006-2009)	No	Yes	Yes	Yes	Yes
≤ 3,300 persons	8 years	3 years (2006-2009)	No	Yes	Yes	Yes	Yes
	10 years	5 years (2006-2011)[a]	No	No	Yes	Yes	Yes
	12 years	7 years (2006-2013)[b]	No	No	No	Yes	Yes
	14 years	9 years (2006-2015)[c]	No	No	No	No	Yes

[a]Includes the initial 3-year exemption available to all systems and the first of three 2-year small system extensions.
[b]Includes the initial 3-year exemption available to all systems and two of three 2-year small system extensions.
[c]Includes the initial 3-year exemption available to all systems and all three 2-year small system extensions.

This would allow for systems with the highest concentrations of PFAS, and therefore the highest risk to public health, to address the issue first and have first access to all the materials and labor needed for treatment, like a "worst-first" approach. Water systems that are closer to the MCL would have a little longer to comply to alleviate strains in the supply chain and labor and would not provide an unreasonable risk.

Another benefit to this approach would be that water systems close to the proposed MCL would have time to consider less costly and invasive approaches to compliance. As stated earlier, AMWA believes source water protection should be EPA's highest priority when it comes to preventing contamination of drinking water supplies. If water systems that are close to the MCL have time to identify the sources of PFAS in their watersheds, they can try to address the issue there instead of spending millions on treatment that may not be necessary.

A feasible compliance timeline is paramount to the success of this rulemaking. Rampant noncompliance places an unnecessary burden on primacy agencies and EPA and undermines public trust in drinking water. The public would be better served by knowing the path to compliance is achievable than by being routinely notified that their drinking water fails to meet newly implemented standards. Repeated notices of noncompliance will only drive more people to drink bottled water, which, ironically, does not have to comply with the same PFAS monitoring and treatment standards. EPA and AMWA must work together to build and maintain trust in drinking water. Unfortunately, distrust of drinking water leads to individuals, including those in low-income and underserved communities, spending money needlessly on less-regulated bottled water.

Section 6: Safe Drinking Water Right to Know

Section 6.1: Public notification

EPA is proposing a tier 2 public notification for a violation of one or more of these three proposed MCLs. AMWA believes this is consistent with existing regulation and general practice and, therefore, supports EPA's decision. AMWA would, however, like to comment on EPA's assumption of full compliance with the proposed rule and subsequently not include any costs related to public notification in the cost-benefit analysis.

Historically, health-based violations of drinking water regulations have increased immediately after new regulations are enacted as utilities work to perfect treatment operations or finish capital improvement projects[18]. It is not practical to assume full compliance when a rule of this magnitude will result in water systems having to plan and implement large capital improvement projects that will likely not be finished in the short three-year compliance time span EPA has proposed. These public notification requirements can result in significant costs to utilities that are taking all necessary actions to be in compliance with the rule but are not given enough time to carry out and finish projects. Therefore, AMWA suggests EPA include some costs related to public notification in its economic analysis to more accurately portray the overall costs that the agency's proposed rule will pass to ratepayers.

Section 6.2: Communication

EPA is seeking comments on what may be needed for water systems to effectively communicate information about the PFAS NPDWR to the public. AMWA is aware that EPA's PFAS Action Plan includes an action to work "collaboratively to develop a risk communication toolbox that includes multi-media materials and messaging for federal, state, tribal, and local partners to...help ensure clear and consistent messages to the public." The association would like to emphasize the critical need for these tools to be developed as soon as possible and asks EPA to include AMWA in the collaboration to work with the agency to develop useful and timely communication material that will help water systems explain EPA's decisions to the public.

EPA should also be at the forefront of explaining the relative risk from drinking water compared to all PFAS exposure pathways. The public should be informed of the other sources of PFAS and how drinking water is only a portion of that. This helps the public make decisions that can limit their PFAS exposure from more than just drinking water, which further protects public health, and does not place the entirety of blame on PWSs. Water systems are removing contaminants from drinking water that other parties put in, so EPA and water systems need to work together on messaging to inform the public about who is responsible for contamination, what can be done to lessen or stop it, and what choices consumers can make to limit their exposure.

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[18] Allaire, M., Wu, H., and Lall, U. (2018). National trends in drinking water quality violations. *Proceedings of the National Academy of Sciences*, *115*(9), 2078-20823. https://www.pnas.org/doi/10.1073/pnas.1719805115.

An important message that has been made difficult to communicate to the public is letting customers know that their water is safe to drink, even when PFAS concentrations are below detection limits. EPA's announcements of health advisories that are in the parts per quadrillion realm made it difficult to say that the water was safe to drink because water systems cannot detect the presence of contaminants at those levels – and therefore cannot tell customers whether their water meets EPA's health advisory. Additionally, EPA had proposed using drinking water health advisory levels for HBWCs in this NPDWR rulemaking. Questions will arise on why the health advisories are used for some PFAS but not others, and the public will lose trust in drinking water if these inconsistencies are not effectively communicated. EPA made these decisions based on its analysis, and, therefore, should be the leader in these communication efforts.

This communication would be helpful for utilities to use in their CCRs. AMWA would like to stress that not all communication techniques work for every utility, so it is important any EPA language be guidance, not required CCR language, for water systems. AMWA welcomes the opportunity to partner on PFAS communication efforts but believes EPA should be the leader in developing and disseminating communication on PFAS health advisories, MCLs, and all information related to the PFAS NPDWR to the public.

Section 7: Treatment Technologies

EPA has identified three readily available treatment technologies that are successful in removing PFAS from drinking water. These three treatment techniques, identified as the BATs, are granular activated carbon (GAC), anion exchange (AIX), or high-pressure membranes, such as reverse osmosis (RO) and nanofiltration (NF). AMWA agrees with EPA's assessment that the proposed MCLs are technologically feasible, but also would like to urge EPA to further explore the economic feasibility of these treatment techniques.

Because PWSs must individually weigh a number of factors before deciding which treatment technology to employ, it is essential that utilities have an adequate amount of time to comply with the proposed NPDWR. PWSs have significant differences in the composition of their source waters, as well as different environmental factors, which can influence a system's water quality. For example, source water composition is different depending on climate, region of the country, and type of water source. Utilities must consider these factors when new treatment techniques are required. The decision on which treatment technologies to use require extensive time and research to make the best choice with minimal negative effects, highlighting the need for an extended compliance timeline.

Section 7.1: Sufficiently available and cost-effective

EPA specifically states in the preamble that it estimates GAC treatment will be sufficiently available to support cost-effective compliance with this proposed regulation. As discussed, water systems at this time are seeing approximately 18-month lead times on GAC vessels for PFAS treatment. This timing does not seem to be sufficiently available when that is half of EPA's

proposed compliance timeline of three years. Should the rule be finalized in its current form, spurring additional nationwide demand for these products, it is likely lead times will increase.

There are considerable concerns over which systems will get priority for the new GAC as well. Systems that already have existing contracts, whether the system is using GAC for total organic carbon (TOC) removal or compliance with a state PFAS MCL, are concerned new contracts may receive priority based on new prices or agreements. Conversely, treatment technology suppliers may not prioritize issuing new contracts if demand is already high with existing contracts. Due to costs, EPA's recommendation, and other factors, GAC will likely be a top choice for many utilities required to apply treatment; therefore, it is imperative EPA thoroughly assess the capacity of suppliers to ensure availability of GAC filtration.

PWSs will likely encounter difficulties implementing any treatment techniques due to increased demands on the supply chain and other regulatory requirements. Similar to GAC, PWSs considering AIX may find it both more difficult and more expensive once the final rule triggers higher demand. Furthermore, other requirements imposed on water systems, like Build America, Buy America (BABA) requirements, can make acquiring certain materials difficult and prolong acquisition timelines.

Another concerning aspect of these technologies is that the removal media does not maintain the same level of performance indefinitely and will require routine replacement or reactivation. For AIX, once the resin has been spent, there is no feasible way to reactivate it. GAC can be reactivated but only a finite number of times. With levels proposed at the PQL of 4.0 ppt, water systems that have already implemented one of these technologies for PFAS treatment will face increased costs and must revise treatment plans. To reliably treat down to the proposed level, which is half the level of the lowest state MCL, will require much more frequent replacement of media. In some instances, PWSs have indicated this will cut their media life in half. This will significantly increase operation and maintenance costs and will also require more frequent and distant transport by trucks of spent material to disposal sites or fossil-fuel-operated reactivation facilities, resulting in more contributions of greenhouse gas (GHG) emissions and quickly fill landfills. With only a select few GAC reactivation facilities in the country, significant transport costs, often time across state lines, will be required.

AMWA wants to reiterate that EPA and the association are both working toward the same goal of protecting public health by providing drinking water that is not only clean and safe but also affordable. Many utilities across the U.S. are struggling with the ability to maintain affordable rates in light of routine required capital and regulatory projects. Regulations must not put unnecessary financial burdens on ratepayers. Any economic hardship can cause individuals to have to make difficult choices like choosing between paying water bills and buying groceries. Access to safe, clean drinking water is a necessity, and it is important to develop regulations that do not unnecessarily compromise the abilities of PWSs to provide water access that is affordable and equitable.

While AMWA was and continues to be extremely supportive of the passage of the Bipartisan Infrastructure Law (BIL), the money provided will be insufficient to cover the cost of this rule.

Between replacing lead service lines, addressing water scarcity, and upgrading aging infrastructure, there simply are not enough federal funds to offset large increases in water bills. It is difficult for utilities to justify rate increases when federal funds available are presented as grants and a catch-all fix to the affordability issue. EPA should use the momentum of recent federal legislation to highlight projects being done with federal funds but also illustrate the need for funding for projects that still need to be done.

Section 7.2: Alternative treatment technology

EPA requested additional information on PFAS removal treatment technologies not identified in the proposed rule that have been shown to reduce levels of PFAS to the proposed standard. Several AMWA members are currently undergoing testing of some emerging alternative absorbance media, like clay, specifically for PFAS removal. Because clay media does not co-remove TOC, it would be beneficial for utilities that have raw water TOC levels that could interfere with other PFAS-removing media. AMWA recommends EPA consider additional treatment techniques once they have been fully tested and shown they meet PFAS removal targets. More options for media would decrease demand for others, like GAC, where there may be a struggle to meet demand.

PWSs testing alternative absorbance media technology have seen initial signs of adequate removal efficacy and have found initial costs to be comparable to AIX and GAC. These alternative media even have the potential to require lower operation and maintenance costs over their lifetimes. As evident with the other technologies EPA lists, there is still uncertainty over the disposal options of the media. AMWA requests that EPA keep additional absorbance technologies in mind and consider their use when possible.

Section 7.3: Co-removal of contaminants

EPA is seeking comments on the utilization of the proposed BATs as sound strategies for addressing PFAS and other regulated and unregulated contaminants that occur in drinking water. Specifically, EPA seeks further comment on the co-removal of HI chemicals and the usefulness of GAC in removing other regulated and unregulated contaminants, like precursors to disinfection byproducts (DBPs). EPA states several times in the preamble that GAC will be effective in removing DBP precursors, something currently being discussed in the National Drinking Water Advisory Council (NDWAC) Microbial and DBP (MDBP) Rule Revision Working Group process.

AMWA cautions EPA in assuming that a treatment technique like GAC will universally co-remove other contaminants. A GAC facility specifically designed to remove PFAS may not be as efficient at removing DBP precursors or other contaminants, as the size and components of the facility were not designed for that purpose. Similarly, current GAC facilities in use for TOC removal may not be removing PFAS to levels required for this proposed rule. These "co-removing" contaminants must also compete for adsorption sites on GAC, further reducing media life and diminishing the effectiveness of PFAS removal. Any changes to these treatment facilities

currently in place may require more construction, increased capacity, and further testing to assess other risk trade-offs.

AMWA would also like to point out that different PFAS mobilize differently through filter columns or beds, indicating that treatment techniques may not universally co-remove contaminants. Shorter chain PFAS tend to move faster through filter media and can be more difficult to remove, often driving the treatment design. If a water system is coming into compliance with an MCL for a longer chain PFAS, there may not be as much co-removal of shorter chain PFAS. Ultimately, treatment facilities need to be tailored to the contaminant of interest. A PWS having a treatment facility in place does not inherently mean the system can be easily adjusted to address more or different contaminants without compromising compliance elsewhere.

Section 7.4: Disposal and reactivation

EPA requests comment on the availability of facilities to dispose of or reactivate drinking water treatment media containing PFAS. Specifically, EPA seeks comment on whether there is sufficient capacity to address the increased demand for disposal options. Typically, spent GAC and AIX media need to either be disposed of in a landfill, reactivated (for GAC only), or incinerated. Looking at the PFAS issue holistically, disposing of media simply takes the PFAS from one area and moves it to another. This is not a long-term solution for PFAS management, and AMWA requests that EPA prioritize and invest in better solutions for PFAS disposal and destruction. As EPA has mentioned, PFAS are extremely persistent; therefore, moving PFAS around will only increase the stockpile of the chemical, increasing the likelihood of localized contamination events. As polluters continue to release PFAS into the environment, there needs to be a solution to safely eliminate it to ensure that communities near disposal sites are not put at risk due to the actions of polluters.

PWSs do not have the capacity on site to temporarily store spent media. Therefore, there must be availability for spent PFAS media disposal or reactivation with no delay. AMWA is very concerned about the ability to transport and dispose of media containing PFAS as the agency moves forward with designation of PFOA and PFOS as hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). If EPA takes this action, wastes of these substances would no longer be allowed to be disposed of in industrial solid waste or municipal landfills. Instead, these waste streams would have to be sent to specified hazardous waste landfills. Additionally, this media would need to be transported by individuals and vehicles with the qualifications to transport hazardous waste. EPA is also in the process of soliciting comment on the possibility of designating more PFAS as CERCLA hazardous substances, further hindering the capacity for disposal space. This would increase the cost of disposal of media containing PFAS, with the financial burdens likely falling on ratepayers rather than those directly responsible for the pollution.

AMWA and other drinking water and wastewater organizations have consistently asserted that any such hazardous substance designation for PFAS must be accompanied by targeted liability

protections for water systems. In the case of drinking water systems that filter PFAS from their water supplies, a hazardous substance designation without liability protections would put these systems at risk after they dispose of water treatment byproducts at an appropriate landfill. Should that landfill ever be the subject of a CERCLA cleanup because of PFAS contamination, the water system could be held liable as a potentially responsible party even if it followed all legal requirements when disposing of the byproducts. EPA has discussed an "enforcement discretion" policy under which it would not pursue this type of PFAS-related CERCLA claim against water systems, but this would be administration-dependent and do nothing to prevent a polluter from undertaking a private right of action claim against a water system to attempt to reduce its liability exposure. The cost analysis of this rulemaking cannot be accurately calculated without taking these potential CERCLA cleanup costs into account.

EPA also requests comments on the impacts the disposal of PFAS-contaminated media will have on communities adjacent to disposal communities. EPA's proposal involves removing PFAS from communities and essentially storing and disposing of it near others, which are in many cases underserved and disadvantaged communities. EPA needs to prioritize research into better destruction techniques that do not harm communities that have already been historically underserved. Disposing of media containing PFAS near these communities compromises the agency's goal of protecting public health.

Environmental justice and climate change impacts are huge issues PWSs must address and are at the forefront of this Administration's priorities. However, this proposal not only puts underserved and disadvantaged communities at risk, but it will also significantly raise drinking water rates of some of the most vulnerable populations. A recent study by Liddie, Schaider, and Sunderland (2023)[19], found that "[Community water systems] serving higher proportions of Hispanic/Latino and non-Hispanic Black residents had significantly increased odds of detecting several PFAS." Consequently, the costs of PFAS removal will not only fall on ratepayers, but it will disproportionately affect Hispanic/Latino and non-Hispanic Black ratepayers. EPA should reflect on this conclusion and work to reduce burdens on these communities when finalizing this proposal.

Section 8: HRRCA/Economic Analysis for the proposed NPDWR

Section 8.1: Evaluation of benefit-cost analysis

AMWA and AWWA commissioned Policy Navigation Group (PNG) to prepare a benefit-cost analysis of EPA's proposed rulemaking to set federal drinking water standards for certain PFAS. The report (Attachment 1), "Benefit-Cost Analysis of EPA's Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation" (PNG Analysis) compares EPA's approach to estimate the social benefits and social costs with federal requirements for regulatory analysis and best practices in the field. PNG also prepared an economic impact analysis of the

[19] Liddie, Schaider, and Sunderland. (15 May 2023). Sociodemographic Factors Are Associated with the Abundance of PFAS Sources and Detection in U.S. Community Water Systems. *Environmental Science & Technology.* DOI: 10.1021/acs.est.2c07255

proposal's effect on household income.

EPA's methodology in its proposal falls short of the best practices for these requirements. Specifically, EPA failed to conduct a formal uncertainty analysis and neglected to consider all the opportunity costs of its proposal. Per EPA's Guidelines for Preparing Economic Analyses[20], the social costs of a rule represent the total burden that a regulation will impose on the economy. Social costs are "defined as the sum of all opportunity costs incurred as a result of a regulation where an opportunity cost is the value lost to society of any goods and services that will not be produced and consumed as a result of a regulation."[20]

Section 8.2: Assessment of EPA's cost estimates

EPA's analysis grossly underestimates the costs of the rule in several ways, including not accounting for inflation and the social cost of carbon. First, EPA prepared its cost estimates before the full effect of inflation and supply chain constraints took hold. As a result, water utilities, like other businesses and consumers, continue to see major price increases. Inflation and supply chain issues continue to drastically impact the American economy, including the water sector. AMWA members have reported price increases from 20-120% (Attachment 2), with water supply chemicals seeing the highest increases. GAC costs also continue to rise.

A June 2022 US News and World Report article, *Inflation Taking the Bite out of New Infrastructure Projects*[21], stated that construction project costs are at least 25-30% higher than in 2021. The article specifically cited the costs of ductile iron pipes and fittings at 25% higher than the previous year. EPA estimated its cost projections in 2021 dollars, so at a bare minimum, construction costs are likely 25-30% higher than agency estimates. Additionally, these estimates using 2021 data will not take into account potentially higher prices, driven by increased demand as a result of this rule promulgation.

In addition, energy costs are also on the rise, as seen in Attachment 2. In its proposal, EPA neglected to include the social costs of carbon – both the benefits and disbenefits – to calculate the economic impacts associated with the rise in greenhouse gas emissions due to the implementation of treatment technologies to address PFAS at drinking water utilities. GAC, the treatment technology many utilities will install to meet this NPDWR, is also typically derived from bituminous coal and reactivated in multiple hearth furnaces operating at high temperatures using fossil-fuel energy. In addition, transport to and from the reactivation facility is done over long distances with diesel trucks. EPA must take these costs into account to make accurate estimations to influence informed decision-making.

AMWA would like to highlight a study prepared for the American Water Works Association (AWWA) by Black & Veatch that assesses more accurate costs of this proposed rule

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[20] EPA. (2010) *Guidelines for Preparing Economic Analyses. Chapter 8: Analyzing Costs.* https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses

[21] Associated Press. (2022, June 1). *Inflation taking bite out of new infrastructure projects*. https://www.usnews.com/news/business/articles/2022-06-19/inflation-taking-bite-out-of-new-infrastructure-projects

implementation using current real-world data[22]. While EPA's estimated range of annualized costs is around $770 million to $1.2 billion, this Black & Veatch study uses real-world data to assess the economic impact of this proposal, finding that the costs of this rulemaking could exceed $3.2 billion annually.

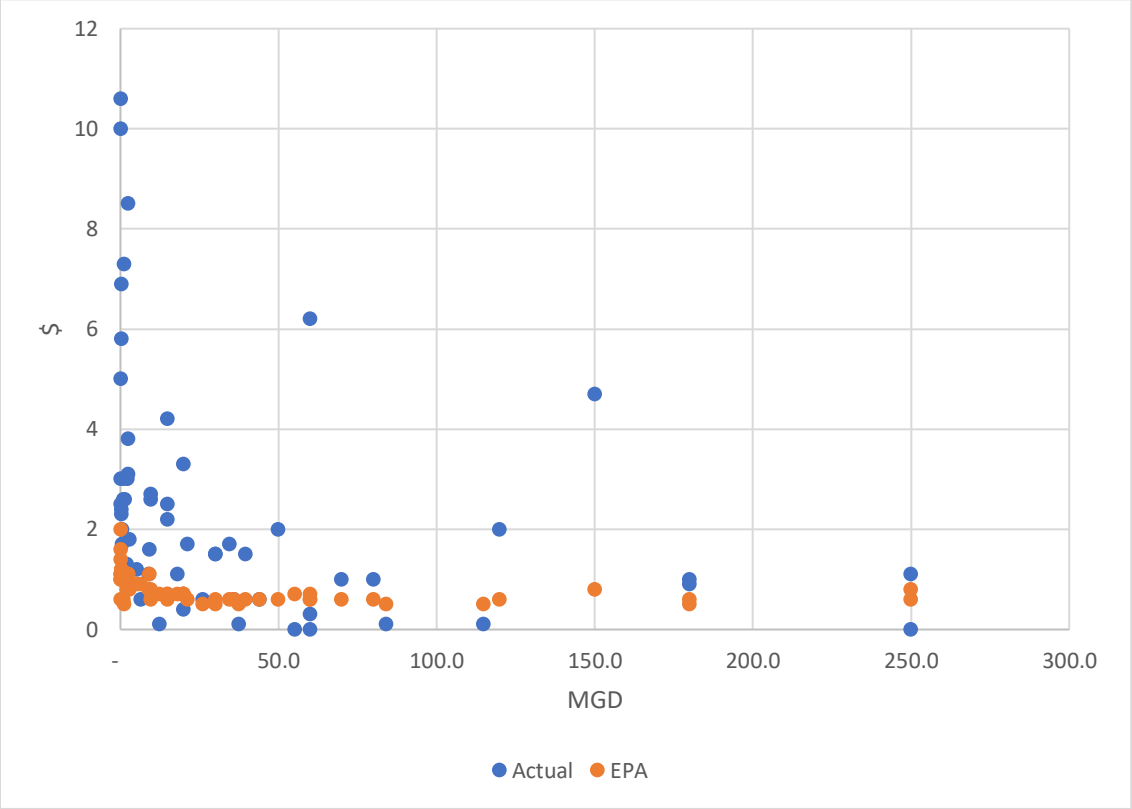
Section 8.3: Methodology of cost analysis

PNG's analysis uses cost data from surveys taken of AMWA and AWWA's members in March-April 2023. Information from 60 systems was incorporated into the analysis to further illustrate the real-world costs associated with PFAS treatment. Information was also included to show other social costs of rule implementation. As reported in the PNG analysis, "AMWA and the AWWA surveyed its members to obtain recent cost data on installed PFAS treatment systems at drinking water treatment plants. Figure 1 plots the ratio of capital costs per the treatment system capacity (in millions of gallons per day) reported by 60 systems. Figure 1 also provides EPA's estimated capital costs for the comparable treatment technique and system size. As shown, EPA's values are most often below reported capital costs. On average across the 60 systems, EPA's estimate is 2.9 times lower than reported values." AMWA has copied this figure below.

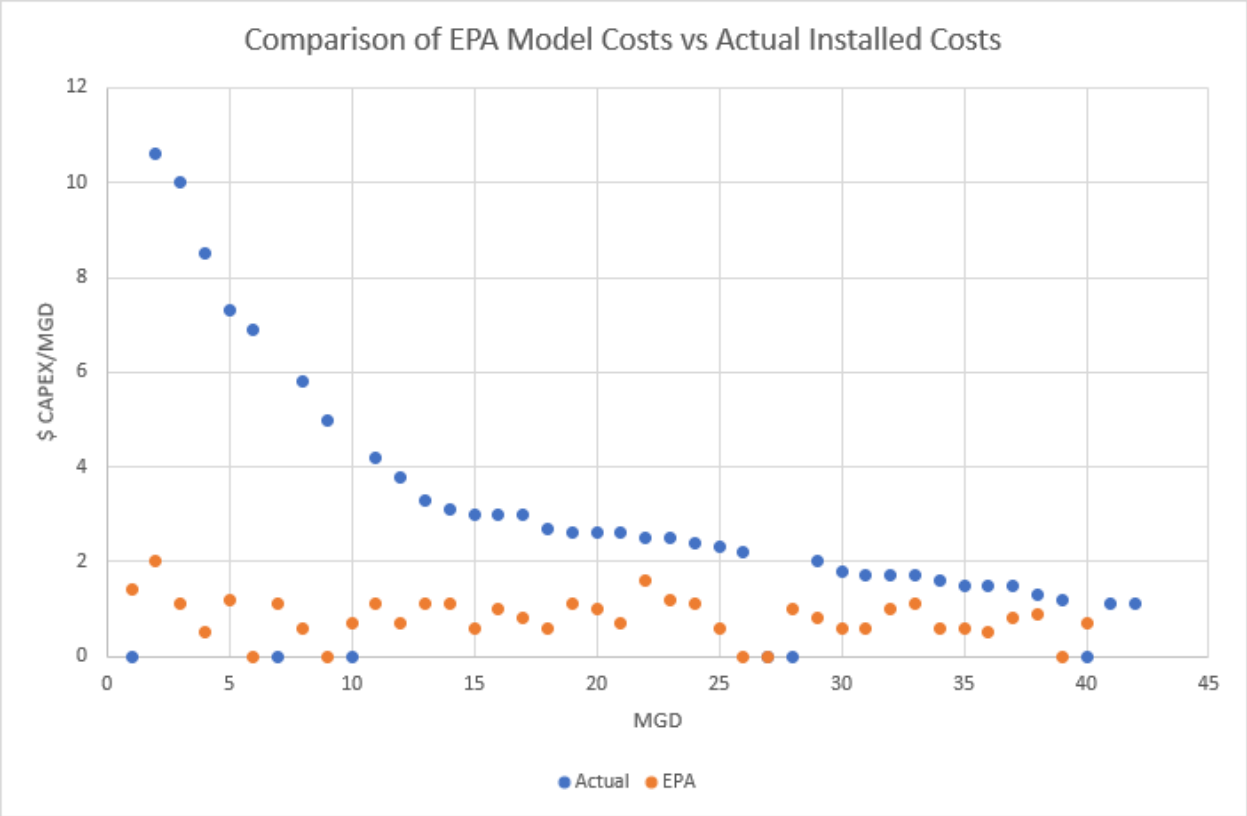
PNG's analysis shows the discrepancy between actual costs and EPA's estimate is greater for small treatment systems, the ones most likely to be installed due to this regulatory action. For systems under 1 MGD, the average ratio between actual system capital expenditures and EPA's is 5.1. For systems under 2 MGD, EPA's models underestimate actual capital expenditures by a factor of 3.6.

[22] AWWA. (2023 March 7). WITAF 56 Technical Memorandum. PFAS National Cost Model Report. https://www.awwa.org/Portals/0/AWWA/Government/2023030756BVFinalTechnicalMemoradum.pdf?ver=2023-03-14-102450-257

Figure 1 (PNG, 2023): Comparison of the Capital Costs of Actual Installed Treatment Systems with EPA Model Results ($/MGD)



Below is the figure shown above reframed for systems with a design capacity from 0-45 MGD.



As stated in PNG's report, "EPA also omits other, non-market social costs. Consuming real resources like activated carbon, electricity, and transportation services have costs that are not captured in their market price. EPA strives to reduce the adverse human health and environmental effects of the non-market social costs of pollution. By requiring treatment for certain PFAS, EPA's rule will lead to increased pollution from transportation, electricity generation, and other construction and operations activity. While the social costs of this additional pollution may be justified by the rule's benefits, EPA must estimate these social costs to demonstrate this claim."

Section 8.4 Need to assess costs of greenhouse gases/social cost of carbon

While EPA did not assess the costs of greenhouse gasses in this proposal, the agency has performed this analysis for other rulemakings - specifically its proposed rule for the New Source Performance Standards for the Synthetic Organic Chemical Manufacturing Industry and National Emission Standards for Hazardous Air Pollutants for the Synthetic Organic Chemical Manufacturing Industry and Group I and Group II polymers and Resins Industry (the Hazardous

Organics NESHAP, or HON)[23]. In the Regulatory Impact Analysis (RIA)[24] on the proposed rule, EPA included the social cost of carbon for the electricity required to operate the air pollution controls in its proposal.

Additionally, in EPA's 2023 Proposed Rule: New Source Performance Standards for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units (EGUs), the RIA includes an appendix with economy-wide modeling results[25]. EPA finds that including these additional costs for the social cost of carbon increases the social cost of the rule by 35 percent. We note that EPA's estimate of the engineering costs for this proposal is roughly the same as EPA's estimate for the PFAS MCL.

EPA should do the same analysis for the PFAS MCL that it has done in these other rulemakings and reflect these additional costs and benefits in its analysis. This will allow EPA to make a well-informed decision that will take substantial costs into consideration while still presenting the opportunity for meaningful health risk reduction.

Section 8.5: Guidance for conducting regulatory analysis not followed

EPA did not follow the requirements of OMB Circular A-4 (2003) in developing the PFAS NPDWR. While EPA's economic analysis (EA) includes a partial uncertainty analysis, under Circular A-4, the agency is required to complete a full formal uncertainty analysis, quantifying uncertainties because the rule has an annual economic effect of $1 billion or more. Simply adjusting the discount rate from 3% to 7% (the latter rate being more representative of current inflation conditions) inverses the cost-benefit result. As detailed in the PNG Analysis of these comments, AMWA believes strongly that the agency should employ a numerical sensitivity analysis and a probabilistic analysis of large, multiple uncertainties. This analysis is especially important because the uncertainty of certain health effects and limitations outlined in EPA's EA (specifically Table 33, Appendix A) could – and should – be quantified and included in a formal uncertainty analysis.

Section 8.6: Affordability and environmental justice

AMWA encourages EPA to:

- evaluate and consider this proposed rulemaking's effects on water affordability nationwide, particularly as the high costs of treatment and disposal will be passed disproportionately onto disadvantaged and rural communities, and

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[23] EPA. (2023, April 25). 88 FR 25080. https://www.federalregister.gov/documents/2023/04/25/2023-07188/new-source-performance-standards-for-the-synthetic-organic-chemical-manufacturing-industry-and

[24] EPA. (2023, March). *Regulatory impact analysis*. https://www.epa.gov/system/files/documents/2023-04/Proposed_HON_RIA_final_2023-03.pdf

[25] EPA. (2023, May 5). https://www.epa.gov/system/files/documents/2023-05/FRL-8536-02-OAR%20111EGU%20NPRM%2020230504_Admin.pdf

- examine the rule's effects on environmental justice.

EPA's analysis does not take into account how the costs of treatment will be spread across U.S. households, and AMWA is concerned the highest costs will be concentrated on many of the nation's most vulnerable populations. EPA should both consider this proposed rulemaking in light of the rising concerns about long-term water affordability and should address the unequal impact of costs in the final rulemaking or accompanying guidance. Furthermore, AMWA urges EPA to consider how the proposed rulemaking will impact communities where PFAS are disposed of and how to support PWS and communities equitably. Ultimately, EPA should consider the unintended effects of this proposed rulemaking on vulnerable populations and address how the agency will support an equal distribution of negative impacts from increased costs and disposal in final rulemaking and implementation.

To understand the impact of this rulemaking, EPA must first consider the greater concerns about water affordability in the United States. Despite the much appreciated $50 billion of federal investment in the water sector from recent legislation, American water infrastructure still requires billions more to maintain adequate infrastructure, prepare for climate change resilience, and protect public health. The American Society of Civil Engineers' (ASCE) Failure to Act study[26] found that the US water sector in 2021 needed over $400 billion to meet engineering standards, and these costs will only increase with additional treatment, climate change, and inflation. The existing water system financing model assumes that most of the money for addressing local water supply issues, whether that issue is aging infrastructure, water quality, lead pipes, cybersecurity, or water supply reliability, can be dealt with largely with local resources (i.e., customer water rates). Given the large funding gap needed without considering PFAS, it is essential that the EPA adequately assess costs in its final rulemaking and create the NPDWR with accurate estimates.

EPA should create the final rulemaking in light of this rule's impacts on water affordability, including how it will increase household water rates across the country. Nationally, many customers can already not afford their drinking water bills. A 2020 analysis by Circle of Blue[27] examined the amount of residential debt in 12 large U.S. cities. The analysis found that in some cities, the average resident with water debt owed on average over $600, and that in four cities over 30% of residents had water debt[6]. This report reflects that households across the US are struggling to pay their water bills already, so EPA should greatly consider how to prepare for any rate increases from the proposed rulemaking.

Specifically, this proposed NPDWR will increase rates at an unsustainable level for households served by smaller, rural water systems. To examine how this proposed rulemaking would increase household rates across the country, Black & Veatch researchers examined estimated costs by PWS size[21]. The researchers found that customers in small systems, which are

[26] ASCE. (2021). *Failure to Act: Economic Impacts of Status Quo Investment Across Infrastructure Systems*. https://infrastructurereportcard.org/wp-content/uploads/2021/03/FTA_Econ_Impacts_Status_Quo.pdf
[27] Circle of Blue. (2020, October). *Customer Water Debt Data and 12 US Cities*. https://www.circleofblue.org/2020/world/chart-customer-water-debt-data-in-12-u-s-cities/

overwhelmingly in rural areas, may face significantly larger household costs of PFAS treatment than what households served by large utilities will see. PNG's analysis estimates that on an annualized basis, household costs will increase $110 to $10,000 depending on system size (Attachment 1, Table 27), which equates to a large percent of annual household incomes, particularly in rural areas (Attachment 1, Table 28; also included below). According to the latest annual Bankrate annual emergency savings survey[28], over 50% of Americans do not have the funds on hand to cover a $1000 emergency expense. An increase of over $1,000 for water treatment, therefore, is unimaginable for many households. Without substantial and recurring federal government subsidies and EPA's honest examination and preparation, these geographic and PWS system size inequities in costs of PFAS treatment will perpetuate with this rulemaking's finalization.

Table 28: Annualized HH Cost from Treatment Costs as a Percentage of Annual Income

CWS Size	Percent of Median HH Income	Percent of 200% Poverty Line HH Income	Percent of Poverty Line HH-of-4 Income	Percent of Lowest Quintile Income	Percent of Poverty Line Single-HH Income
< 100	15%	20%	40%	44%	81%
101 to 500	5.4%	7.3%	15%	16%	30%
501 to 1,000	2.4%	3.3%	6.6%	7.3%	13%
1,001 to 3,300	1.1%	1.5%	3.0%	3.3%	6.1%
3,301 to 10,000	0.74%	1.00%	2.0%	2.2%	4.1%
10,001 to 50,000	0.42%	0.57%	1.1%	1.3%	2.3%
50,001 to 100,000	0.24%	0.33%	0.70%	0.73%	1.3%
100,001 to 1,000,000	0.17%	0.22%	0.45%	0.50%	0.91%
> 1M	0.15%	0.20%	0.41%	0.46%	0.83%

EPA should consider the distribution of PFAS nationwide and understand that without additional federal support, the burden of treating PFAS will fall disproportionately on communities of color. AMWA supports the Agency's goal of fairly treating all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[29] However, in this proposal and related activities, EPA has failed to examine or plan for whether communities are treated fairly with regard to the

[28] Bankrate. (2023, February 23). Bankrate's annual emergency savings report. https://www.bankrate.com/banking/savings/emergency-savings-report/
[29] EPA. (2023, May 12). Environmental justice. https://www.epa.gov/environmentaljustice

costs required to implement this proposed regulation. A recent study by Liddie, Schaider, and Sunderland[19] analyzed over 7,000 community water systems and found that CWSs "serving higher proportions of Hispanic/Latino and non-Hispanic Black residents had significantly increased odds of detecting several PFAS." This finding indicates that communities of color may be more likely to be in an area with industrial or other sources of PFAS contamination and that their community will likely have to treat more PFAS out of their water, increasing customer rates. In its final rulemaking, AMWA encourages EPA to consider how to partner with CWSs to ensure that communities of color are both equally protected from PFAS in drinking water and not disproportionately required to pay for contamination their communities did not create.

Furthermore, given the increased association between communities of color and water systems contaminated with PFAS[19], AMWA asks EPA to examine the impacts of disposal of PFAS-contaminated media on communities near disposal sites. Specifically, in the final rulemaking and implementation, EPA should examine how to support PWSs and fenceline communities in equitably distributing risks from PFAS disposal. EPA's proposal involves removing PFAS from drinking water to protect communities, but this will require storing and disposing PFAS near other communities until implementing destruction technologies are readily available. EPA needs to prioritize research into better destruction techniques that do not harm communities that have already been historically underserved. Without proper consideration and community support, disposing of media containing PFAS near communities compromises the agency's goal of protecting public health. Prior to finalizing this NPDWR, EPA should plan for further evaluation and cooperation with PWSs to equitably remove and dispose of PFAS.

Section 8.7: Evaluation of benefit-cost analysis: regulatory alternatives

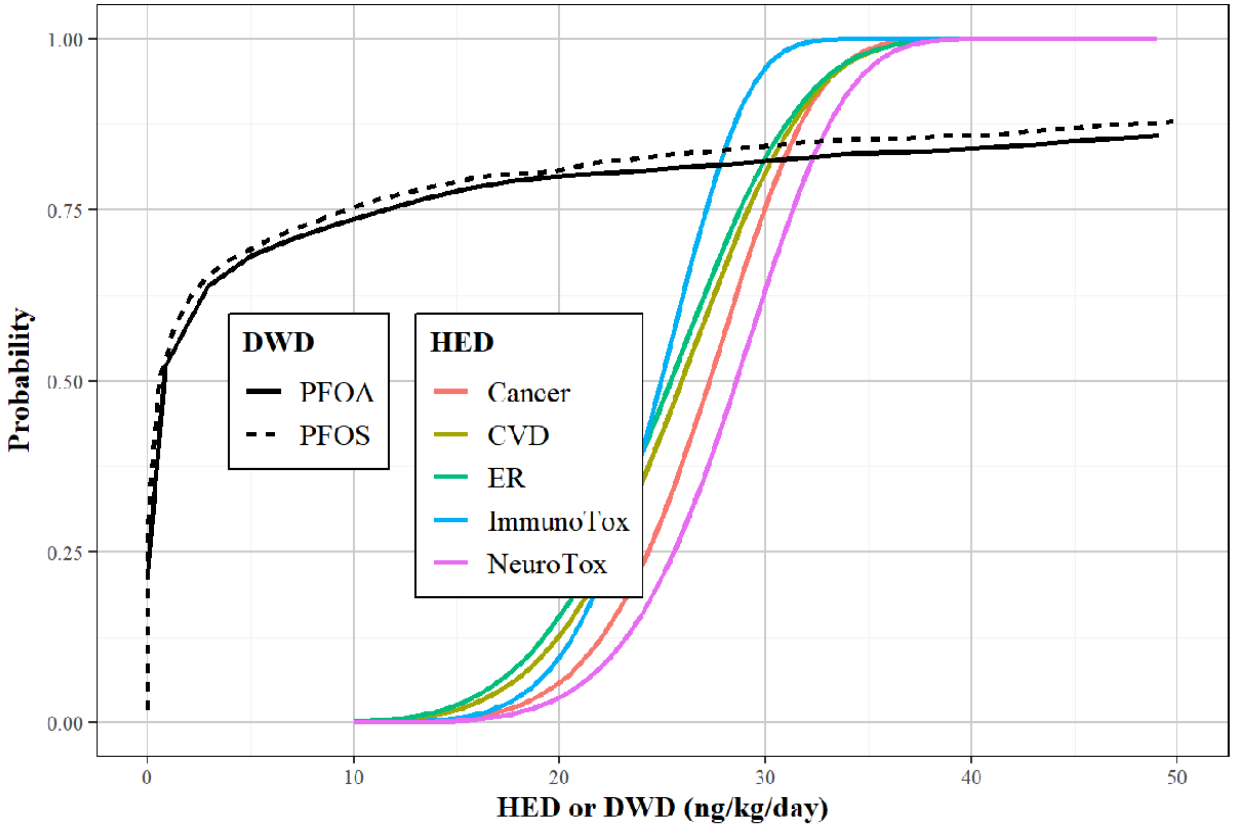
Given the underestimation of costs, partially due to the social cost of carbon and social costs generally, AMWA asks EPA to carefully consider whether the benefits of finalizing the rule at 10 ppt better justify the costs while still presenting a meaningful reduction in public health risks. In the Economic Analysis, EPA presented estimated costs and benefits of regulatory alternatives for PFOA and PFOS of setting MCLs at 5.0 ppt and 10.0 ppt.

Considering that the costs will be disproportionately borne by smaller systems and disadvantaged communities, EPA should explore what, if any, health benefits accrue going from an MCL of 10 ppt to an MCL of 4.0 ppt, and consider if the social benefits and reduced overall costs of 10 ppt would be more appropriate. The limitations and uncertainties EPA acknowledges in its model application in the Economic Analysis warrant further investigation into quantified costs and benefits this rule will impose.

EPA's analysis falls short of analyzing the full impact of the proposed rulemaking by only including engineering costs. Not including the social costs of carbon and other social costs hinders the Administrator from having all necessary information to set the PFOA and PFOS drinking water standard at a level that maximizes health risk reduction benefits at a cost that is justified, given those benefits.

Figure 8 in Attachment 1, and copied below, shows that the most benefits will occur for the population that has the highest exposure to PFOA and PFOS.

(PNG, 2023 Figure 8) Probability Distribution of HED by Disease Type for All Ages and Probability of Dose from Drinking Water for the Population



The analysis by PNG replicated work by Chen et al and described in Attachment 1 aims to identify the most comprehensive evaluation of possible biologic changes in response to PFOS exposure. An adverse effect starts with biologic change; if there is little change in response to PFOS exposure at a certain dose, the likelihood of an adverse effect at that dose is greatly diminished. The Chen et al. and Chou et al. papers show the principal cellular and genomic changes in animal and human cells across a range of doses and cell types. For the most sensitive tissue and with the longest duration of PFOS exposure, the analysis identified 108 potential cellular and genomic changes and the dose that led to a 10 percent change in activity. A 10 percent change in activity does mean an adverse effect will happen – it is a benchmark commonly used by regulatory agency to mark when a chemical has a clear effect on the body. From these estimated benchmark doses, the analysis applied an additional safety factor of 30 to account for variation in responses in the human population. As a result, the analysis shows that below an internal dose of 20 ng/kg/day, there is little biological activity from PFOS exposure. Assuming a simple model of accumulation and excretion in the body, this dose translates to a 70 kg person drinking 2 liters a day of drinking water containing PFOS at 46 ppt.

Therefore, below a level equivalent to that concentration, very few if any adverse effects are expected. As a result, reducing existing state MCLs that range up to 15 or 20 ppt are expected to have minimal benefit, and EPA could set MCLs at 10 ppt without imposing any additional public health risks.

In addition, given the challenges with timelines and lab capacity as explained in Sections 5.5 and 5.6, if EPA were to finalize the rule with a 10 ppt MCL for PFOA and PFOS, with an extended compliance timeline, the agency would be protecting public health while simultaneously reducing burdens on PWSs. At the same time that EPA promulgates the final rule, the agency could recognize the possibility of moving forward to lower the MCL for PFOA and PFOS after receiving and analyzing additional information that would better inform a more complete and accurate RIA. This would include:

- Nationwide occurrence data received from UCMR 5;
- A more robust and accurate cost estimation; and
- A better reflection of up-to-date research and analyses on health benefits of further reducing PFAS concentration at the ppt level.

A phased MCL level would also alleviate some of the supply chain, labor shortage, and data gap issues many PWSs are currently facing. EPA has looked at exposure of concentrations of certain PFAS over a lifetime; therefore, allowing time for water systems with low levels of PFAS to address contamination properly and cost-effectively will not pose additional health risks.

Section 8.8: Cost of co-occurring PFAS

In section 7.3 of these comments, AMWA responds to EPA's request for comment regarding the co-removal of contaminants with this rulemaking. While BATs described in this proposal can co-remove other PFAS, EPA should consider co-removal consequences on overall removal effectiveness. With treatment techniques like GAC, various contaminants compete for adsorption sites, which can diminish the effectiveness of PFAS removal. GAC would have to be replaced or reactivated more often to account for this co-removal. Additionally, media will need to be replaced more often if the PFOA and PFOS MCLs are finalized at 4 ppt rather than 10 ppt, thus increasing annual costs of treatment.

Treatment techniques also do not have the same efficacy for every PFAS chemical. Specifically, short chain PFAS generally break through more quickly than long chain. This provides less opportunity for adsorption unless the flow rate through the media is reduced. Treatment designs are typically contaminant specific, and while this may create opportunity for co-removal, the success is situation dependent. To remove additional PFAS compounds, modifications and additions would likely need to be made, further increasing project costs.

Section 8.9: Lab capacity and sample costs

As mentioned earlier, significantly more samples need to be taken by PWSs to assess the extent of issues related to PFAS in the source and finished waters. EPA estimates the cost per sample of EPA methods 533 and 537.1 are $376 and $302, respectively. AMWA believes these costs are generally on par with current pricing for large commercial labs. Using the three estimations from individual water systems mentioned in Section 5.5, additional testing will significantly increase costs. Using method 537.1 costs, the increase in costs for those water systems that must do additional testing will be: $270,720 additional costs for 720 samples/year, $188,000 for 500 samples/year, and $60,160 for 160 samples a year. These cost estimates do not even factor in sampling and delivery costs. These costs are not unique to these three systems and will be required at any system implementing or even considering a treatment technique. Some utilities also use both methods as an additional assurance, which would almost double the costs.

Based on EPA's estimations of annual PWS sampling cost of $90.32 million, this results in EPA expecting a total of approximately 240,213 (90.32 million divided by $376, cost per sample) samples annually for all water systems. With approximately 52,000 water systems subject to this proposed rulemaking, that results in between 4-5 samples per water system (240,213 samples divided by 52,000 water systems). This is an unrealistic estimation. Not only do many water systems have multiple EPTDS which will increase this sample number, but compliance monitoring samples are not the only samples that will need to be analyzed. Additionally, since EPA has made it difficult to prove detections less than the proposed trigger level, which is below the PQL, many water systems will not be able to qualify for continued reduced monitoring, which would have made this number more reasonable.

AMWA asserts that it will not be simple for PWSs to acquire data below the PQL. AMWA members have indicated that a popular commercial lab has informed them that a water system on a UCMR 5 contract who would like to see results below 4 ppt would need to perform an entirely separate sampling event due to QAQC considerations. This would require water systems to pay twice for results below 4 ppt if they cannot amend the contract, and they would still only receive results above 2 ppt. Most PWSs will not be able to gain the data necessary to comply with the proposed reduced monitoring requirements, and could see significant increase in costs to get data between 2-4 ppt.

High sample costs and limitations only reinforce the need for a longer compliance period and a focused approach on water systems with the highest concentrations of PFAS. More time will give labs time to adjust to the increased demand and will keep costs down for those systems that need to implement treatment. AMWA suggests EPA refine the rule before promulgation to better account for the significant increase in demand for lab capacity and analysis.

Section 8.10: Public notification costs

AMWA would like to reiterate concerns outlined in section 6.1 with EPA's assumption of 100% compliance with this rulemaking, resulting in no estimation of public notification costs. It is

unreasonable for EPA to assume no system will be in non-compliance, especially as the agency is proposing only a three-year compliance deadline. Historically, there are spikes in non-compliance after a regulation takes effect as water systems work to address the issue as quickly as possible. EPA should look at non-compliance from previously NPDWRs and estimate non-compliance and public notification costs. Public notification costs can be significant, particularly if translation and other services are also required.

Section 8.11: Cost of hazard index PFAS

As detailed in Section 3.2 above, there may be systems that have one or more of the four PFAS Health Index chemicals driving their treatment response, particularly if they do not have PFOA or PFOS. Therefore, there will be significant costs associated with treating for them.

EPA's assumption that costs associated with compliance with the HI PFAS must be reexamined. If EPA does not have the proper data to quantify the number of systems with HI PFAS and undetectable levels of PFOA and PFOS, then it is inappropriate for EPA to assume the cost is not significant. As mentioned in section 3.2, some AMWA members have indicated that HI PFAS are either the driver of treatment decisions when co-occurring with PFOA and/or PFOS or are the only PFAS with detectable concentrations at their utility. This means the HI PFAS are responsible for some or all the costs of treatment at several large utilities. EPA cannot say the costs of treating the four HI PFAS are insignificant until they have a nationwide dataset that assesses the number of systems affected by each of the six PFAS included in this proposal.

Complete occurrence data from UCMR 5 will help EPA complete this cost analysis that the agency says currently is "unlikely to be substantially" underestimated. AMWA reiterates its earlier comment that EPA should reconsider finalizing the regulatory determination of the HI PFAS as it collects and analyzes UCMR 5 data.

In Table 41 (88 FR 18703), EPA states the UCMR 3 data for PFBS and PFNA are insufficient and that there are no UCMR 3 data for GenX available. If EPA does not have the data to support whether utilities will be out of compliance with the HI, then it cannot appropriately assume that these potential exceedances do not need to be part of the cost estimate. AMWA disagrees with EPA that excluding information on PFBS, PFNA, and Gen X occurrence in the national cost estimates is insignificant.

Section 8.12: Additional factors

EPA should focus its final analyses on the issues raised in these comments. AMWA believes that EPA's time and resources would be better spent by updating its cost analysis to reflect today's economic reality more accurately. EPA should work to portray the actual cost increases for labor, water treatment chemicals, lab analyses, materials, and construction that have been exacerbated since 2021. Additionally, the agency must include the social costs of carbon and additional energy usage and GHG emissions for GAC, IX, and RO treatments.

Costs associated with treating HI PFAS must be considered. This requires more knowledge on the nationwide occurrence of these compounds. The agency cannot assume that addressing the costs of PFOA and PFOS is sufficient when the additional four PFAS will be driving treatment decisions at some PWSs. It is incorrect for EPA to assume that designation of PFAS compounds as hazardous substances will result in insignificant costs of affordability. EPA's own analysis (tables 22 and 23 in the preamble) estimates that the total annual household cost could increase as much as 9.4% to 14% for GAC treatment, up to $100 more a year, if PFAS are designated as hazardous substances under CERCLA and hazardous constituents under RCRA. To say this increase is insignificant disregards hardships the public faces and the difficult financial situations many households are in, particularly in rural and less advantaged communities that will see the highest of these increases.

While EPA and AMWA have been extremely supportive of the Bipartisan Infrastructure Law (BIL) funds that are dedicated to addressing PFAS and other emerging contaminants, AMWA cautions EPA in using messaging that implies the dollars available are enough to cover the cost of this rulemaking. Such messaging creates a difficult situation for water systems and local officials who are forced to raise water rates to implement treatment in compliance with this proposed rule when the public is receiving messaging that available federal funding will fully cover PFAS treatment. The reality is that federal funding to date will be far from enough, and ratepayers will be the primary financiers of this proposed rule. Water systems need EPA's help to simultaneously acknowledge and applaud the BIL investment in drinking water while also urging for more, as the nation's water problems will need significant improvements in the coming years as our comments and assessment of costs (Attachment 1) indicate. EPA's most recent Drinking Water Infrastructure Needs and Assessment (DWINA) estimates that drinking water utilities will need more than $31 billion per year for the next twenty years for infrastructure to support drinking water regulatory compliance. AMWA therefore urges EPA to refrain from communicating to the public that federal investments alone will cover the costs of this proposed rulemaking.

Attachment 1

BENEFIT-COST ANALYSIS OF EPA'S PROPOSED PER- AND POLYFLUOROALKYL SUBSTANCES NATIONAL PRIMARY DRINKING WATER REGULATION

Prepared by:

Policy Navigation Group

May 2023

EXECUTIVE SUMMARY

The Association of Metropolitan Water Agencies (AMWA) and the American Water Works Association (AWWA) asked Policy Navigation Group (PNG) to prepare a social benefit-cost analysis of EPA's proposed rulemaking to set federal drinking water standards for certain per- and polyfluoroalkyl substances (PFAS). PNG also prepared an economic impact analysis of the proposal's effect on household income.

EVALUATION OF EPA'S BENEFIT-COST METHODOLOGY AGAINST BEST PRACTICES

The report first compares EPA's approach to estimate the social benefits and social costs with federal requirements for regulatory analysis and best practices in the field. EPA's methodology falls far short of best practices and these requirements. EPA failed to follow two important requirements of federal requirements for regulatory analysis by not considering all of the opportunity costs and by not conducting a formal uncertainty analysis. Omitting the effect of the rulemaking on the entire economy underestimates the rulemaking's social costs by over $1 billion. As EPA demonstrated in a recent rulemaking, EPA can – and must -- estimate the social costs of rulemaking throughout the economy.

Federal requirements for regulatory analysis require EPA to conduct a complete, mathematical, and transparent uncertainty analysis for regulatory actions with costs and benefits estimated to be greater than $1 billion. EPA failed to perform this analysis. The combined effect of these omissions is that EPA underestimates the social costs and fails to convey the full uncertainty of the social benefit estimates. By not presenting the full range of uncertainty in the estimate, EPA presents a misleadingly large benefit estimate.

In addition, EPA's cost models substantially underestimate the installation costs of PFAS treatment systems as evidenced by actual cost data from water systems and by expert analysis by a water sector engineering firm. For smaller systems, the majority of the systems that EPA projects will require treatment, EPA underestimates the capital costs by a factor of five.

EPA also fails to account for other social costs such as additional costs from water rate increases and the non-market costs of greater greenhouse gas emissions. Since EPA has accounted for the social costs of regulation-induced greenhouse gas emissions in a recent rulemaking, the Agency should do so for this rulemaking.

ESTIMATES OF THE SOCIAL BENEFITS AND SOCIAL COSTS FROM EPA'S PROPOSED REGULATORY ACTION

Recognizing these flaws, this analysis provides a methodology to overcome many of them. The analysis uses the engineering firm's cost estimates to estimate the treatment costs, EPA's data for the occurrence and monitoring costs of the rule, and EPA's estimates for the

economy-wide social costs of the proposal. The analysis uses EPA data to estimate and to value the social costs of greenhouse gas emissions that would be caused by the proposed requirement. As shown in Table ES-1, the social costs are projected to be at least seven times greater than EPA's estimates.

EPA's benefit estimates for PFAS treatment place too much weight on a few possible adverse effects and too little weight on the range of potential adverse effects EPA describes in the supporting documents. Ultimately, EPA's quantified benefit estimates rest on scientific findings that other public health organizations do not support. By failing to account for the possibility that these adverse effects may not exist, EPA overstates the social benefits it quantifies.

Therefore, this analysis' objective is to identify the most comprehensive evaluation of possible biologic changes in response to PFOS exposure. An adverse effect should start with biologic change; if there is little change in response to PFOS exposure at a certain dose, the likelihood of an adverse effect at that dose is greatly diminished. The analysis estimates the social benefits by harnessing recent studies that carry out longstanding practices recommended by the National Academy of Sciences (NAS) to develop hazard assessments that use more of the available scientific information and are more compatible with benefit-cost analysis.

Rather than EPA's approach to quantify a few adverse effects, this analysis considers a wide range of cellular and genomic evidence, animal data, and human epidemiological studies. Based on published studies, the analysis considers 108 diseases that are associated with cellular and genomic responses in in vitro testing. Using the results of Bayesian mathematical evidence integration, the analysis identifies 108 diseases and estimates the probability of these diseases occurring in individuals at different levels of PFOS in drinking water.

Since these studies find that changes in biological activity are likely only to occur at the high end of the modeled drinking water exposure, the analysis develops a bounding estimate of the benefits of reducing PFOS in drinking water. The purpose of the bounding estimate is to establish an upper bound of the possible benefits for PFOS. The bounding estimate assumes conditions that clearly are not realistic and clearly overestimate the likelihood of an adverse effect for several reasons. First, the analysis assumes that a 10 percent genomic or cellular change leads to a person suffering the disease. This outcome is implausible since that change may not be large enough to be significant; since there is an additional 30-fold safety factor applied to this 10 percent change, and since the body has numerous repair mechanisms that respond when there is abnormal biological changes.

Second, the bounding estimate assumes that the current population's path towards these diseases is halted and is reversed by the drinking water standard. This assumption leads to 90 percent of the total benefits. A more realistic approach would be to assume, as EPA does in the EA, that reducing exposure today causes small changes to the baseline probabilities of contracting a disease. As an illustration, EPA may assume the MCL changes a 60-year old's odds of getting CVD in the future from 23 percent to 22.95 percent; the bounding estimate assumes that all of the exposed 60-year olds' probabilities of contracting CVD from PFOS exposure are eliminated.

Therefore, the bounding estimate shows that, even if all PFOS exposure above any level that shows some biological activity is certain to cause a disease, the benefits are still five times lower than the expected costs. The results of this bounding estimate are shown in Table ES-1. Even with many implausible assumptions to increase the social benefits, the results for PFOS are six times lower than the expected social costs. It is likely that the social benefits are at least ten times lower than this bounding estimate based on the scientific evidence.

Table ES-1: Comparison of Estimated National Annualized Benefits and Costs for EPA's Proposed Rule

	EPA's Estimates at Seven Percent Discount Rate	PNG's Estimates at Seven Percent Discount Rate
Benefits ($ M/year)	908	<1,200
Costs ($ M/year)	1,205	7,500

ECONOMIC IMPACTS

These social costs will fall heavily on low-income households and households served by small public water systems. Despite EPA's claims, recently enacted federal support for water utilities is insufficient to pay for even the capital costs of the proposal's requirements. As a result, ratepayers may pay a significant portion of the compliance costs of the rulemaking. Certain ratepayers are projected to pay hundreds of dollars per household per year due to this rulemaking.

CONCLUSIONS

Even if the benefits from the bounding estimate were doubled to account for PFOA and the other four PFAS, the benefits would still be below the costs. The social costs of EPA's proposal exceed the social benefits.

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ACRONYMS

AACE	Association for the Advancement of Cost Engineering
AMWA	American Metropolitan Water Agencies
ATSDR	Agency for Toxic Substances and Disease Registry
AUC	Area Under the Curve
AWWA	American Water Works Association
B	Billion
B&V	Black and Veatch
BMD	Benchmark Dose
DBP	Disinfection Byproduct
DWC	Drinking Water Concentration
DWIBW	Body-Weight-Adjusted Drinking Water Ingestion
CAPEX	Capital Expenditures
CCL	Contaminant Candidate List
CDC	Centers for Disease Control and Prevention
CVD	Cardiovascular Disease
CWS	Community Water System
DALY	Disability-Adjusted Life-Year
EA	Economic Analysis
EFH	Exposure Factors Handbook
EFSA	European Food Safety Agency
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPTDS	Entry Point to the Distribution System
ER	Endocrine Response
EWM	Economy Wide Modeling
GAC	Granular Activated Carbon
GE	General Equilibrium
GW	Groundwater
HBD	Human Body Dose
HC	Health Canada
HDL	High-Density Lipoprotein
HED	Human Equivalent Dose
HESD	Health Effects Support Document
HFPO-DA	Hexafluoropropylene Oxide-Dimer Acid
HH	Household
HHS	U.S. Department of Human Health Services
HRRCA	Health Risk Reduction and Cost Analysis
HI	Hazard Index
ICER	Institute for Clinical and Economic Review
IIJA	Infrastructure Investment and Jobs Act

IRIS	Integrated Risk Information System
IVIV	In Vitro-In Vivo
IX	Ionic Exchange
LDL	Low-Density Lipoprotein
M	Million
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCMC	Markov chain Monte Carlo
MOE	Margin of Exposure
NAAQS	National Ambient Air Quality Standards
NAS	National Academies of Science
NCEE	National Center for Environmental Economics
ng/L	Nanograms per Liter
NHANES	National Health and Nutrition Examination Survey
NOAEL	No-Observed-Adverse-Effect-Level
NPDWR	National Primary Drinking Water Regulation
NPRM	Notice of Proposed Rulemaking
NPV	Net Present Value
NTNCWS	Non-transient Non-community Water Systems
NTP	National Toxicology Program
O&M	Operations and Maintenance
OLEM	EPA Office of Land and Emergency Management
OMB	U.S. Office of Management and Budget
PBPK	Physiologically-Based Pharmacokinetic
PFAA	Perfluorinated Alkyl Acids
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutanesulfonic Acid
PFHpA	Perfluoroheptanoic Acid
PFHxS	Perfluorohexanesulfonic Acid
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PNG	Policy Navigation Group
POD	Point-of-Departure
POU	Point-of-Use
ppt	Parts Per Trillion
PWS	Public Water System
RCC	Renal Cell Carcinoma
RfC	Reference Concentration
RfD	Reference Dose
RO	Reverse Osmosis
SBREFA	Small Business Regulatory Enforcement Fairness Act

SC-CO_2	Social Cost of Carbon Dioxide
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SEDAC	Socioeconomic Data and Applications Center
SOC	Synthetic Organic Compound
SW	Surface Water
TC	Total Cholesterol
TK	Toxicokinetic
UCMR	Unregulated Contaminant Monitoring Rule
µg/mL	Microgram per Milliliter
WBS	Work Breakdown Structure
WHO	World Health Organization
WTP	Willingness-to-Pay
WUC	Water Utility Council
VOC	Volatile Organic Compound
VSL	Value of a Statistical Life

I. INTRODUCTION

1. Overview of EPA's Proposed Rulemaking and Economic Analysis

Notice of Proposed Rulemaking (NPRM)

On March 29, 2023, the Environmental Protection Agency (EPA) published a Notice of Proposed Rulemaking (NPRM) in the *Federal Register* to propose a National Primary Drinking Water Regulation (NPDWR), Maximum Contaminant Level Goals (MCLGs), and Maximum Contaminant Levels (MCLs) for several per- and polyfluoroalkyl substances (PFAS).[1] The NPDWR are legally enforceable standards that require treatment in public water systems (PWSs) to ensure certain contaminants do not exceed specified levels in drinking water. The level is set by the enforceable MCL, which is the highest level of a contaminant that is allowed in drinking water. An MCLG is the non-enforceable level of a contaminant in drinking water under which there is no expected risk to human health. EPA issued a request for public comment on the following:

- The determination to set individual MCLs of four parts per trillion (ppt) or nanograms per liter (ng/L) for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). EPA seeks comment on its evaluation of feasibility, treatment capabilities at CWSs, and costs;
- The preliminary determination to regulate four additional PFAS, including: perfluorohexane sulfonic acid (PFHxS), hexafluoropropylene oxide dimer acid (HFPO-DA) and its ammonium salt (also known as a GenX chemicals), perfluorononanoic acid (PFNA), perfluorobutane sulfonic acid (PFBS). EPA seeks comment on its evaluation of health information and occurrence data;
- The determination to set a MCL through a Hazard Index (HI) approach set at a unitless one for any mixture of one or more of the four additional PFAS (PFHxS, HFPO-DA, PFNA, and PFBS). EPA seeks comment on its HI approach;
- EPA's methodology used to estimate national costs for the proposed rule; and,
- EPA's approach to estimate the health impacts of exposure to PFAS covered by the proposed rule. EPA seeks comment on its assumptions and the magnitude of risks avoided by the proposed regulatory actions.

Economic Analysis (EA)

EPA is required to conduct an economic analysis (EA) for the proposed NPDWR in compliance with Executive Order (EO) 12866 and SDWA's requirements for a Health Risk Reduction and Cost Analysis (HRRCA).[2] In its EA, EPA provides its assessment of quantified and nonquantifiable health risk reduction benefits and compliance costs, including:

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[1] U.S. Environmental Protection Agency, "PFAS National Primary Drinking Water Regulation Rulemaking," *Federal Register*, no. 88 FR 18638 (March 2023).

[2] "P.L. 104-182: The Safe Drinking Water Act" (1996).

- Health risk reduction benefits for which there is a factual basis in the rulemaking record to conclude that such benefits are likely to occur as the result of compliance with each treatment level;
- Benefits likely to occur from co-occurring contaminants reductions that may be attributed solely to compliance with the MCL;
- Costs likely to occur solely due to compliance with the MCL, including monitoring, treatment, and other costs;
- Incremental costs and benefits associated with each alternative MCL considered;
- Effects of the contaminant on the general population, including sub-population groups likely to be at greater risk of adverse health effects due to exposure to contaminants in drinking water;
- Any increased health risk that may occur as a result of compliance, including co-benefits and co-occurring contaminant risks; and,
- Other relevant factors, including the quality and extent of the information and uncertainties in the analysis.

EPA evaluated the benefits associated with several rule options, including its preferred option. The EA presents quantified health benefits from avoided cases of illnesses and deaths expected from reductions in PFAS exposures resulting from the NPRM. Quantified economic benefits are estimated as avoided morbidity and mortality due to cardiovascular disease (CVD), avoided low birthweight, and avoided cases of renal cell carcinoma (RCC).

In EPA's EA, the costs of the proposed NPDWR are the expenses incurred by PWS to monitor for PFAS, to notify consumers, to adopt treatment technologies, and to conduct subsequent record-keeping and monitoring requirements. EPA also includes the costs associated with primacy agency implementation. The EA estimates the number of water systems that must procure treatment technologies and incur administrative costs to comply with the rule. EPA's estimated annualized benefits are summarized in Table 1 and range between $908 million (M) to $1,233 M at seven percent and three percent discount rates, respectively. EPA estimates the annualized costs over 82 years between $772 M to $1,205 M at three and seven percent discount rates, respectively.

Table 1: EPA's Estimated National Annualized Benefits and Costs for the Proposed NPDWR

	Three Percent Discount Rate ($ M/year)	Seven Percent Discount Rate ($ M/year)
Benefits	1,233	908
Costs	772	1,205

2. Outline of the Report

The analysis spans six sections. This section provides an overview of EPA's proposed rule and its supporting EA. Section II discusses best practices in benefit-cost analyses and evaluates

EPA's EA against these best practices. The section identifies fundamental limitations in EPA's framework and methodology, analytical gaps that it is obligated under government directives to include in its estimates, and other implications from its assumptions.

Section III presents an alternative analysis of the social benefits of EPA's proposed rule. The section contains the methodological framework, data, and assumed values. The analysis provides a discussion of the results and limitations. Similarly, Section IV presents the social cost analysis by first outlining the approach and data sources and then by providing results for each component of the analysis. Section V provides a focused discussion on the economic impacts of EPA's rules on household income. The concluding section, Section VI, compares these estimates with EPA's estimates.

II. BENEFIT-COST ANALYSIS BEST PRACTICES

1. Summary of Circular A-4 and EPA's Economic Analysis Guidelines

Circular A-4

Since 1981, the U.S. Office of Management and Budget (OMB) has issued regulatory analysis guidance and directives to Executive branch agencies to promote best practices, to promote public transparency, and to ensure the different agency estimates are comparable. OMB's directive, Circular A-4 Regulatory Analysis, was last issued in 2003 and provides directives for the best practices to estimate the potential social benefits and social costs of a regulatory action using best economic principles.[3]

EPA failed to follow two important requirements of Circular A-4 by not considering all of the opportunity costs and by not conducting a formal uncertainty analysis. The combined effect of these omissions is that EPA underestimates the social costs and fails to convey the full uncertainty of the social benefit estimates. By not presenting the full range of uncertainty in the estimate, the EA presents a misleadingly large benefit estimate.

Opportunity Cost

One important principle in benefit-cost analysis – and in economics in general – is the opportunity cost of a resource:

> "Opportunity cost" is the appropriate concept for valuing both benefits and costs. The principle of "willingness-to-pay" (WTP) captures the notion of opportunity cost by measuring what individuals are willing to forgo to enjoy a particular benefit…. The use of any resource has an opportunity cost regardless of whether the resource is already owned or has to be purchased. That opportunity cost is equal to the net benefit the resource

[3] On April 6, 2023 OMB proposed revisions to Circular A-4. This analysis uses the 2003 Circular A-4 that is in place at the time of this report.

> would have provided in the absence of the requirement. For example, if regulation of an industrial plant affects the use of additional land or buildings within the existing plant boundary, the cost analysis should include the opportunity cost of using the additional land or facilities.[4]

EPA's EA only includes engineering cost estimates. While the prices of the goods and labor EPA includes in the engineering analysis generally reflects their opportunity costs, EPA does not include the opportunity costs that occur in other sectors in society.

Other sectors have opportunity costs when the price of drinking water increases in response to this rulemaking and when this rulemaking shifts capital and labor to the water sector for compliance. EPA's analysis shows that the required regulatory activities will shift capital and resource use substantially. EPA states that the maximum spending level would approach $10 billion in one year using its estimates.[5] EPA predicts household costs for drinking water will also rise by hundreds of dollars per year.[6] These costs will be borne not only by households, but also by businesses that purchase water for their operations. EPA's rule will therefore raise the costs of an input to almost all businesses. The price increase will have additional and substantial social costs. EPA has conducted extensive modeling of the economy-wide costs from regulations in the water sector but does not include these results in its analysis. In addition, as discussed in Section IV.2, EPA has recently conducted a regulatory economic analysis that accounts for opportunity costs and finds them significant.[7] Therefore, EPA has the methodologies, data, and experience to comply with Circular A-4 and present the more complete social costs of the rule.

Formal Uncertainty Analysis

EPA's benefit and cost models use data and mathematical relationships that are uncertain. Describing the uncertainty helps policy officials and the public understand the quality and the likelihood of the benefit and cost estimates. Uncertainty can be described in words, with some quantification, and with formal, statistical approaches that ensure all of the available information about the uncertainty is used. In Circular A-4, OMB discusses situations when agencies must conduct a formal, mathematical uncertainty analysis:

> For major rules involving annual economic effects of $1 billion or more, you should present a formal quantitative analysis of the relevant uncertainties about benefits and costs. In other words, you should try to provide some estimate of the probability distribution of regulatory

[4] U.S. Office of Management and Budget, "Circular A-4: Regulatory Analysis," September 17, 2003, 18.

[5] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," March 2023, 9–13.

[6] U.S. Environmental Protection Agency, 8–69.

[7] U.S. Environmental Protection Agency, "Regulatory Impact Analysis for the Proposed New Source Performance Standards for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units," May 2023, app. B.

benefits and costs…For rules that exceed the $1 billion annual threshold, a formal quantitative analysis of uncertainty is required.[8]

Specific analytical approaches OMB recommends for formal uncertainty analyses include the following:

- **Numerical sensitivity analysis**. EPA must examine how the results vary with plausible changes in key assumptions, choices of data inputs, and alternative analytic approaches. "Sensitivity analysis is especially valuable when the information is lacking to carry out a formal probabilistic simulation. Sensitivity analysis can be used to find 'switch points' - critical parameter values at which estimated net benefits change sign or the low cost alternative switches;"[9]
- **Probabilistic analysis of large, multiple uncertainties**. EPA must formally simulate and examine identified uncertainties through expert judgment and, for example, Delphi methods. "Experts can be used to quantify the probability distributions of key parameters and relationships. These solicitations, combined with other sources of data, can be combined in Monte Carlo simulations to derive a probability distribution of benefits and costs;"[10]

In its EA, EPA only conducted a partial mathematical uncertainty analysis. Since EPA estimates that the effect of the rule is above $1 B in one year, EPA did not comply with the requirements of Circular A-4. The most significant omission is that EPA fails to model the quantitative effect of the uncertainty in EPA's causal determination that PFOA and PFOS are associated with certain health effects. As discussed in Appendix B, other public health agencies do not find a causal relationship between PFOS and PFOA exposure and key health effects that EPA quantifies as social benefits. This difference has several important implications. First, these findings show that EPA's methodology has significant uncertainty. Second, these findings show that EPA's quantified benefits are biased to be too high. If these other agencies are correct, there is no dose-response relationship and thus the benefits from reduced exposure for these adverse effects is zero. Instead of its qualitative discussion, EPA should present a distribution of benefit estimates including the probability that studies that show no relationship or an inverse relationship between PFAS and certain adverse effects are true.

Instead of a formal uncertainty analysis, EPA provides a list of limitations. The words in these lists do not modify EPA's social cost and benefit numbers, however. EPA's list of limitations is significant.[11] Table 33 in Appendix A gives the limitations EPA listed in the analysis. However, there are two problems with EPA's list. While EPA does list some limitations and uncertainties

[8] U.S. Office of Management and Budget, "Circular A-4: Regulatory Analysis," September 17, 2003, 40–41.

[9] U.S. Office of Management and Budget, 41.

[10] U.S. Office of Management and Budget, 41.

[11] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," 5–39 & 6–108.

with some directional information, EPA could – and must – incorporate these uncertainties into its display of quantified estimates.

Many of the limitations that EPA discloses could be quantified and incorporated into a formal uncertainty analysis. For example, EPA states that its value of statistical life (VSL) is the major value in its benefits estimate. However, EPA does not provide a distribution of potential values even though EPA acknowledges uncertainties in its VSL estimate. Other federal agencies, however, and researchers have put together distributions of potential VSL values.[12] EPA could easily incorporate uncertainty in the VSL value into its formal uncertainty analysis.

2. Evaluation of EPA's Benefit-Cost Methodologies

Costs

While there are numerous individual problems with EPA's cost models, the sum of these issues is more important than the laundry list of flaws. As the saying goes, "all models are wrong; some models are useful." The fundamental problem with EPA's model is that it is not useful – it fails to predict actual, installed treatment systems' costs by a substantial margin. EPA's models underestimate the costs of installed groundwater systems, surface water systems, granular activated carbon (GAC) systems, reverse osmosis, or ion-exchange systems. It does not come close to a comparable model by a major engineering firm that designs and installs PFAS treatment systems.

One principal reason that EPA's models may deviate from reality may be their vintage. As EPA states, the models were developed from 2006 to 2012.[13] Another reason could be the lack of adequate independent peer review. According to the background documents, EPA sought a three-person, letter peer review of the GAC model around 2006 and then made additional changes to the model that have not been peer reviewed.[14] EPA states that the IX model received even less of a comprehensive review since reviewers did not review a complete model – more than 10 years ago.[15]

The AMWA and the AWWA surveyed its members to obtain recent cost data on installed PFAS treatment systems at drinking water treatment plants. Figure 1 plots the ratio of capital costs per the treatment system capacity (in millions of gallons per day) reported by 60 systems. Figure 1 also provides EPA's estimated capital costs for the comparable treatment technique

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[12] See, for example, Banzhaf, H. (2022). The Value of Statistical Life: A Meta-Analysis of Meta-Analyses. Journal of Benefit-Cost Analysis, 13(2), 182-197. doi:10.1017/bca.2022.9

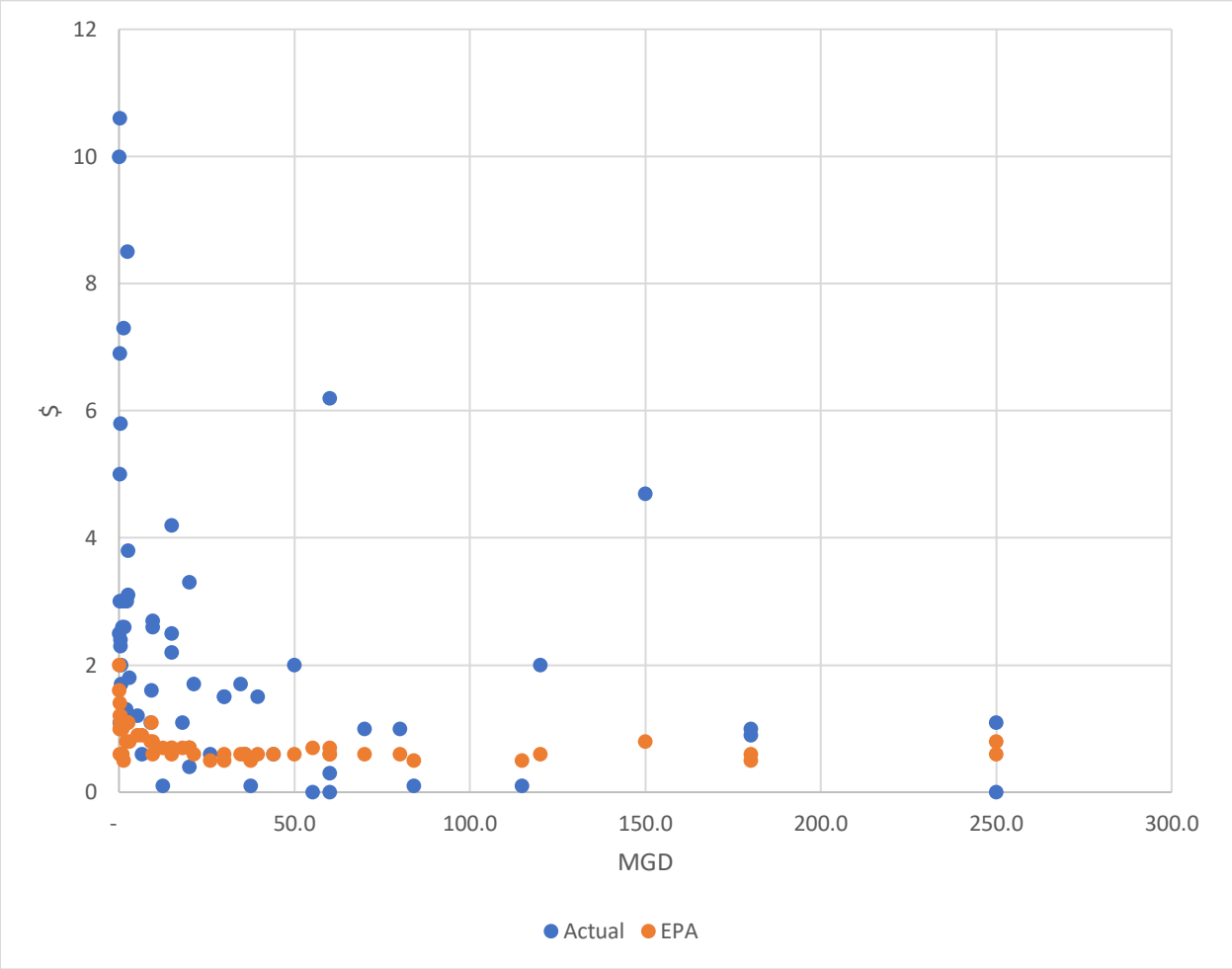
[13] U.S. Environmental Protection Agency, "Best Available Technologies and Small System Compliance Technologies for Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water," February 2023.

[14] U.S. Environmental Protection Agency, "Work Breakdown Structure-Based Cost Model for Granular Activated Carbon Drinking Water Treatment," February 2023.

[15] U.S. Environmental Protection Agency, "Work Breakdown Structure-Based Cost Model for Ion Exchange Treatment of Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water," February 2023.

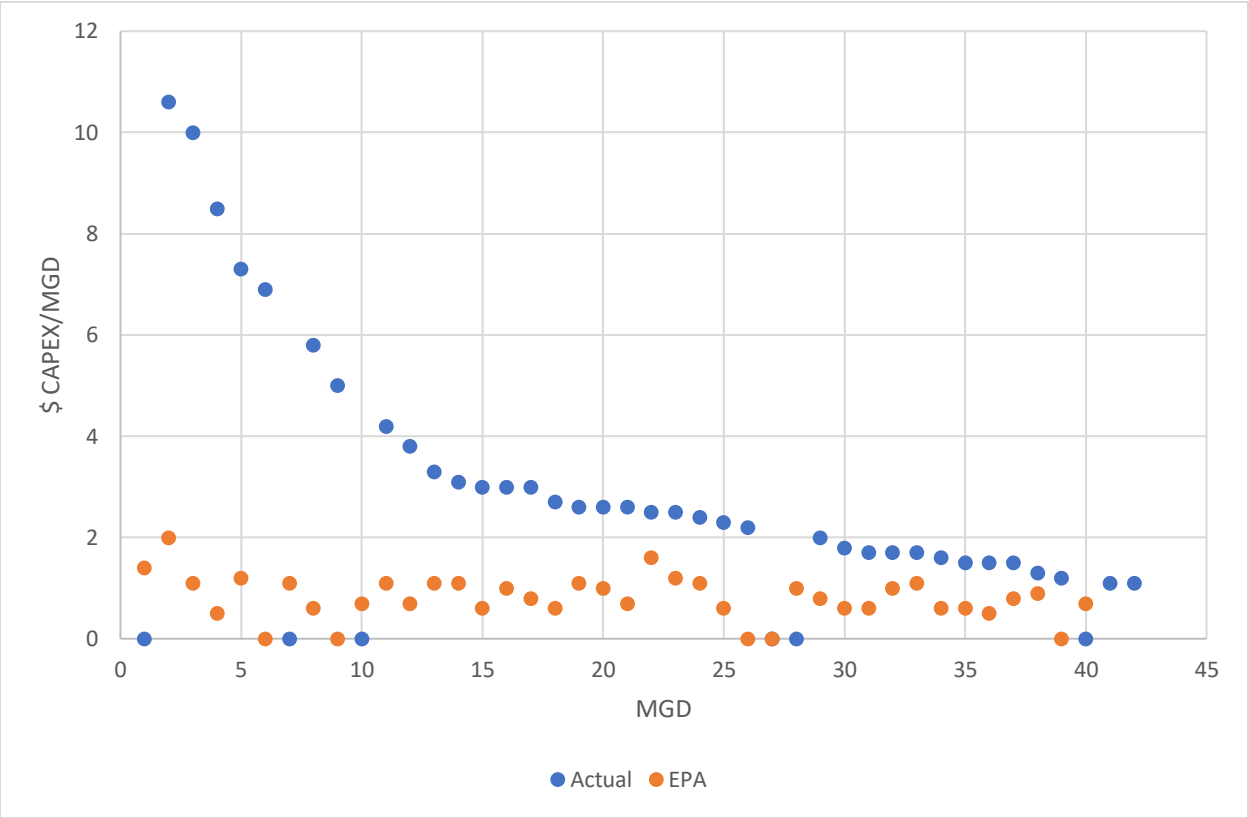
and system size. As shown, EPA's values are most often below reported capital costs. On average across the 60 systems, EPA's estimate is 2.9 times lower than reported values.

Figure 1: Comparison of the Capital Costs of Actual Installed Treatment Systems with EPA Model Results ($/MGD)



The discrepancy is greater for small treatment systems, the ones most likely to be installed due to this regulatory action. Figure 2 shows the detail of Figure 1 for systems below 50 MGD. For systems under 1 MGD, the average ratio between actual system capital expenditures and EPA's is 5.1. For systems under 2 MGD, EPA's models underestimate actual capital expenditures by a factor of 3.6.

Figure 2: Comparison of the Capital Costs of Actual Installed Treatment Systems with EPA Model Results for Systems Below 50 MGD ($/MGD)



EPA also omits other, non-market social costs. Consuming real resources like activated carbon, electricity, and transportation services have costs that are not captured in their market price. EPA strives to reduce the adverse human health and environmental effects of the non-market social costs of pollution. By requiring treatment for certain PFAS, EPA's rule will lead to increased pollution from transportation, electricity generation, and other construction and operations activity. While the social costs of this additional pollution may be justified by the rule's benefits, EPA must estimate these social costs to demonstrate this claim.

EPA's Quantified Incremental Adverse Effects

While the thousands of pages in the EA, appendices, and supporting information give the impression of substance, the Agency ultimately rests its artifice on a flawed foundation. The benefits estimate suffers both from claiming too much from little evidence and from too little application where the literature provides ample evidence. Some of the specific problems with EPA's approach are listed below.

EPA's analysis rests on an assumption of causality in which "exposure to these PFAS may cause adverse health effects" and "that PFOA and PFOS are likely to cause cancer."[16] However, there is substantial uncertainty as to whether those associations are causal. In this section, we compare EPA's analysis of the existing scientific literature with those of Health Canada (HC), the European Food Safety Agency (EFSA), and the World Health Organization (WHO). Specifically, we review findings and limitations for birthweight, cardiovascular disease (CVD) and cancer. Additional information on the findings, interpretations, and limitations from EPA, HC, WFSA, and WHO are outlined for each adverse effect in Appendix B.

Birthweight

Of the 32 studies that EPA used in its PFOA toxicity assessment, 21 reported some mean birthweight deficits in the overall population with limited evidence of exposure-response relationships.[17] Birthweight was found to have an inverse relation to PFOA concentration in a study of 293 infants at a mean PFOA concentration of 0.0016 micrograms per milliliters (µg/mL).[18] A 2012 study observed lower birthweights with increasing levels of maternal PFOA concentration (median concentration of 0.0037 µg/mL).[19]

Among the 21 studies showing some adverse associations in the overall population, there was a wide range of observed birthweight changes from –14 to –267 grams across both categorical and continuous exposure estimates.[20] Among those with continuous PFOA results in the overall population, 14 of 20 studies reported deficits from –27 to –82 grams with increasing PFOA exposures. EPA notes, however, that there is limited evidence of exposure-response relationships and potential bias due to hemodynamic differences:

> Three of the four smallest associations were based on earlier biomarker samples. Thus, some of these reported results may be related to pregnancy hemodynamic influences on the PFOA biomarkers during pregnancy. For example, 11 of the 12 largest mean BWT deficits (–48 grams or larger per unit change) in the overall population were detected among studies with either later pregnancy samples (i.e., maternal samples during trimesters 2, 3, or post-partum or umbilical cord samples).[21]

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[16] U.S. Environmental Protection Agency, "PFAS National Primary Drinking Water Regulation Rulemaking," 18638–39.

[17] U.S. Environmental Protection Agency, "Toxicity Assessment and Proposed Maximum Contaminant Level Goal for Perfluorooctanoic Acid (PFOA) in Drinking Water," March 2023, 3–205.

[18] U.S. Environmental Protection Agency, 3–192.

[19] U.S. Environmental Protection Agency, 3–192; Mildred Maisonet et al., "Maternal Concentrations of Polyfluoroalkyl Compounds during Pregnancy and Fetal and Postnatal Growth in British Girls," *Environmental Health Perspectives*, 2012.

[20] U.S. Environmental Protection Agency, "2023b," 3–201.

[21] U.S. Environmental Protection Agency, 3–201.

EPA's caveat is important. Researchers have raised concerns with confounding and with possible reverse causation in studies taken late in pregnancy.[22] Studies measuring concentrations in early pregnancy and prior to pregnancy do not show the same association.

For PFOS, one study found that birth weight, head circumference, and ponderal index were inversely associated with umbilical cord PFOS concentration in 293 infants.[23] Deficits in mean birth weight per one natural logarithm (ln) increase in PFOS concentration were found. Another study evaluated fetal growth outcomes in female births and found that increased maternal PFOS concentration (median concentration 0.0196 µg/mL) was associated with lower birth weights.[24] A prospective cohort study in Japan found that their "fully adjusted model showed no significant negative correlation between PFOA levels and birth weight. In contrast, a $\log_{10}$-unit increase in PFOS levels correlated with a decrease in mean birth weight of 148.8 g (95% CI, 297.0 to 0.5 g) for PFOS in the fully adjusted model."[25] Another study examined 429 mother-infant pairs from the Taiwan Birth Panel Study and found that umbilical cord blood PFOS concentration was inversely associated with gestational age, birth weight, and head circumference.[26]

However, studies conducted in Canada and Japan did not find a statistically significant association between birthweight and PFOS concentration in maternal blood.[27] Similarly, an examination of 429 mother-infant pairs from the Taiwan Birth Panel Study did not find a significant association between umbilical cord blood PFOS concentration and birthweight.[28]

A Canadian study of 252 pregnant women found no statistically significant association between birthweight or gestation length and PFOS concentration measured in maternal blood, although mean birthweight increased slightly by increasing PFOS levels.[29] In its Health Effects Support Document, EPA notes that low confidence studies are included for consistency in the

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[22] Steenland, Kylea; Barry, Vaughna; Savitz, Davidb. Serum Perfluorooctanoic Acid and Birthweight: An Updated Meta-analysis With Bias Analysis. Epidemiology 29(6):p 765-776, November 2018. | DOI: 10.1097/EDE.0000000000000903

[23] Benjamin Apelberg et al., "Cord Serum Concentrations of Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoate (PFOA) in Relation to Weight and Size at Birth," *Environmental Health Perspectives*, 2007.

[24] Maisonet et al., "Maternal Concentrations of Polyfluoroalkyl Compounds during Pregnancy and Fetal and Postnatal Growth in British Girls."

[25] Noriaki Washino et al., "Correlations between Prenatal Exposure to Perfluorinated Chemicals and Reduced Fetal Growth," *Environmental Health Perspectives*, 2009.

[26] Mei-Huei Chen et al., "Perfluorinated Compounds in Umbilical Cord Blood and Adverse Birth Outcomes," *PLOS One*, 2012.

[27] Michele Hamm et al., "Maternal Exposure to Perfluorinated Acids and Fetal Growth," *Journal of Exposure Science and Environmental Epidemiology*, 2010; Health Canada, "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Perfluorooctane Sulfonate (PFOS)," December 2018.

[28] Mei-Huei Chen et al., "The Impact of Prenatal Perfluoroalkyl Substances Exposure on Neonatal and Child Growth," *Science of the Total Environment*, 2017.

[29] Hamm et al., "Maternal Exposure to Perfluorinated Acids and Fetal Growth."

direction of association.[30] As shown in Appendix B, agencies have recognized additional limitations in study data, including selection bias, small study sizes, and confounding. This is also true of other adverse effects included in EPA's assessment.

Health Canada explains that "more studies with better adjustments and follow-up in different populations would be needed to confirm the observed associations."[31] Similarly, for certain effects, EFSA mentions that more studies are needed to support causality. Specific to birthweight, EFSA said that while "a recent study seems to strengthen the causality, the decrease in birth weight after adjusting for confounders is not large and the potential longer term consequences of this decrease are unclear."[32] A Department of Health and Human Services toxicological profile cited by WHO concluded that "no studies found increases in the risk of low birth-weight infants" associated with maternal PFOS serum levels."[33]

CVD

In a study described in the 2016 Health Advisory (HA), no association with hypertension in 1,655 children aged 12–18 years from the NHANES was found.[34] An occupational study reported an inverse association for mortality from heart disease among all cohort members.

Since publication of EPA's 2016 PFOA health effect support document, EPA found 49 new epidemiological studies report on the association between PFOA and CVD, including outcomes such as hypertension, CAD, congestive heart failure, microvascular diseases, and mortality.

Of the ten studies that examined blood pressure as a continuous measure, six reported statistically significant positive associations.[35] EPA also points to two NHANES-based studies examining CVD that reported significant associations between PFOA and CVS.[36] However,

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[30] U.S. Environmental Protection Agency, "2023b," 3–195.

[31] Health Canada, "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Perfluorooctanoic Acid (PFOA)," December 2018, 46.

[32] Dieter Schrenk et al., "Risk to Human Health Related to the Presence of Perfluoroalkyl Substances in Food" (European Food Safety Authority, September 2020), 7.

[33] Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Perfluoroalkyls" (US Department of Health and Human Services, May 2021), 479; World Health Organization, "PFOS and PFOA in Drinking-Water: Background Document for Development of WHO Guidelines for Drinking-Water Quality," September 2022, 32, https://www.cmbg3.com/library/WHO-Draft-Drinking-Water-Document.pdf.

[34] Wen-Wen Bao et al., "Gender-Specific Associations between Serum Isomers of Perfluoroalkyl Substances and Blood Pressure among Chinese: Isomers of C8 Health Project in China," *Science of the Total Environment*, 2017.

[35] U.S. Environmental Protection Agency, "2023b," 3–151.

[36] Anoop Shankar, Jie Xiao, and Alan Ducatman, "Perfluorooctanoic Acid and Cardiovascular Disease in US Adults," *Archives of Internal Medicine*, October 2012.

another study using a larger NHANES dataset did not observe an association nor a positive trend between quartiles of exposure and CVD incidence.[37]

Some findings were mixed and inconsistent across studies. For those examining strokes, for example, one found a slight positive association,[38] while another observed a significant inverse association.[39]

Cancer

While EPA cites multiple lines of evidence to support its carcinogenic finding, this section compares different agencies' conclusions concerning the epidemiologic evidence. Two studies involving participants in the C8 Health Project showed a positive association between PFOA levels (mean at 24 ng/mL) and kidney and testicular cancers.[40] The C8 Science Panel concluded that a probable link existed between PFOA exposure and testicular and kidney cancer.[41]

In an occupational study in Italy, statistically significant increases in liver cancer mortality, malignant neoplasms of the lymphatic and hematopoietic tissue, and in all malignant neoplasms with cumulative serum PFOA exposure greater than 16,956 ng/mL-years. In another occupational study based on a West Virginia DuPont cohort, no significant associations with incidence of cancers of the bladder, colorectal, prostate, and melanoma were observed when compared to the general population.[42]

Fifteen epidemiological and one animal toxicological study that investigated the association between PFOS and cancer were identified. Although the epidemiological evidence found mixed results across tumor types, EPA says that the available study findings support a plausible correlation between PFOS exposure and carcinogenicity in humans.

PFOS was associated with an increased risk of kidney cancer in a medium confidence study.[43] A case-control study within the National Cancer Institute's Prostate, Lung, Colorectal, and

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[37] Mengmeng Huang et al., "Serum Polyfluoroalkyl Chemicals Are Associated with Risk of Cardiovascular Diseases in National US Population," *Environment International*, 2018.

[38] Huang et al.

[39] Robert Hutcheson, Kim Innes, and Baqiyyah Conway, "Perfluoroalkyl Substances and Likelihood of Stroke in Persons with and without Diabetes," *Diabetes and Vascular Disease Research*, 2020.

[40] Vaughn Barry, Andrea Winquist, and Kyle Steenland, "Perfluorooctanoic Acid (PFOA) Exposures and Incident Cancers among Adults Living near a Chemical Plant," *Environmental Health Perspectives*, 2013.

[41] C8 Science Panel, "C8 Probable Link Reports," 2012.

[42] Kyle Steenland and Susan Woskie, "Cohort Mortality Study of Workers Exposed to Perfluorooctanoic Acid," *American Journal of Epidemiology*, November 2012.

[43] Joseph Shearer et al., "Serum Concentrations of Per- and Polyfluoroalkyl Substances and Risk of Renal Cell Carcinoma," *Journal of the National Cancer Institute*, 2021.

Ovarian Screening Trial reported a statistically significant positive trend in risk of renal cell carcinoma with pre-diagnostic PFOS serum levels.

One study also observed statistically significant increased odds of ovarian cancer both per ng/mL increase in PFOS and in the two highest quartiles of exposure, although the association was significantly inverse for the second quartile of PFOS exposure.[44]

The evidence database for the carcinogenicity of PFOS is comprised of several epidemiological studies and a single chronic cancer. The available epidemiology studies report elevated risk of bladder, prostate, kidney, and breast cancers after chronic PFOS exposure. However, EPA notes that the study designs, analyses, and mixed results do not allow for a definitive conclusion on the relationship between PFOS exposure and cancer outcomes.

EPA explains that the low confidence sources are limited by selection bias, and confounders specific for cancer outcomes, including smoking and socioeconomic factors, were not addressed and behavioral risk factors could have differed. The EFSA, HC, and the WHO do not find the epidemiology evidence robust enough to support a causal link between PFOA exposure and cancer (see Table 38 and Table 39 in Appendix B).

In summary, since other competent public health agencies have reviewed the same scientific literature as EPA and have reached different conclusions on the existence and the strength of the associations between PFOS and PFOA exposure and disease, EPA must take this uncertainty into account. EPA must do so in a quantitative, reproducible uncertainty analysis as required by Circular A-4. Providing the range of potential benefits will also increase the public's understanding of the regulatory options.

Additional Assumptions in EPA's EA

Changes to Baseline Due to Voluntary Actions

EPA assumes that drinking water concentrations will remain constant in the absence of its proposed rule. As a result, EPA's assumption overstates the net benefits of the rule because other PFAS actions and regulations will likely decrease occurrence in drinking water.

In the absence of EPA's proposed rule, the baseline PFAS occurrence will likely decline due to increasing regulatory action at the state level and additional voluntary actions. Additionally, in September 2022, EPA published a NPRM designating PFOA and PFOS as CERCLA hazardous substances.[45] The designation, if finalized, will have far-reaching impacts as industries and utilities shift activity to prevent PFAS releases and litigation. Utilities may try to reduce PFOA

[44] Ogbedor Omoike et al., "Association between per and Polyfluoroalkyl Substances and Markers of Inflammation and Oxidative Stress," *Environmental Research*, May 2021.

[45] "Designation of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) as CERCLA Hazardous Substances," *Federal Register* 87, no. 171 (September 2022): 54415–42.

and PFOS concentrations to reduce their CERCLA liability with or without a federal drinking water standard.

Finally, there will be more voluntary PFAS treatment installations as a result of increased federal funding initiatives dedicated to reducing PFAS contamination levels. Of the $48 billion appropriated for drinking water and wastewater in the IIJA, $4 billion is set aside to address emerging contaminants in drinking water with a focus on PFAS and an additional $5 billion will be appropriated to help small and disadvantaged communities address emerging drinking water contaminants.[46] This funding can only be used to address capital costs.

Dollar Year

EPA uses 2020 prices as the data source for its projection of costs to 2026. Producer prices have shot up since 2021 due to supply shortages, disruption of trade due to the global pandemic, and financial assistance provide to individuals, businesses, and the economy during the pandemic. EPA chose as the baseline year for its analysis a year that is not representative of current conditions and the likely near-term future when most of the rule's expenditures will be made. Inflation appears to be likely to persist in the near-term. Moreover, the economic policies underway to reduce inflation – raising federal interest rates and reducing the money supply – are increasing the cost of capital, a major input factor into this proposal's costs. By selecting a baseline year for the analysis that had low interest rates and prices and that is not representative of the near-term's economic conditions, EPA is artificially lowering expected compliance costs.

Valuation

EPA uses Value of Statistical Life (VSL) estimates to estimate the economic value of avoided premature deaths.[47] EPA approximates VSL growth using a compound annual growth rate of projected values to obtain a VSL suitable for valuation of mortality risk reductions during the period of analysis (2023-2104). As a base value, EPA used a VSL estimate of $4.8 million ($1990, 1990 income year), which is the central tendency of the VSL distribution recommended for EPA's regulatory impact analyses. In the EA, this estimate is adjusted for inflation and income growth. Estimates used in the EA range from $10.7 million in 2023 to $17.7 million in 2104.

As discussed above, EPA did not model the uncertainty in its VSL estimate. More fundamentally, EPA did not include the effect of income growth on other opportunity costs in the rule. If consumers' willingness to pay to avoid mortality risk increases with income, then it is reasonable to assume that consumers' willingness to pay to avoid other economic

[46] U.S. Environmental Protection Agency, "Emerging Contaminants (EC) in Small or Disadvantaged Communities Grant (SDC)," n.d.

[47] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," 2–4.

displacements and adverse effects also increases with income. By including income growth in the valuation of benefits but not costs, EPA biases the results.

EPA used the cost of illness (COI) valuation approach to estimate the economic value of avoided morbidity (non-fatal heart attacks and ischemic strokes, birth weight decrements, and cancers). The COI-based values used in the EA reflect medical care expenditures and opportunity costs associated with condition management and treatment. COI metrics do not meet the requirements set out by Circular A-4 and other best practices to use consumers' willingness-to-pay (WTP) metrics.[48]

In conclusion, EPA's EA for the proposed rule departs from analysis required by Circular A-4. As a result, the EA portrays misleading estimates of the social benefits and the social costs and fails to describe the uncertainty in these estimates.

III. ESTIMATES OF THE SOCIAL BENEFITS FROM EPA'S PROPOSED REGULATORY ACTION

EPA posited numerous adverse effects in the MCLG documents for PFOA, PFOS, and the four PFAS that comprise the HI MCL.[49] However, EPA quantified the social benefits for only three of them, cardiovascular disease (CVD), avoided low birthweight, and avoided cases of renal cell carcinoma (RCC). Moreover, the biological mechanisms for adverse effects in the EA's quantified benefits are not established and the human study data is equivocal. EPA's limited approach raises questions as to the potential existence and the size of social benefits from avoiding the other adverse effects EPA claims could arise from PFAS exposure.

Given the significant social costs if EPA's proposal is promulgated, this analysis sought to evaluate a larger scope of potential health effects. To do so, the analysis employs genomic and cellular studies of human and animal genes to identify how PFOS exposure causes biological changes in cellular function and at the genetic level. If a dose does not alter this biological activity materially, many adverse effect pathways to disease can largely ruled out at levels occurring in drinking water.

The analysis rests on recent, peer-reviewed published studies that use best practices for evidence integration of different lines of toxicological evidence. These toxicology results fit well into benefit-cost analysis.

1. Rationale for the Approach

[48] U.S. Office of Management and Budget, "Circular A-4: Regulatory Analysis," September 2003.

[49] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," 6-1.

For over 60 years, toxicology has developed three principal types of evidence – epidemiological studies of human populations, controlled dose experiments in animals, and in vitro testing to measure responses to chemical exposure in cells, genes, and other biological systems. In the last 20 years, the amount and the breadth of in vitro information has soared as researchers have created new, fast, and low-cost techniques to measure cellular and genetic responses.[50] For example, inexpensive, high-throughput transcriptomics data generation platforms allow rapid observations of a constituent's interaction and activation of the full set of human genes. With the generation of this data arose the question: what to do with it and how to interpret it?

How to interpret and to integrate different lines of evidence has always been a challenge in toxicology. Concern arose in the 2000s with the transparency, decision criteria, and reproducibility of EPA's evidence integration in Integrated Risk Information System (IRIS) hazard assessments, for example.[51] In a major report, the National Academies of Science (NAS) recommended that EPA develop transparent, reproduceable mathematical approaches to integrate genomic, in vitro mechanistic data, animal experimental data, and data from human observations.[52] The NAS recommended EPA move toward a formal, mathematical approach to integrate lines of evidence using Bayesian statistics. In its findings, the NAS stated:

> **Finding**: Quantitative approaches to integrating evidence will be increasingly needed by and useful to EPA.
>
> **Recommendation**: EPA should expand its ability to perform quantitative modeling of evidence integration; in particular, it should develop the capacity to do Bayesian modeling of chemical hazards. That technique could be helpful in modeling assumptions about the relevance of a variety of animal models to each other and to humans, in incorporating mechanistic knowledge to model the relevance of animal models to humans and the relevance of human data for similar but distinct chemicals, and in providing a general framework within which to update scientific knowledge rationally as new data become available.[53]

EPA did not follow this recommendation in the EA. EPA continues the practice of picking certain studies for its quantitative assessments while ignoring and not including the data from other high-quality studies. While EPA states that data from animal studies and mechanistic studies are supportive, EPA does not support these claims in a transparent, reproducible manner. For example, for its estimate of the social benefits from the association between PFOA and PFOS exposure and lower birth weights, EPA selects one study for PFOA and used only the data from this study. EPA apparently re-analyzes the data in the selected study for

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[50] National Academies of Sciences, Engineering, and Medicine, "Using 21st Century Science to Improve Risk-Related Evaluations" (The National Academies Press, 2017).

[51] National Research Council, "Review of EPA's Integrated Risk Information System (IRIS) Process Review of EPA's Integrated Risk Information System (IRIS) Process."

[52] National Research Council, "Review of EPA's Integrated Risk Information System (IRIS) Process Review of EPA's Integrated Risk Information System (IRIS) Process."

[53] National Research Council, 105.

PFOS but apparently did not state if the Agency submitted this reanalysis to independent peer review.

After the 2014 NAS report, researchers continued to develop full human genomic test data and genomic dose-response modeling. The advent of these new tools -- and the information they provide -- has underscored this challenge of how to integrate genomic in vitro evidence into hazard assessments.

The National Academy of Sciences issued a major report on these New Approach Methods (NAM) in 2017.[54] The 2017 report recommended that agencies incorporate NAMs into chemical risk assessments since they could provide substantially more data and insight more quickly than traditional toxicity testing. As the National Toxicology Program (NTP) found, research groups in universities, private institutions, and government agencies expanded their use of NAMs in the peer-reviewed literature. In 2018, the NTP convened experts and published its approach to genomic dose-response modeling. NTP explained the advantages:

> NTP's approach to study design focuses on obtaining the best data to determine accurate estimates of biological potency using modeling. The use of a broad array of gene sets such as those curated by MSigDB is to ensure that all known biological signaling processes are covered, therefore ensuring that the most sensitive estimation of biological potency.[55]

In other words, rather than only toxicology experiments with a limited number of animal studies of potentially unclear biologic mechanisms of action, genomics data can measure changes in all human signaling processes. These genomics experiments can be replicated, can be conducted quickly at different dose levels, and can test the genomes and cells of many different individuals.

However, the NTP identified two major remaining issues: consistent study design of genomic studies and the biological interpretation of the findings.[56] While the NTP guidance (and comparable EPA guidance) provides a standard for study design, the remaining fundamental uncertainty – genes do not fully determine health outcomes – remained. It is essential for benefit-cost analysis that the genetic changes have direct links to adverse effects consumers understand and value. To interpret the genomic data, researchers have turned to in vitro-in vivo (IVIV) studies and modeling to develop mathematical relationships between the results of known animal studies and genomic response and signaling data. The IVIV techniques then link genomic data to measured adverse effects in whole organisms.[57] Thus, researchers are developing mathematical techniques to link genomic data to animal data. Recent studies are

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[54] National Academies of Sciences, Engineering, and Medicine, "Using 21st Century Science to Improve Risk-Related Evaluations."

[55] National Toxicology Program, "NTP Research Report on National Toxicology Program Approach to Genomic Dose-Response Modeling," April 2018, 4.

[56] National Toxicology Program, "NTP Research Report on National Toxicology Program Approach to Genomic Dose-Response Modeling."

[57] Very recent studies find that hazard values developed through genomic analysis are similar to value derived from animal assays. In general, the genomic values are more health-protective than values derived from animal studies.

confirming NTP's conclusion that these studies are more sensitive (i.e., more health protective) than results obtained from whole organism studies.[58]

Mathematical evidence integration also combines the risk of cancer and the risk of noncancer effects into the same hazard metric. As the NAS stated, Bayesian dose-response methods can be applied to different lines of evidence to create probabilistic estimates of risk for both cancer and noncancer effects. This capability is vital since EPA's current hazard metrics and -- study selection by judgement as in this EA – are incompatible with EPA's regulatory analysis requirements.

The mismatch between EPA's current toxicity metrics and benefit-cost analysis is well understood. Over 30 years ago, the NAS called for EPA to adopt probabilistic hazard assessment and to move away from single hazard values such as a reference dose. In its 2009 *Science and Decisions* report evaluating EPA's risk assessment practices, the NAS concluded: "The end products of noncancer (and nonlinear cancer) assessments in the current paradigm (exposure-effect quotients that qualitatively indicate potential risk—MOEs [Margin of Exposure], RfDs [Reference Doses], and RfCs [Reference Concentrations], Figure 5-1) are inadequate for benefit-cost analyses or for comparative risk analyses."[59] The NAS emphasized:

> Historically, dose-response assessments at EPA have been conducted differently for cancer and noncancer effects, and the methods have been criticized for not providing the most useful results. Consequently, noncancer effects have been underemphasized, especially in benefit-cost analyses. A consistent approach to risk assessment for cancer and noncancer effects is scientifically feasible and needs to be implemented.[60]

The 2009 *Science and Decisions* report also provided EPA with extensive recommendations concerning uncertainty analysis, value of information analysis, and risk characterization.

Mathematic evidence integration also enables formal uncertainty analysis to be conducted on the hazard assessment. The outputs of Bayesian modeling are probabilities of adverse effects that are related to the dose, allowing estimates of how these probabilities change with a change in dose. These incremental effects fit well into benefit-cost analysis. Benefit-cost analysis rests on estimating the value to society of incremental shifts in resources to different policy outcomes. Probabilistic risk assessment measures provide more information and fit into the incremental analysis framework of benefit-cost analysis.

EPA's benefit-cost analysis for the proposal rests on toxicity relationships that suffer from the same issues raised by the NAS in 2009 and 2014. The EA's benefit estimate selects just three critical effects even though EPA states that PFOS and PFOA are associated with many other effects. This analysis seeks to consider a greater range of potential biological mechanisms of action for PFOS and to quantify these effects following the NAS recommendations for hazard identification, evidence

[58] National Toxicology Program, "NTP Research Report on National Toxicology Program Approach to Genomic Dose-Response Modeling," 4.

[59] National Research Council, "Science and Decisions: Advancing Risk Assessment" (Washington, DC: National Academies Press, 2009), 133.

[60] National Research Council, 8.

integration, and presentation of the maximum value of avoiding the probabilities of change through exposure in drinking water.

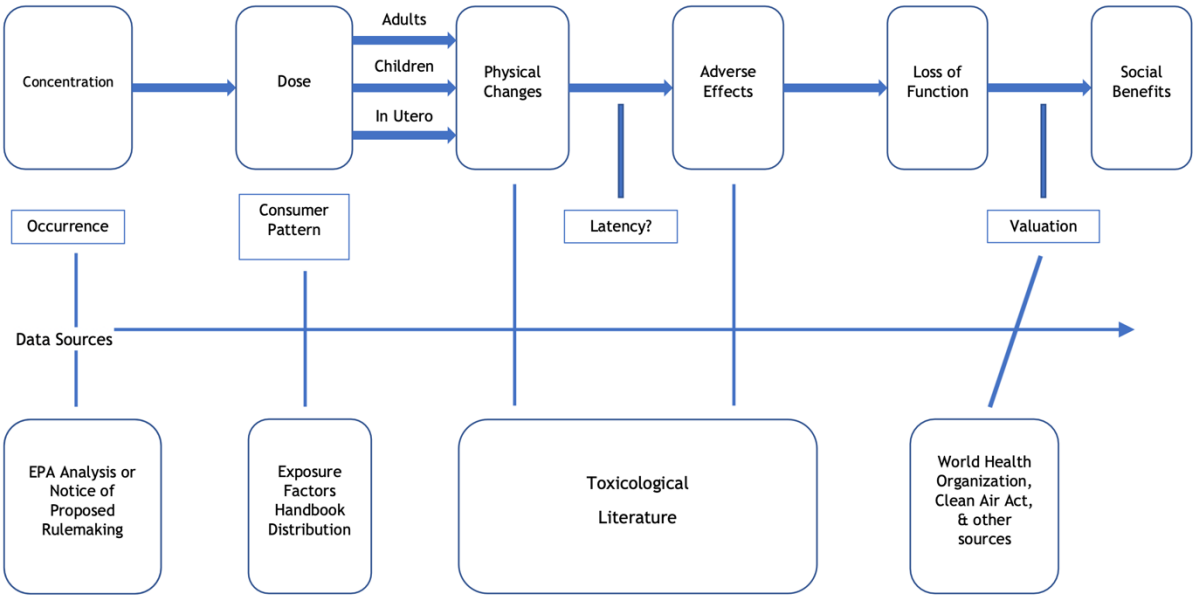
2. Summary of the Analytical Approach

This analysis attempts to overcome some of the limitations in EPA's approach which relies on only a few studies, evaluates only two possible PFOS adverse effects, and ignores relevant data and studies.

Figure 3 presents an overview of our methodological approach to the benefits analysis. The assessment is performed in the following sequential steps:

1. **Concentration**. The concentration of PFAS in drinking water is based on occurrence data from EPA's EA.
2. **Dose from Drinking Water Exposure**. Drinking water consumer patterns are based on EPA's Exposure Factors Handbook (EFH) and take into account age, sex, race, and body weight.
3. **Physical Changes and Adverse Effects**. The latest toxicological literature presents modeling of how PFOS concentration and dose estimates are likely to result in the probability of physiological changes and, subsequently, adverse effects.
4. **Loss of Function and Valued Social Benefits**. The analysis takes the loss of function (i.e. disease) from the modeled physical changes and adverse effects from the literature and applies quantification from the World Health Organization (WHO) and willingness-to-pay estimates to estimate total social benefits.

Figure 3: Overview of Benefits Methodological Framework



In summary, this approach has several major advantages over EPA's approach in the EA:

- Includes many more potential adverse effects from PFOS exposure in drinking water than analyzed in the EA;
- Includes potential incremental noncancer and cancer effects into the same hazard metric;
- Develops estimates of the probability of these adverse effects to construct a distribution of the potential population health benefits;
- Assigns values to the expected values of these adverse effects based on internationally-recognized metrics for morbidity and mortality; and,
- Values these effects with a WTP value consistent with Circular A-4 and best practices.

While our approach has significant advantages over EPA's methods, it has limitations. Some limitations are due to fundamental uncertainty; some could be fixed. Due to the limited time available for public comments, this analysis has limitations that could be addressed with additional analysis. Since this information is available in the literature, EPA could construct a more comprehensive and a more robust social benefit estimate using this approach.

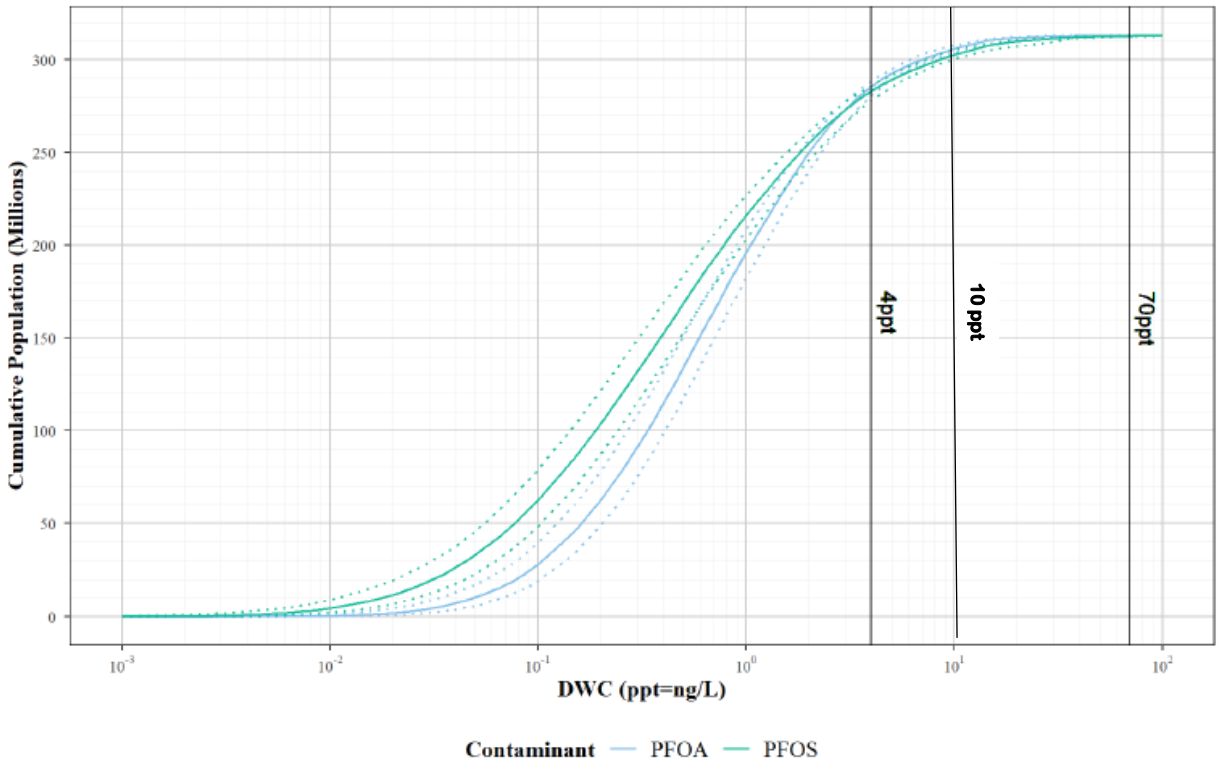
3. Data and Assumed Values

Occurrence in Drinking Water

The analysis uses EPA's projection of PFOA and PFOS occurrence data and population estimates for the benefit estimates. As done in the EA, the distribution of occurrence of the selected PFAS in PWS is estimated and then modified to account for existing state regulatory standards.

The analysis adopts the results of the modeling in Cadwallader et al that the EA uses.[61] The authors' approach efficiently uses available data and established Markov methods to project which systems are likely to have PFAS occurrence in the absence of sampling data. The analysis replicated the paper's results with mechanical and mathematical methods.[62] Data points were extracted from the Figure 4 of Cadwallader et al. through a digital tool that uses reverse engineering to plot underlying numerical data from data visualizations.[63] The chart was uploaded onto a canvas and the y- and x-axes were calibrated as linear and logarithmic information, respectively, to extract the data points. We then fit a curve to the points to allow assignment of simulated concentration levels to segments of the population. Figure 4 below gives the baseline simulated drinking water concentration distribution.

Figure 4: Cumulative Distribution of Estimated Population Exposed to PFOA and PFOS



[61] Adam Cadwallader et al., "A Bayesian Hierarchical Model for Estimating National PFAS Drinking Water Occurrence" (AWWA Water Science, May 25, 2022).

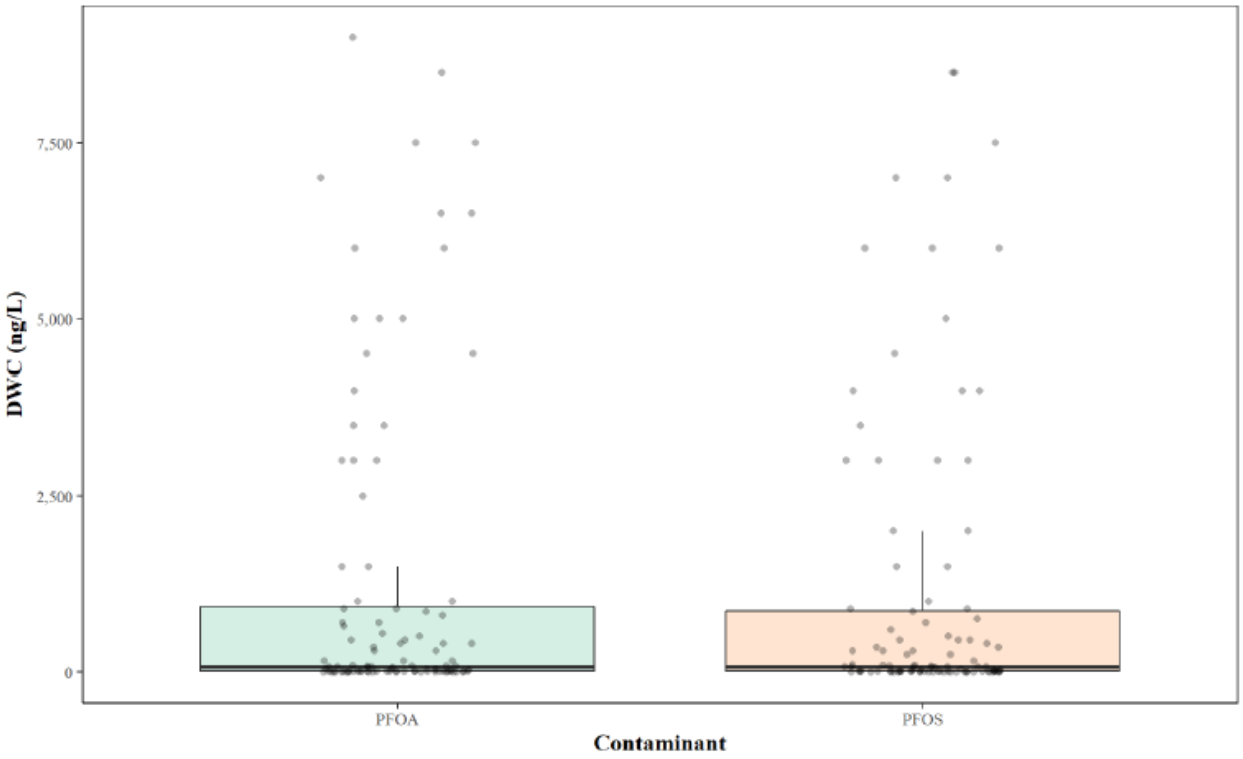
[62] IBID

[63] Ankit Rohatgi, "WebPlotDigitizer" (Pacifica, California, September 16, 2022), https://automeris.io/WebPlotDigitizer/.

The fitted curve overpredicts the total public drinking water population percentage by 12.5 percent at the high end of the distribution. As with any statistical estimation, there is more uncertainty at points further away from the central estimate. Since it is the high end of the distribution where the majority of the benefits will occur, the analysis trims the shape of the simulated curve by reducing the population amounts predicted by the curve by 12.5 percent so that the population in the analysis equals EPA's estimate of 277 million consumers of public drinking water.

Figure 2, the population distribution, was converted to the probability distribution and simulated drinking water concentration data were generated by randomly drawing drinking water concentration (DWC) from the probability distribution. The simulated DWC data are displayed in the boxplot in Figure 3:

Figure 5: Simulated Drinking Water Concentration of PFOA and PFOS Before the Proposed Rule



Baseline Population

Some states have promulgated drinking water MCLs for PFAS.[64] In its EA, EPA reviewed state websites and identified states with standards promulgated as of July 2022 for the PFAS compounds considered under the proposed rule (see Table 2).

[64] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," 4-22 & 4-23.

Table 2: State PFAS MCLs included in EPA's EA (ppt)

State	PFOA	PFOS	PFBS	PFHxA	PFHxS	PFNA	HFPO-DA	Sum[65]
New Jersey	14	13				13		
Vermont	*	*			*	*		20
New Hampshire	12	15			18	11		
Massachusetts	*	*			*	*		20
Michigan	8	16	420	400,000	51	6	370	
New York	10	10						

EPA assumed in its occurrence model that estimates exceeding state limits are equivalent to the state-enacted limit to estimate the benefits and costs of the proposed rule. EPA also assumed that the state MCL is the maximum baseline PFAS occurrence value for all entry points in the state.[66] This adjustment was made to the EPA's occurrence model PFAS estimates for PFOA, PFOS, and PFHxS. Systems in states with PFAS regulations are still expected to incur incremental costs to comply with the proposed rule since EPA's proposed standards are more stringent than current state drinking water standards. Similarly, EPA notes that "populations served by PWSs in the states with PFAS regulations are expected to benefit from further reductions in PFAS exposures."[67]

While EPA adjusts the occurrence data to account for promulgated MCLs, it assumes its baseline will remain constant in the future, excluding proposed regulations as well as changes in drinking water PFAS occurrence due to issued and future guidance and other regulatory actions. Several states have passed non-MCL regulations or will promulgate either new MCLs or other actions in the future that all impact PFAS occurrence levels in drinking water. To allow comparisons with EPA's estimates, the analysis does not reduce the assumed population by assuming other states will promulgate state standards before the federal MCL. However, pending state standards and voluntary actions are likely to reduce baseline exposure and thus the incremental benefits of this action.

[65] Asterisks indicate PFAS regulations at an overall threshold value indicated in the Sum column.

[66] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," 4-23.

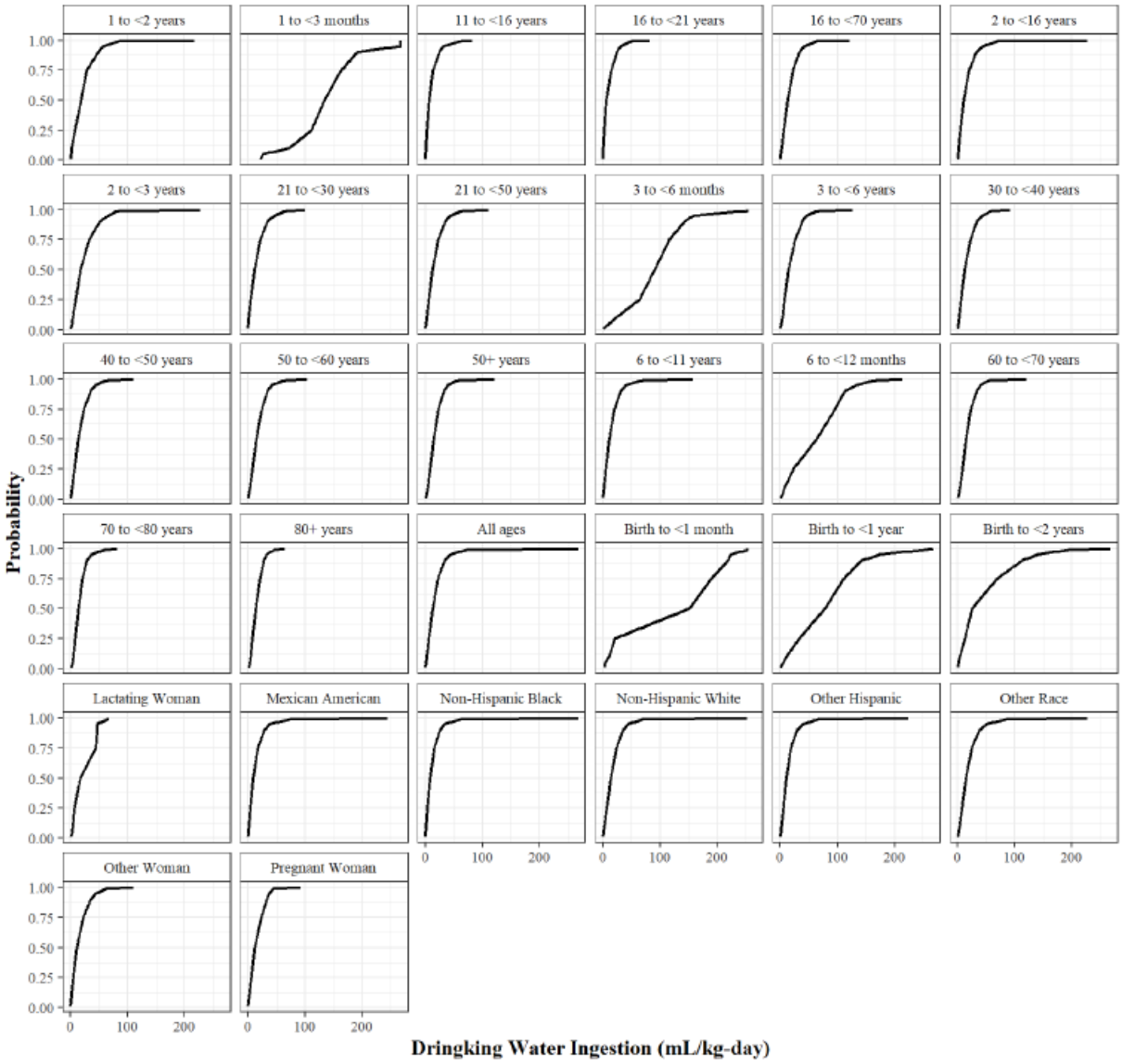
[67] U.S. Environmental Protection Agency, 4-23.

Drinking Water Intake/Body Weight Data

Consumption

For water ingestion and daily dose estimation, we use data distributions from EPA's Exposure Factors Handbook.[68] EPA revised the water ingestion information in 2019 in the Handbook to include more recent data. The analysis uses the consumers-only, direct and indirect drinking water intake values to construct an intake distribution for the U.S. population.

Figure 6: Probability Distribution of Drinking Water Ingestion Rate[69]



[68] U.S. Environmental Protection Agency, "Exposure Factors Handbook," 2011, https://www.epa.gov/expobox/about-exposure-factors-handbook.

[69] Figure 4 is a graphical description of data in EPA's Exposure Factors Handbook (EFH).

Figure 4 shows the probability distribution of direct and indirect public drinking water consumption by age group and other sensitive subgroups.

Population Distribution of PFOS Dose from Drinking Water Consumption

The Drinking Water Dose (DWD) is a translation of the drinking water intake to a dose metric. Values of DWD of PFOS before and after the proposed rule are determined so that they can be compared against the available toxicology information. It is calculated by multiplying a value taken from the drinking water concentration distribution and a value taken from the drinking water intake distributions.

Duration

The analysis assumes people consume drinking water from the same water source for their lifetimes, consistent with EPA's approach.

Human Equivalent Dose (HED) for Different Diseases

The analysis searched the scientific literature to find studies that employed approaches that encompass more potential adverse effects and that analyze this data in an approach consistent with benefit-cost analysis. A paper by Chen et al. that integrated human and animal cellular response data into a probabilistic risk assessment of PFOS is the primary source for the benefit estimate.[70]

In the paper, Chen et al extracted toxiogenomic dose-response data and other data from a public repository of in vivo animal and in vitro human high-throughput studies.[71] Studies of at least three different doses of PFOS were identified in mice, rats, and human cells. The results were filtered to identify the differentially expressed genes. These genetic responses were enriched by applying a disease ontology approach to cluster the genetic changes into disease pathways.

Applying a Bayesian dose-response model to this genetic data from animal studies and in vitro human cell data, the authors developed benchmark doses (BMDs). The authors selected a ten percent change as the benchmark response, the change significant enough to indicate that the PFOS concentration was altering cellular function. Finally, the authors used a physiological based pharmacokinetic (PBPK) model to convert the BMDs to human equivalent doses (HEDs). Each HED is a probability distribution of cellular response for that disease by dose. The paper and the supporting information contain more detailed information on the author's approach.

The Chen et al. drew on data from different concentrations of PFOS exposure to different cells and from different exposure durations.[72] The analysis selected the HEDs from the liver cells and derived from 14 days of exposure since (1) it yielded the most potential adverse

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[70] Qiran Chen, Wei-Chun Chou, and Zhoumeng Lin, "Integration of Toxicogenomics and Physiologically Based Pharmacokinetic Modeling in Human Health Risk Assessment of Perfluorooctane Sulfonate," *Environmental Science & Technology*, 2022.

[71] Chen, Chou, and Lin, 3624.

[72] Chen, Chou, and Lin, 3267.

effects; (2) studies show that the body tends to deposit longer chain PFAS in liver tissue; and, (3) the HEDs were lower than other results. This selection may overestimate the potential adverse effects and social benefits. Chen et al. identified 108 responses to disease pathways in the 14-day liver tissue results.[73] The disease ontology and disease groups are listed in Table 4.

Table 3: Human Equivalent Dose (HED) for Different Diseases (ng/kg-day)

Disease Ontology	Disease Group/ Pathway
colon cancer	Cancer
ovarian carcinoma	Cancer
ovarian cancer	Cancer
pharynx cancer	Cancer
renal carcinoma	Cancer
nasopharynx carcinoma	Cancer
female reproductive organ cancer	Cancer
breast carcinoma	Cancer
prostate cancer	Cancer
male reproductive organ cancer	Cancer
bone cancer	Cancer
bone marrow cancer	Cancer
colorectal cancer	Cancer
connective tissue cancer	Cancer
head and neck cancer	Cancer
intestinal cancer	Cancer
kidney cancer	Cancer
large intestine cancer	Cancer
lipomatous cancer	Cancer
musculoskeletal system cancer	Cancer
ocular cancer	Cancer
ovary epithelial cancer	Cancer
retinal cancer	Cancer
retinal cell cancer	Cancer
sensory system cancer	Cancer
smooth muscle cancer	Cancer
adenocarcinoma	Cancer
adenoma	Cancer
autonomic nervous system neoplasm	Cancer
breast adenocarcinoma	Cancer

[73] Chen, Chou, and Lin, 3626.

Disease Ontology	Disease Group/ Pathway
cell type benign neoplasm	Cancer
colon carcinoma	Cancer
head and neck carcinoma	Cancer
leiomyosarcoma	Cancer
liposarcoma	Cancer
lymphoblastic leukemia	Cancer
malignant glioma	Cancer
malignant ovarian surface epithelial-stromal neoplasm	Cancer
mammary Paget's disease	Cancer
myeloma	Cancer
neuroblastoma	Cancer
neuroendocrine carcinoma	Cancer
osteosarcoma	Cancer
peripheral nervous system neoplasm	Cancer
renal cell carcinoma	Cancer
retinoblastoma	Cancer
acute myocardial infarction	CVD
chronic obstructive pulmonary disease	CVD
thalassemia	CVD
liver cirrhosis	CVD
arteriosclerosis	CVD
myocardial infarction	CVD
fatty liver disease	CVD
amyloidosis	CVD
arteriosclerotic cardiovascular disease	CVD
atherosclerosis	CVD
cerebrovascular disease	CVD
coronary artery disease	CVD
familial hyperlipidemia	CVD
heart valve disease	CVD
hematopoietic system disease	CVD
ischemic bone disease	CVD
kidney disease	CVD
kidney failure	CVD
lipid metabolism disorder	CVD
lipid storage disease	CVD
mitral valve disease	CVD
nutrition disease	CVD

Disease Ontology	Disease Group/ Pathway
obesity	CVD
obstructive lung disease	CVD
cerebral infarction	CVD
endocrine system disease	ER
gestational diabetes	ER
pancreas disease	ER
osteoporosis	ER
polycystic ovary syndrome	ER
HELLP syndrome	ER
hyperandrogenism	ER
inherited metabolic disorder	ER
lysosomal storage disease	ER
overnutrition	ER
reproductive system disease	ER
sex differentiation disease	ER
anemia	ImmunoTox
autoimmune disease of gastrointestinal tract	ImmunoTox
hepatitis	ImmunoTox
bacterial infectious disease	ImmunoTox
primary bacterial infectious disease	ImmunoTox
autosomal recessive disease	ImmunoTox
parasitic infectious disease	ImmunoTox
autoimmune disease of urogenital tract	ImmunoTox
blood coagulation disease	ImmunoTox
bone remodeling disease	ImmunoTox
bone resorption disease	ImmunoTox
lung disease	ImmunoTox
malaria	ImmunoTox
primary biliary cirrhosis	ImmunoTox
urinary system disease	ImmunoTox
Alzheimer's disease	NeuroTox
amyotrophic lateral sclerosis	NeuroTox
Parkinson's disease	NeuroTox
brain disease	NeuroTox
brain infarction	NeuroTox
essential tremor	NeuroTox
motor neuron disease	NeuroTox
prion disease	NeuroTox

Disease Ontology	Disease Group/ Pathway
tauopathy	NeuroTox
toxic encephalopathy	NeuroTox

These 108 HEDs cover a wide range of possible health effects. For example, the analysis includes 46 different types of cancers and tumor formation.

The authors applied a 30-fold uncertainty factor to the HEDs derived from animal data to reflect animal-human extrapolation and human variability and a 10-fold uncertainty factor to human HEDs to reflect population variability.[74] As an additional safety factor, our analysis applies a uniform 30-fold uncertainty factor to all HEDs and divide the HEDs by this factor.

As shown in Table 4, the analysis groups the 108 HEDs into five disease groups: cancer, immunotoxicity, neurological, cardiovascular disease (CVD), and endocrine response (ER). Each HED is a probability distribution based on dose. Following the practice of fitting a distribution to a series of HED values shown in Figure 4 of Chou and Lin, a distribution is fitted on the HED data extracted the supporting information package of Chen et al. and is done so for each of the five disease types.[75]

[74] Chen, Chou, and Lin, "Integration of Toxicogenomics and Physiologically Based Pharmacokinetic Modeling in Human Health Risk Assessment of Perfluorooctane Sulfonate."

[75] Chen, Chou, and Lin; Wei-Chun Chou and Zhoumeng Lin, "Probabilistic Human Health Risk Assessment of Perfluorooctane Sulfonate (PFOS) by Integrating in Vitro, in Vivo Toxicity, and Human Epidemiological Studies Using a Bayesian-Based Dose-Response Assessment Coupled with Physiologically Based Pharmacokinetic (PBPK) Modeling Approach," *Environment International*, 2020.

Figure 7: Probability Distributions of HEDs by Disease and Disease Type

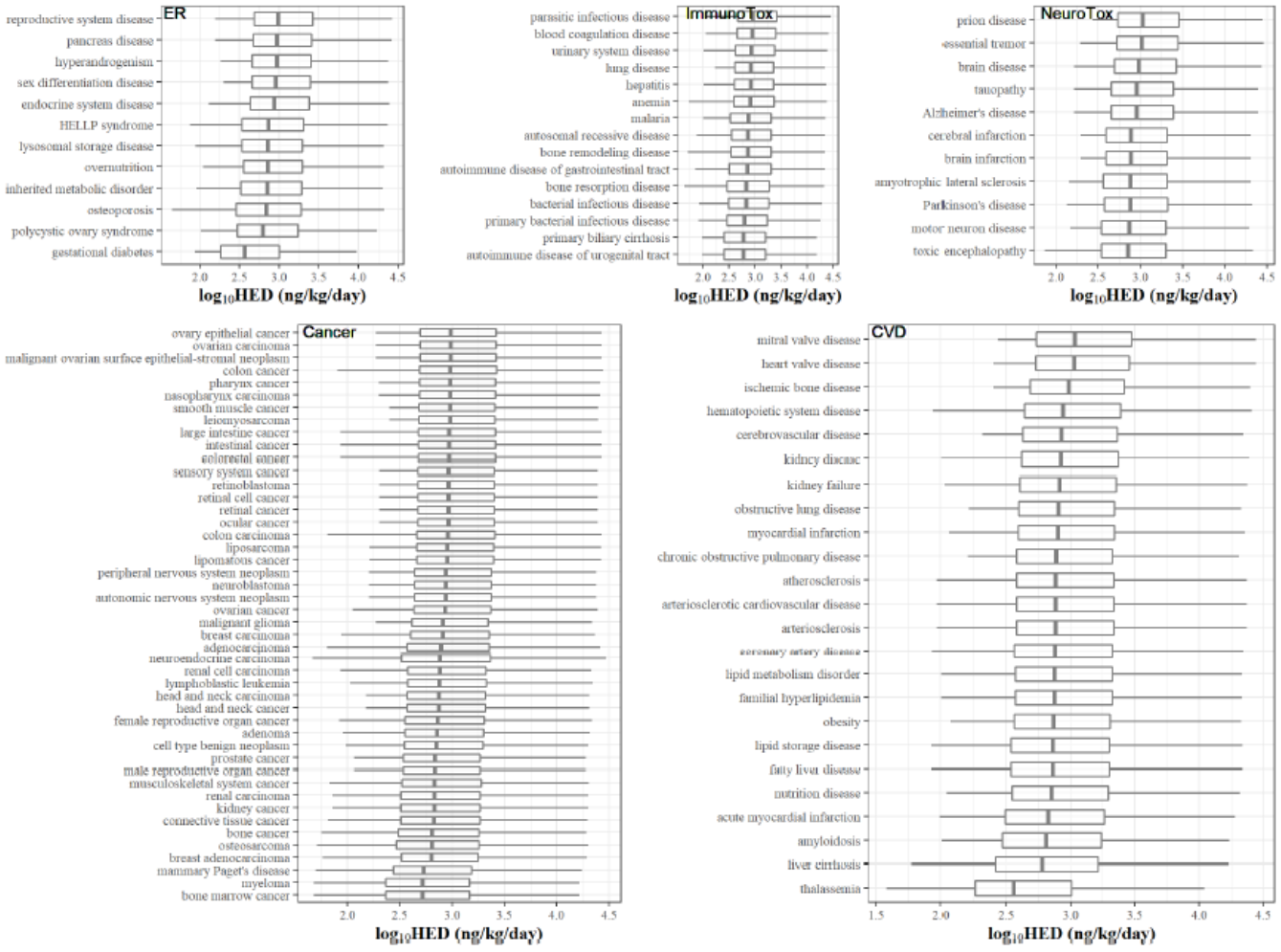
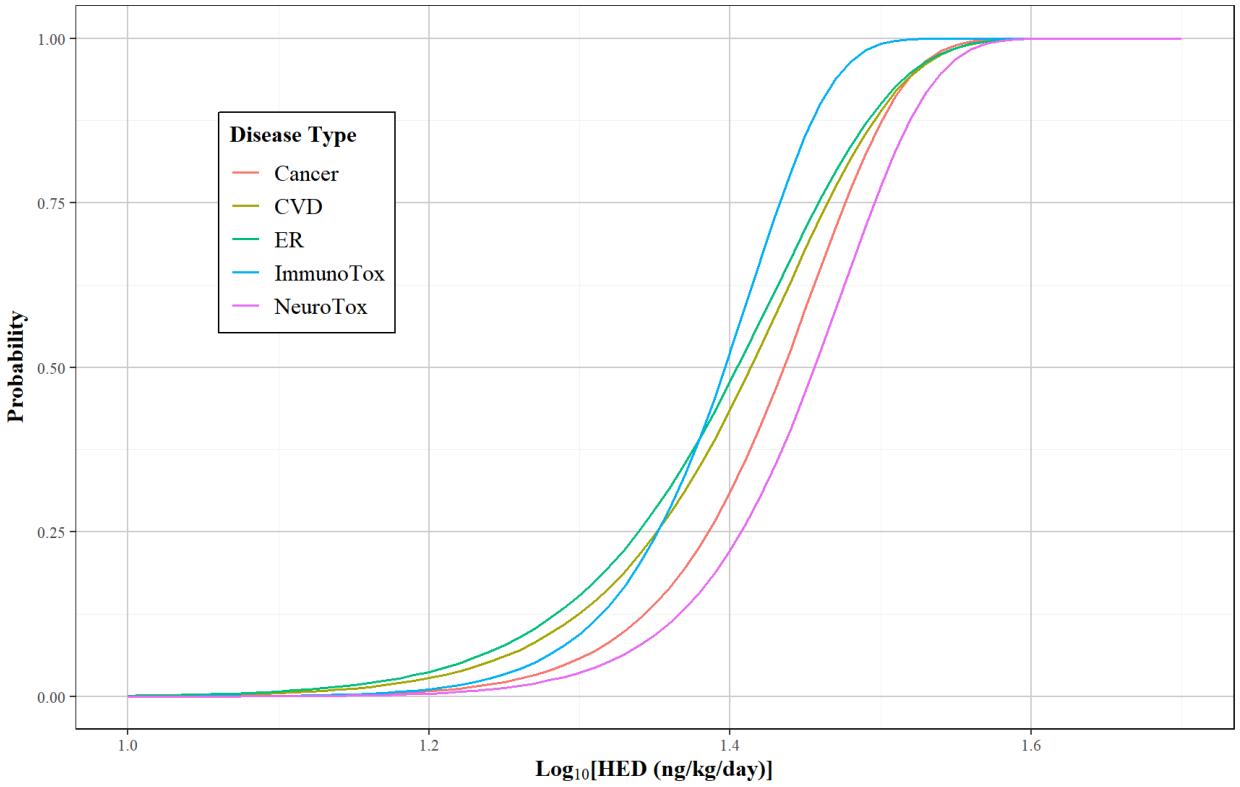


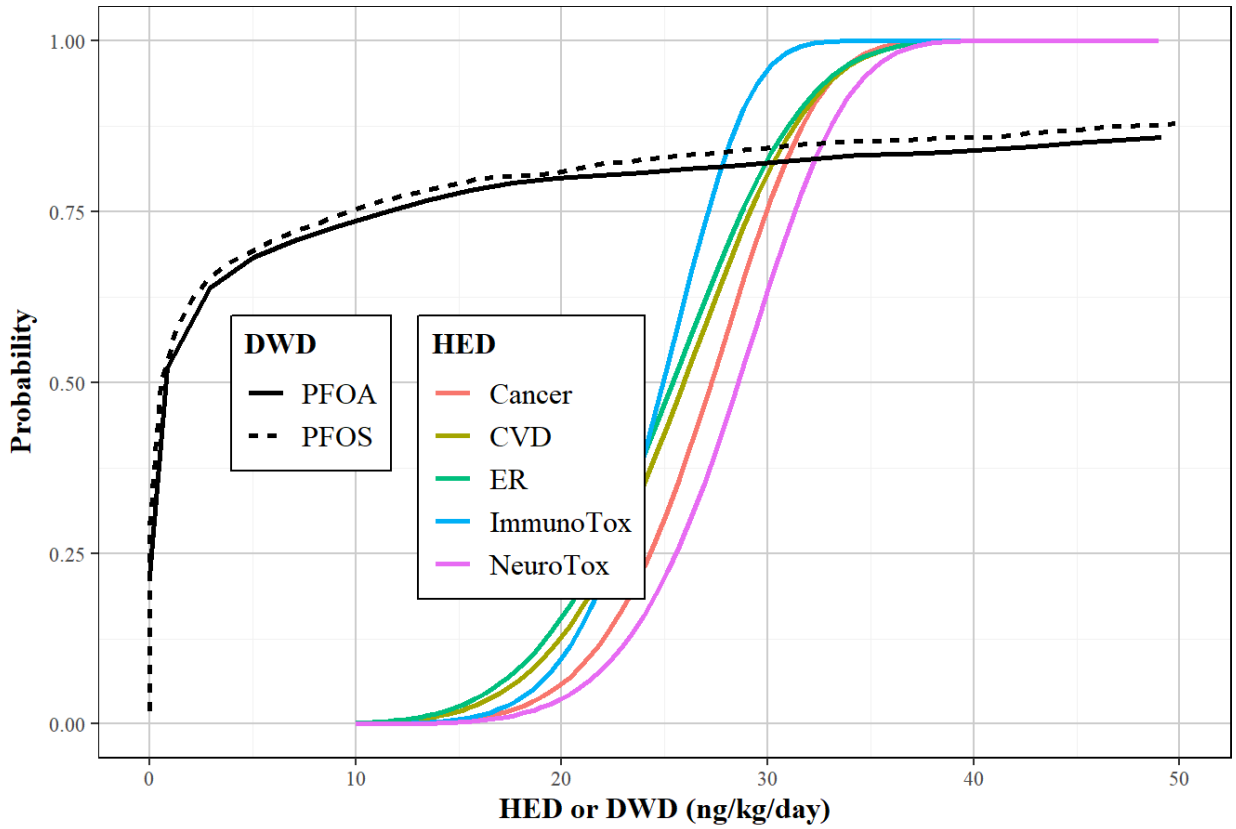
Figure 7 plots the probability distribution of the 108 diseases by HED levels. Each disease has a central tendency estimate and a range of probabilities that vary with dose. As with Chou et at., this analysis used a Weibull distribution to fit a curve to the log10(HED) data. Figure 8 is a simplification of Figure 7 since it plots median HED values of the distributions of all 108 diseases aggregated by disease type.

Figure 8: Probability Distribution of Log10(HED) by Disease Type



The analysis then overlays the distributions of the disease probabilities (HEDs) and the drinking water doses (DWDs) for both PFOS and PFOA in Figure 9. Several features become apparent. First, below a dose of 20 ng/kg/day, the probability of all diseases is effectively zero. Second, on the other end of the HED distribution, once the DWD exceeds 52 ng/kg/day, the probability is effectively one – or a certainty that this population would have a disease if the gene and cell response data are perfectly causal. Third, consumers with high end exposures are likely to generate the majority of the benefits. From the DWD curve, 81 percent of the population is expected to be below 20 ng/kg/day. Fourth, at the proposed MCL, there is no expected remaining risk. EPA's proposed action would reduce the expected risk to zero. Finally, reducing the level of current state PFOS MCL to EPA's proposed PFOS MCL is not expected to yield any health benefits.

Figure 9: Probability Distribution of HED by Disease Type for All Ages and Probability of Dose from Drinking Water for the Population



Confidence in the Chen et al work is extended when additional studies are considered. Chou and Lin took a similar approach to Chen et al.'s work and reached similar findings.[76] In this study, the researchers gathered data from high-throughput in vitro assays from EPA's ToxCast program, from six controlled dose animal studies, and four human epidemiology studies. The authors selected a range of assays related to the disease groups in Chen et al. As in that study, Chou and Lin considered in vitro data when at least one dose group had a ten percent change in response.[77] The authors also applied a Bayesian dose-response model to integrate the human, animal, and in vitro evidence. The authors calculated HEDs for all the studies. Table 3 of the paper lists the calculated HEDs. Even by applying an uncertainty factor of 30 to the HEDs in Chou and Lin, all of the in vitro and animal studies have estimated PFOS HEDs equal to or greater than those in Chen et al. While the human studies give lower HEDs, the authors explain that the uncertainty over the dose measurement in the epidemiolocal studies, the co-exposure to a mixture of PFAS, and other limitations suggest that the human HEDs are conservative. The Chou and Lin paper complements and reinforces the Chen et al. findings

[76] Chou and Lin, "Probabilistic Human Health Risk Assessment of Perfluorooctane Sulfonate (PFOS) by Integrating in Vitro, in Vivo Toxicity, and Human Epidemiological Studies Using a Bayesian-Based Dose-Response Assessment Coupled with Physiologically Based Pharmacokinetic (PBPK) Modeling Approach."

[77] Chou and Lin.

that there is little significant biological activity at doses below 20 ng/kg/day as measured through a wide range of in vitro assays and through animal experimental data.

4. Expected Disease Probabilities from Current Drinking Water Intake

The analysis then randomly samples from the PFOS intake from drinking water and compares the dose to the HED disease group probabilities. This comparison is carried out through several steps.

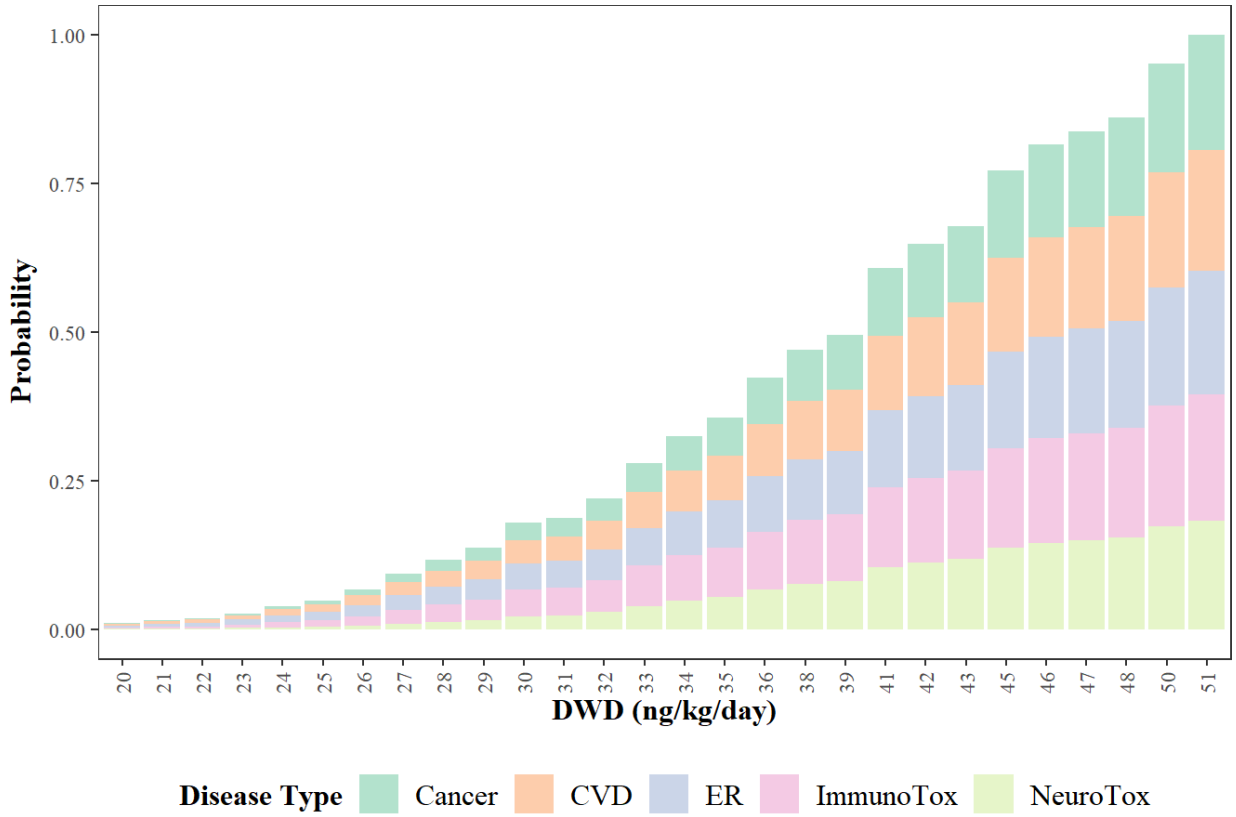
Calculate the Probability of a Disease Group

As shown in Figure 8, for the same dose, a person could be at risk of contracting a disease in multiple disease groups. Each person is only subject to the risk from a single disease in the analysis. To assign the sample population to a disease group, the area under the curve (AUC) of each disease curve for different HED doses in Figure 5 is estimated. The probability of being in each disease group is equal to the proportion of the area under each cumulative distribution curve (see Figure 7).

Probability of Disease Type

We utilize a Monte Carlo simulation by taking 1,000 random samples from the DWD curves for PFOA and for PFOS in Figure 9 and calculating the AUC for each disease group. If the drinking water dose is above 20 ng/kg/day, then there is a positive probability of each of the five diseases. Figure 10 below shows the results of this calculation for PFOS.

Figure 10: Probability of Disease Group for All Ages for PFOS



This figure shows both the absolute probability of having a disease and the relative probability of each disease type for a given drinking water dose. In Figure 10, at a dose of approximately 38 ng/kg/day, the probability of having a disease is approximately 50 percent. The colors in the stacked bar at that dose show that this 50 percent risk is the sum of the risks for each of the five disease groups. Once the dose reaches and exceeds 52 ng/kg/day, the estimate is that the probability is certain and the proportions among the disease groups do not change as dose increases.

5. Bounding Estimate of Benefits

Since it appears unlikely that much of the current population exposed to PFOS in public drinking water will garner significant benefits, the analysis creates a bounding estimate of benefits to compare with the social costs. The objective is to map out an extreme upper bound on the possible benefits from the proposed MCLs. The bounding estimate rests on assumptions that overstate the potential benefits:

- **Causality.** The analysis assumes that a probability of disease predicted by the genomic data will in fact occur. Intervening biological repair mechanisms are assumed not to be effective or exist. This assumption clearly overstates the probability and the severity

of potential disease from PFOS exposure in drinking water. Due to the many environmental, diet, and random events that perturb the body's functions, the body contains many repair mechanisms. Other studies support that this bounding estimate will overstate the potential benefits substantially:

  - In a recent study of PFOA, a HED generated from liver cell cultures was found to predict response levels 40-60 times less than actual responses observed in a human clinical trial with controlled PFOA doses.[78]
  - Another study compared 43 chemicals' "safe" dose from both genomics data and traditional toxicity testing. The genomics "safe" value was on average almost 6-fold less than the values derived from controlled animal experiments.[79]

- **A 10 Percent Change in Response Causes Disease.** In addition to the causality assumption, the bounding estimate further assumes that the BMD change of a 10 percent response is sufficient to overcome the body's defenses and to cause a disease. In reality, a larger response or disruption could be necessary to cause disease.
- **Existing Population will Gain the Full Benefits.** The analysis assumes that the population that straddles the rule's effective date will gain all the potential reductions in the probability of adverse effects. In reality, lower future exposure may lessen probabilities of future harm, but not eliminate them. Past exposure may have created an enduring increase in lifetime risk. Since 96 percent of the benefits in this bounding estimate accrue to current members of the population, reducing the existing population's assumed benefits would substantially lower the benefits.
- **HEDs with Large Potential Benefits as Surrogates for All HEDs in a Disease Group.** Some of the HEDs in the five disease groups have limited occurrence in the U.S. population or have very low adverse health impacts. The analysis transfers the estimated benefit of some of the HEDs with larger benefits to all HEDs with likely small impacts.

Therefore, these assumptions imply that a more realistic estimate of the social benefits is at least 10 times lower than those in this bounding estimate. However, the purpose is to explore whether the social benefits can exceed the costs even with these unrealistic assumptions – and with a more comprehensive consideration of potential benefits.

While the analysis constructed a full uncertainty analysis for the variables with uncertainty, the analysis presents the central tendency estimates for simplicity.

[78] Styliani Fragki et al., "New Approach Methodologies: A Quantitative in Vitro to in Vivo Extrapolation Case Study with PFASs," *Food and Chemical Toxicology* 172 (2023).

[79] Byron Kuo et al., "Comprehensive Interpretation of in Vitro Micronucleus Test Results for 292 Chemicals: From Hazard Identification to Risk Assessment Application," *Archives of Toxicology* 96 (2022).

Population Cohorts

The analysis estimates the population that is expected to have a dose from drinking water consumption above 20 ng/kg/day. There are two populations that will benefit from this rule: the population at the time of the rule's effective date and future population that are born in the United States or come to the United States after the rule is effective. The analysis uses the term "new population" as the term for this latter group. The benefit methodology for each group is different.

Existing Population

We apply the following steps to estimate the proportion of the current population that could benefit from the proposed drinking water standard:

Adjust Population to Existing Residents that Consume Public Water in States without Standards

Our analysis assumes that the water systems are in compliance with the rule in 2026. The analysis assumes that the changes eliminate the risk to the 2026 population drinking public water. The present value of the benefits to the current population are assumed to occur over three years, corresponding to roughly the half-life of PFOS. This approach overestimates benefits for several reasons. First, adverse effects from exposure prior to the rule may be irreversible. Second, since the half-life is estimated to be greater than three years, after three years, the average U.S. consumer will still have more than half of their baseline PFOS concentration due to past drinking water consumption. Third, consumers may shift their consumption habits away from public drinking water sources in response to the final rule and in response to lag between public notification and PFAS treatment.

We adjust the population by EPA's proportion of U.S. residents that consumer public water. We further reduce this population to public water consumers in states that are likely not to have a state drinking water standard in place by 2026.

New Population

As stated above, the new population includes people born in the years after the effective date and new residents of the United States. New residences are assumed to have the same age profile and disease incidence as the existing population. The analysis uses Census Department decanal projections for new residents and new births.[80] For births, yearly values are created by assuming a linear relationship between the Census' estimates for each decade from 2020 to 2060. We assume the U.S. will enjoy approximately 1.1 million new residents and 4.1 million new births annually during the study period. For the bounding estimate, the analysis assumes that all newborns grow and live a full life to enjoy the benefits, that there is

[80] U.S. Census Bureau, "2017 National Population Projections Tables: Main Series," 2017, https://www.census.gov/data/tables/2017/demo/popproj/2017-summary-tables.html.

no emigration, that health care innovations do not reduce the adverse effects from the HED diseases.

The study period includes the annual population additions from 2027 to 2056.

Determine Disease Incidence and Individuals Expected to Suffer Diseases

Estimating the number of avoided cases of diseases from this regulatory action has three steps. First, the existing population and new populations are multiplied by the DWD distribution to determine the number of people expected to have a dose above 20 ng/kg/day from drinking water. This population is broken into unit increments of dose.

Second, for each dose, the corresponding population is divided into one of the five disease groups based on the proportions in Figure 7. Each population in these disease group/dose categories is then multiplied by the probability of having the disease from Figure 6 for that dose.

Finally, this resulting product is multiplied by the percentage of the population incidence of the disease. The analysis assumes that the existing population has consumed PFOS at current levels for some time. Therefore, if the diseases predicted by the HEDs are caused by current PFOS exposure, the current number of cancer cases in the U.S. population include the cases caused by PFOS exposure through drinking water. Therefore, if the genomic data predicts a reduction in the probability of disease, the number of existing U.S. cancer cases will be reduced by this regulatory action. The benefits will be therefore a reduction in the overall population cancer incidence.

The analysis thus requires the incidence in the existing U.S. population of the HEDs. We employ different approaches for each of the five disease groups based on data availability.

Cancer

Data on age-adjusted cancer incidence for specific cancers for the current U.S. population is obtained.[81] The analysis uses the major cancers in the HEDs. The analysis did not estimate the risk reduction from rarer cancers such as bone and ocular cancers.

CVD

The analysis gathered specific incidence information on COPD, stroke, fatty liver disease, liver cirrhosis, and acute myocardial infarction (AMI). Some of the HEDs were precursors to these diseases or are captured in the mortality and morbidity estimates for the specific diseases listed. The benefits for COPD are reduced to 30 percent of estimated values since 70

[81] U.S. Census Bureau.

percent of COPD is estimated to be caused by smoking.[82] For the other HEDs in the CVD disease group, the analysis applies a uniform valuation discussed below.

Neurological

The analysis gathers the population incidence rate for Alzheimer's and Parkinson's Disease. The remaining HED represent relatively rare diseases or categories in which Alzheimer's, Parkinson's are the most common specific disease. For the other HEDs in the Neurotologic disease group, the analysis applies a uniform valuation discussed below.

Immunotoxicity and Endocrine Disruption

As with the neurological disease group, the expected values are not likely to be significant in the total bounding estimate. The analysis applies a uniform value for each unique adverse effect in these categories.

Valuation of Disease Cases

The same valuation approach is used for existing and new populations. For each of the five disease groups, information on the burden of the major diseases and of their latency periods is taken from the literature.[83] The analysis calculates a net present value of the value of avoiding the disease in 2023 dollars by placing the value of avoiding the disease in the time of its average latency and then discount the future benefit.

The 108 HEDs span a range of potential effects, some clearly adverse like cancer and some only potentially adverse such as neoplasms. To quantify these adverse effects with the same metric, the analysis uses the disability-adjusted life-year (DALY) methodology. This metric combines the lost value from a disease's reduction in life span and from its reduction in abilities. The WHO employs DALYs as part of its Global Burden of Diseases project to standardize disease burdens across countries.[84] To allow comparisons, researchers have measured DALYs for many other diseases that are not part of the WHO project.

This analysis first links any of the HEDs to diseases the WHO valued for the United States in its 2019 Global Disease Burden analysis. The DALY per case of the disease in the United States is estimated by dividing the WHO's DALYs in the United States by the incidence rate of the disease in the United States. For the remainder of the HEDs, the scientific literature is searched to find DALY estimates and incident rates for the United States. Some of the HEDs

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[82] World Health Organization, "Chronic Obstructive Pulmonary Disease (COPD)," March 16, 2023, https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-(copd).

[83] Marcia R Weaver et al., "Health Care Spending Effectiveness: Estimates Suggest That Spending Improved US Health from 1996 to 2016," *Health Aff (Millwood)* 41, no. 7 (2022): 994–1004.

[84] World Health Organization, "Global Health Estimates: Leading Causes of DALYs," n.d., https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/global-health-estimates-leading-causes-of-dalys.

are precursors and did not have DALY estimates. Others were effects that may lead to the same adverse outcome, such as breast cancer and breast neoplasms. Table 4 shows some of the DALY estimates for the major HED diseases.

Table 4: DALY Estimates for Major HED Diseases

Disease Ontology	Disease Group/ Pathway	DALY
colon cancer	Cancer	11
ovarian carcinoma	Cancer	9.9
ovarian cancer	Cancer	9.7
pharynx cancer	Cancer	6.7
renal carcinoma	Cancer	6.7
nasopharynx carcinoma	Cancer	5.4
female reproductive organ cancer	Cancer	5
breast carcinoma	Cancer	2.9
prostate cancer	Cancer	1.9
male reproductive organ cancer	Cancer	1
adenocarcinoma	Cancer	18
neuroblastoma	Cancer	22
acute myocardial infarction	CVD	0.85
chronic obstructive pulmonary disease	CVD	10.6
thalassemia	CVD	5.9
liver cirrhosis	CVD	4.6
arteriosclerosis	CVD	0.85
myocardial infarction	CVD	0.85
fatty liver disease	CVD	0.49
kidney disease	CVD	0.042
cerebral infarction	CVD	26
gestational diabetes	ER	8.4
pancreas disease	ER	3.9
osteoporosis	ER	0.96
polycystic ovary syndrome	ER	0.24
autoimmune disease of gastrointestinal tract	ImmunoTox	22
hepatitis	ImmunoTox	7.8
bacterial infectious disease	ImmunoTox	2.9
primary bacterial infectious disease	ImmunoTox	2.9
autosomal recessive disease	ImmunoTox	0.75
parasitic infectious disease	ImmunoTox	0.08
malaria	ImmunoTox	0
Alzheimer's disease	NeuroTox	29
amyotrophic lateral sclerosis	NeuroTox	6

Disease Ontology	Disease Group/ Pathway	DALY
Parkinson's disease	NeuroTox	0.51

Valuation of Each Disease

The Department of Human Health Services' (HHS) economic analysis guidelines use a WTP estimate of approximately $800,000 per DALY.[85] This value is a transformation of the VSL to a life-year metric. This valuation is used in this analysis since it is consistent with Circular A-4's directive to use WTP values to estimate social benefits.[86]

Latency and Commencement of Benefits

The proposed regulation would reduce PFOS exposure in drinking water over time. As in EPA's analysis in the RIA, this analysis must determine the lag between the reduction in PFOS exposure and the change in disease occurrence. We first gather data on the latency between initiation and the manifestation of a disease. The HEDs span diseases with latency periods of a few days to several decades. To standardize each disease with a valuation, we discount the value of the disease to an equivalent current value by its latency period at a seven percent discount rate. For example, if a disease has a DALY loss of $400,000 when it occurs five years in the future, the value today is $285,000 (rounded). For the new population, many diseases are not expected to occur until the person reaches his/her 50s or 60s. Therefore, the valuation of avoiding the adverse effects in the future must be discounted to current dollars.

Discount Rates

Circular A-4 recommends providing estimates of net benefits using both 3 percent and 7 percent discount rates. OMB also outlines the rationale for discounting:[87]

- Resources that are invested will normally earn a positive return, so current consumption is more expensive than future consumption, since you are giving up that expected return on investment when you consume today.
- Postponed benefits also have a cost because people generally prefer present to future consumption. They are said to have positive time preference.
- Also, if consumption continues to increase over time, as it has for most of U.S. history, an increment of consumption will be less valuable in the future than it would be

[85] U.S. Department of Health and Human Services, "Guidelines for Regulatory Impact Analysis," 2016.

[86] U.S. Office of Management and Budget, "Circular A-4: Regulatory Analysis," September 2003.

[87] U.S. Office of Management and Budget, 32.

today, because the principle of diminishing marginal utility implies that as total consumption increases, the value of a marginal unit of consumption tends to decline.

OMB's basic guidance on discount rates is provided in Circular A-94, which explains that a real discount rate of 7 percent should be used as a base-case.[88] This rate is an estimate of the average before-tax rate of return to private capital in the economy. "It is a broad measure that reflects the returns to real estate and small business capital as well as corporate capital. It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector."

However, when regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower discount rate is appropriate. The alternative most often used is sometimes called the "social rate of time preference," meaning the rate at which society discounts future consumption flows to their present value. If the rate that the average saver uses to discount future consumption is taken as a measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. OMB explains that this rate has averaged around three percent in real terms on a pre-tax basis.

Valuation of Avoided Disease Cases

Table 5 gives the valuation per case of avoided disease for the major HEDs.

Table 5: Valuation of Avoided Disease Cases by Major HEDs

Existing Population HEDs	Avoided Costs		Future Population	
	NPV at 3 percent	NPV at 7 percent	NPV at 3 percent	NPV at 7 percent
Cancer[89]	($mil)	($mil)	($mil)	($mil)
colon cancer[90]	7.2	5.5	1.5	0.2
ovarian cancer[91]	4.8	2.5	1.4	0.1
pharynx cancer[92]	3.1	1.6	0.9	0.08
renal carcinoma	2.6	1.1	0.8	0.1

[88] U.S. Office of Management and Budget, 33; U.S. Office of Management and Budget, "Circular A-94," n.d.

[89] National Institutes of Health, National Cancer Institute, "SEER*Explorer: An Interactive Website for SEER Cancer Statistics," April 19, 2023, https://seer.cancer.gov/statistics-network/explorer/.

[90] Rebecca Siegel et al., "Colorectal Cancer Statistics, 2023," *CA: A Cancer Journal for Clinicians* 73, no. 3 (2023).

[91] New York State Cancer Registry, "Ovarian Cancer Incidence and Mortality by Age Group, New York City, 2016-2020," February 2023.

[92] National Institute of Dental and Craniofacial Research, "Oral Cancer Incidence (New Cases) by Age, Race, and Gender," April 2023.

Existing Population HEDs	Avoided Costs		Future Population	
	NPV at 3 percent	NPV at 7 percent	NPV at 3 percent	NPV at 7 percent
female reproductive organ cancer	4.9	1.5	0.6	0.1
breast carcinoma	1.7	1.1	0.53	0.08
prostate cancer	0.9	0.5	0.2	0.02
male reproductive organ cancer	0.5	0.3	0.3	0.1
Esophageal[93]	9.6	5.4	2	0.1
Brain[94]	14.5	11.1	3.4	0.4
CVD				
chronic obstructive pulmonary disease[95]	3.6	1.2	2	0.3
arteriosclerosis[96]	0.4	0.3	0.3	0.1
myocardial infarction	0.4	0.3	0.3	0.1
acute myocardial infarction[97]	0.5	0.3	0.1	0.01
fatty liver disease[98]	0.4	0.3	0.2	0.04
cerebral infarction[99]	8.7	2.9	2.7	0.2
thalassemia	4.4	4.1	4.4	4.1

[93] Nicolas Patel and Bikramjit Benipal, "Incidence of Esophageal Cancer in the United States from 2001-2015: A United States Cancer Statistics Analysis of 50 States," *Cureus Journal of Medical Science* 10, no. 12 (2018); GBD 2017 Oesophageal Cancer Collaborators, "The Global, Regional, and National Burden of Oesophageal Cancer and Its Attributable Risk Factors in 195 Countries and Territories, 1990–2017: A Systematic Analysis for the Global Burden of Disease Study 2017" 5 (2020).

[94] Roswell Park Comprehensive Cancer Center, "Understanding Brain Tumors: The Basics," February 12, 2018; Kimberly Miller et al., "Brain and Other Central Nervous System Tumor Statistics, 2021," *CA: A Cancer Journal for Clinicians* 71, no. 5 (2021).

[95] U.S. Centers for Disease Control and Prevention, "Chronic Disease Indicators (CDI)," 2023, https://nccd.cdc.gov/cdi.

[96] U.S. Centers for Disease Control and Prevention, "QuickStats: Percentage of Adults Aged ≥18 Years with Diagnosed Heart Disease, by Urbanization Level and Age Group — National Health Interview Survey, United States, 2020," *Morbidity and Mortality Weekly Report* 71, no. 778 (2022), http://dx.doi.org/10.15585/mmwr.mm7123a4.

[97] Kristi Reynolds et al., "Trends in Incidence of Hospitalized Acute Myocardial Infarction in the Cardiovascular Research Network (CVRN)," *American Journal of Medicine* 130, no. 3 (2017): 317–27.

[98] Youn Huh, Yoon Jeong Cho, and Ga Eun Nam, "Recent Epidemiology and Risk Factors of Nonalcoholic Fatty Liver Disease," *Journal of Obesity & Metabolic Syndrome* 31, no. 1 (2022): 17–27.

[99] U.S. Centers for Disease Control and Prevention, "Stroke Facts," 2023, https://www.cdc.gov/stroke/facts.htm#:~:text=The%20death%20rate%20for%20stroke,41.1%20per%20100%2C000%20in%202021.

Existing Population HEDs	Avoided Costs		Future Population	
	NPV at 3 percent	NPV at 7 percent	NPV at 3 percent	NPV at 7 percent
liver cirrhosis[100]	3.3	2.8	1.2	0.3
Neuro				
Alzheimer's disease	11.5	4.6	3.5	0.3

For some of the common immunotox and endocrine disruptor diseases, the net present value benefits are less than $100 million. There are 17 HEDs remaining that are unique diseases. As a bounding estimate, we assign each one an avoided cost present value of $100 million to generate the bounding estimate in Table 5.

Incremental Effect of the Proposed Regulatory Action

As stated above, in this bounding estimate the rulemaking is assumed to eliminate the incremental probability of harm from current PFOS concentrations in drinking water to the existing population and to future populations from 2027 to 2056.

6. Results

PFOS

Table 7 gives the results of this bounding exercise. The annualized social benefits for the proposed PFOS drinking water standard are approximately $1.4 billion per year at a seven percent discount rate. This estimate arises from consideration of 108 possible disease states that arise from observed changes in biological function. It would appear that it is implausible that other adverse effects that do not rely on biological function changes could be large enough to exceed this bounding estimate.

As discussed in the next section, this benefit estimate is more than five times less than the estimated social costs. Since a more likely estimate of the social benefits are more than ten times lower than this bounding estimate, the social costs of EPA's proposed regulatory action exceed the potential social benefits by a large margin.

[100] Yuan-Bin Liu and Ming-Kai Chen, "Epidemiology of Liver Cirrhosis and Associated Complications: Current Knowledge and Future Directions," *World Journal of Gastroenterology* 28, no. 41 (2022): 5910-30.

Table 6: NPV of Estimated Annualized Benefits ($ M)

	NPV	Annualized
	(2026-2056 at 7% Discount Rate)	7% Discount Rate
All Cancers	1,100	86
CVD	11,000	760
Alzheimer's	1,700	140
Stroke	210	17
Fatty Acid Liver Disease	130	10
Liver Cirrhosis	97	8
All Others	1,700	140
Total	16,000	$1,200

PFOA

As the occurrence data and EPA's population estimates show, there is extensive overlap between the populations that would benefit from a PFOS standard and a PFOA standard. There does not appear to be comparable studies to Chen et al. and Chou and Lin in the literature for PFOA. In EPA's MCLG documents, EPA finds that PFOA and PFOS share many of the same adverse effects at roughly the same dose levels. The estimated occurrence in drinking water is roughly the same as shown in Figure 4.

Even doubling or trebling the benefits from the PFOS bounding estimate to account for the social benefits of PFOA, however, does give benefits close to the social costs.

Table 7: NPV of Estimated Annualized Benefits ($ M)

	NPV	Annualized
	(2026-2056 at 7 percent)	at 7 percent
Colon Cancer	1,000	81
Ovarian Cancer	94	8
Oral Cancer	210	17
Renal	240	19
Cervix	51	4
Breast	920	74
Prostate	370	30
Testis	11	1
Esophageal	300	24

	NPV	Annualized
Brain	790	63
COPD	540	43
Fatty Acid Liver Disease	24	2
Liver Cirrhosis	21	2
Stroke	30	2
Heart Attack	340	27
Alzheimer's	11,000	900
All Others	1,700	140
Total	18,000	1,400

IV. ESTIMATES OF THE SOCIAL COSTS FROM EPA'S REGULATORY ACTION

EPA's proposed rule will cause a range of social costs above and beyond those included in EPA's EA. The direct costs to society, as EPA discusses, are primarily the treatment and engineering costs non-compliant water systems will incur to comply. These social costs include the capital resources required for PFAS treatment, the O&M costs associated with installation and implementation of treatment strategies, and the 0other monitoring and administrative costs to maintain compliance.

Additional market costs that EPA does not quantify include the near-term additional costs water systems face due to scarcity in the labor force and supply chain constraints; the opportunity costs associated with periods of time required to install treatment technologies; and the economy-wide general equilibrium (GE) effects as the regulation shifts resources from consumption of other goods and services to very specific capital investments.

There are other non-market social costs associated with the proposed rule, as well. Treatment systems require electricity and, as water systems' energy consumption rises, society will carry the social costs of increased carbon dioxide emissions.

1. Likely Compliance Strategies

To comply with EPA's proposed rule, drinking water systems that have PFAS detections exceeding one or more of the proposed MCLs will install limited or total system treatment technologies. Today's effective PFAS treatment systems include the following:

- **Ionic exchange (IX)**. IX involves selective ion exchange in solution with ions bound to a resin matrix.[101] IX resins have a limited capacity for adsorption and are affected by contaminant concentrations and flow rates, similar to GAC. However, IX resins are highly selective toward PFAS removal, with minimal removal of other contaminants. The overall efficacy of IX for PFAS removal is specific to the water matrix, treatment goals, and system design.
- **Granular activated carbon (GAC)**.[102] GAC systems use carbon-based materials (e.g. coal) that, once activated, produce absorbent media with pores that organic compounds attach to and become absorbed onto. GAC has a finite capacity for compound adsorption and contaminants compete for adsorption sites. Disposal and reuse are considerations with this method, as reactivating GAC media contaminated with PFAS is expected to be more limited in drinking water applications.
- **Reverse osmosis (RO) systems**. RO is a membrane-based treatment process in which a semi-permeable barrier removes dissolved contaminants.[103] These treatment systems are more expensive than GAC or IX systems but are most viable when the GAC/IX replacement frequency requirements are cost-prohibitive due to high influent PFAS concentrations. Membrane elements are mounted into pressure vessels arranged in stages, banks, or arrays, the number of which depends on the specified recovery level.

Each treatment technology carries specific capital investment costs as well as operation and maintenance (O&M). Furthermore, installing treatment systems takes time. Temporarily shutting off a well while installation is completed means that a system will incur the opportunity cost associated with a decreased water supply capacity. With promulgation of EPA's final MCLs, hundreds of systems nationwide will be in non-compliance and require treatment. This sudden increase in demand will place a strain on supply chains and the labor force to meet the increased demand for equipment and labor. Water systems will bear near-term additional costs due to a scarcity in the labor force and in capital equipment.

Some systems that require treatment will also consider additional or alternative compliance strategies such as permanently shutting off a groundwater well and, subsequently, interconnecting raw water sources within the system. As with temporary well shut offs, these systems will incur opportunity costs of decreased water supplies. While shutting off wells will likely be one compliance strategy for some systems, we limit our analysis to the assumption that all systems will install treatment and, as a result, incur the following direct costs:

- Capital investment costs;
- O&M and labor costs;
- Near-term additional costs due to labor and capital equipment scarcity; and,
- Administrative costs such as reporting, permitting, and taxes.

[101] Black & Veatch, "PFAS National Cost Model Report" (American Water Works Association, March 7, 2023), 6.

[102] Black & Veatch, 3.

[103] Black & Veatch, 9.

In addition to costs with prices that can be measured in goods and services markets ("Market Costs"), EPA's rulemaking has costs that are not trade in markets ("Non-market Costs"). The analysis estimates the major market and non-market costs.

2. Market Costs

Approach

Affected Systems and Service Population

To estimate the number of affected groundwater (GW) and surface water (SW) systems by system size, the total inventory of community water systems (CWSs) by size of service population is multiplied by the average population per system.[104] The CWS are broken out by size and by water source. Then, for both small and large systems, the analysis estimates the percentage of the population by system size.[105] For example, of the 53 million (M) in total population served by small systems, 29 M (or 55 percent) are served by systems within the 3,301-10,000 person service population size category. CWSs serving between 100,000-1 M people represent 41 percent of the total population served by large systems.

Table 8: Total CWSs and Service Population by System Size and Source

	Total CWSs (1,000)		Avg. Population per CWS (1,000)		Total Service Population by CWS size (1,000)				Pct of Population by System Size (%)	
CWS Size	GW	SW	GW	SW	GW	SW	Total - Small	Total - Large	Small	Large
< 100	11	0.74	0.06	0.06	650	45	690		1.3	
101 to 500	13	2	0.25	0.03	3,300	580	3,800		7.2	
501 to 1,000	4.1	1.2	0.73	0.75	3,000	880	3,900		7.4	
1,001 to 3,300	5.5	2.5	1.9	2	10,000	4,900	15,000		29	
3,301 to 10,000	2.8	2.2	5.7	6.1	16,000	14,000	29,000		55	

[104] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," 4-7; U.S. Environmental Protection Agency, "SDWIS Federal Reporting Services Fourth Quarter 2021 Dataset," 2021, https://www.epa.gov/ground-water-and-drinking-water/safe-drinking-water-information-system-sdwis-federal-reporting.

[105] "Small systems" serve less than or equal to 10,000 people, while "large systems" serve populations greater than 10,000.

	Total CWSs (1,000)		Avg. Population per CWS (1,000)		Total Service Population by CWS size (1,000)				Pct of Population by System Size (%)	
10,001 to 50,000	1.4	2.0	21	23	28,000	46,000		75,000		31
50,001 to 100,000	0.16	0.42	67	70	1,100	29,000		40,000		16
100,001 to 1,000,000	0.074	0.35	200	240	15,000	85,000		100,000		41
> 1M	0.002	0.023	1,200	1,200	2,400	28,000		30,000		12
Total	38	11			90,000	210,000	53,000	240,000	100	100

The analysis then applies these percentages to total populations affected by the proposed rule for small and large systems, which EPA estimates at 3.7 M and 60.6 M, respectively.[106] This assumption gives total affected population by system size, which then is divided by the average population by system size to arrive at an estimated number of systems that will be required to treat.

Table 9: Total and Impacted Population at Small and Large PWSs

		Small Systems			Large Systems		
Total Affected Population				3,752,014			60,630,000
CWS Size	**Ave Population by Size**	**Pct of Small Systems (%)**	**Est. population (1,000)**	**Est. Number of Systems**	**Pct of Large Systems (%)**	**Est. population (1,000)**	**Est. Number of Systems**
< 100	0.061	1.3	49	800			
101 to 500	0.25	7.2	270	1,100			
501 to 1,000	0.73	7.4	280	380			
1,001 to 3,300	1.9	29	1,100	580			
3,301 to 10,000	5.7	55	2,100	370			
10,001 to 50,000	21				31	19,000	896
50,001 to 100,000	67				16	10,000	148
100,001 to 1,000,000	200				41	25,000	121

[106] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," tbls. 4-26.

	Small Systems				Large Systems		
> 1M	1,200				12	7,400	6
Total		100	3,800	3,200	100	61,000	1,172

To estimate how these totals are distributed by water source type, the estimated number of systems per CWS size is multiplied by ratios from the CWS inventory. For example, as shown in Table 8, 650 of the 690 CWSs serving populations under 100 persons rely on ground water (GW). Thus, 94 percent of the approximately 800 number of affected systems in Table 9 for this system size are assumed to use ground water sources.

Table 10: Total Systems by Water Source

	Est. number of affected systems	GW	SW
< 100	810	750	52
101 to 500	1,100	940	150
501 to 1,000	380	290	84
1,001 to 3,300	580	400	180
3,301 to 10,000	370	200	160
10,001 to 50,000	900	360	530
50,001 to 100,000	150	41	110
100,001 to 1,000,000	120	21	100
> 1M	6		6

Cost Estimates

EPA Cost Estimates

The analysis then analyzes EPA's cost estimates at system size levels. To estimate a combined annualized cost per CWS estimate across both water source types, the following approach is employed. First, using the CWS inventory values by water source and system size, the analysis estimates, for each system size category, the percentage of total systems that rely on GW and those that rely on SW (see Table 11). These percentages are applied to EPA's estimated mean annualized cost per CWS and water source.

Table 11: CWS ratios

CWS Size	Total CWSs (1,000)[107]			Percentage (%)			EPA's Mean Annualized Cost per CWS[108] ($1,000)			Combined Annualized Cost per CWS ($1,000)
	GW	SW	Sum	GW	SW	Sum	GW	SW	Sum	
< 100	11	0.074	11	94	6.5	100	$15	$22	$38	$16
101 to 500	13	2	15	86	14	100	$25	$33	$59	$26
501 to 1,000	4.1	1.2	5.3	78	22	100	$35	$49	$85	$39
1,001 to 3,300	5.5	2.5	8.0	69	31	100	$56	$72	$130	$61
3,301 to 10,000	2.8	2.2	5.0	56	44	100	$123	$140	$270	$130
10,001 to 50,000	1.4	2.0	3.4	41	59	100	$280	$380	$660	$340
50,001 to 100,000	0.16	0.42	0.58	28	72	100	$640	$580	$1,200	$600
100,001 to 1,000,000	0.074	0.35	0.42	18	82	100	$900	$3,700	$4,600	$3,200
> 1M[109]	0.002	0.023	0.025	8.0	92	100				

Black and Veatch Cost Estimates

Black and Veatch (B&V) recently developed a national cost estimate for water systems to remove PFOA and PFOS from drinking water and comply with a proposed NPDWR using cost data and design methodology to capture accurate system-level cost estimates for drinking water treatment.[110]

[107] U.S. Environmental Protection Agency, 4-7; U.S. Environmental Protection Agency, "SDWIS Federal Reporting Services Fourth Quarter 2021 Dataset."

[108] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation Appendices," March 2023, tbl. C-9.

[109] EPA does not present average or specific costs for systems >1 M. EPA identified 25 PWSs serving >1M people based on SDWIS/Fed estimates. Rather than model treatment costs using the MCMC model PFAS values, UCMR3 data & system consumer confidence reports are used to obtain entry point PFAS values.

U.S. Environmental Protection Agency, app. N.1.

[110] Black & Veatch, "PFAS National Cost Model Report."

Relying on B&V's cost estimates for systems presents two main advantages. First, it relies on recent data inputs, overcoming the dollar year limitation of EPA's EA discussed earlier in the report. Producer prices have risen as a result of supply shortages, global trade disruptions, and financial stimulus for the economy during the pandemic. Thus, B&V's analysis is more consistent with current conditions. The second advantage to using B&V's cost estimates is that the inputs and results are based on more recent engineering experience with building and designing treatment systems:

> The spreadsheet tool developed to perform this task accepts inputs for individual or combined target effluent levels for the six PFAS compounds represented in the database. After both occurrence data and potential regulatory levels are input, Visual Basic scripts within Excel may be initiated by a user to run a Monte Carlo analysis and generate a 10th percentile, 90th percentile, and most probable costs for the capital, operations and maintenance (O&M), and life-cycle costs for a typical entry point to the distribution system (EPTDS) for each PWS in the database. For each system, the tool selects the treatment technology with the lowest life-cycle cost.[111]

Moreover, the capital costs for a CWS are based on the design flow per entry point to the distribution system (EPTDS).[112] The design flow was used for capital cost estimates since equipment should be sized for peak treatment flow rates. Costs were independently calculated for IX, GAC vessels, GAC basins, and reverse osmosis (RO). Capital costs generated for individual systems represent a Class 5 Association for the Advancement of Cost Engineering (AACE) estimate, at approximately one to two percent maturity level of deliverable definition.

As shown by the expert analysis by a water sector engineering firm, EPA's cost models substantially underestimate the installation and operating costs of PFAS treatment systems. While EPA's cost estimates range from $16,000 to $3.2 M, B&V's estimates are between $250,000 and $11 million.[113] As shown in Table 12, B&V's estimates are between four and 16 times larger than EPA's estimates for the same system size.

These ratio differences are stark. Assuming 100 gallons of water used daily per person and based on average population served by CWS size, we estimate total annual gallons per CWS. We compare this to the annualized cost per CWS using both EPA and B&V estimates and include the results in Table 12. For the smallest systems serving populations <100 people, the additional annual cost per thousand gallons of water as a result of EPA's proposed rule is approximately $110 based on B&V's cost estimates, compared to $7.1/1,000 gallons/year based on EPA's cost estimates.

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[111] Black & Veatch, 14.

[112] Black & Veatch, 20.

[113] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation Appendices," tbl. C–9; Black & Veatch, "PFAS National Cost Model Report," tbl. A-1.

Table 12: Annualized Cost per CWSs that Treat or Change Water Source: Comparison between EPA's and B&V's Estimates

CWS Size	EPA Annualized Cost ($/CWS/yr)	B&V Annualized Cost ($/CWS/yr)	Ratio	Gallons used per CWS per year (1,000 gal/yr)	EPA Cost per Thousand Gallons ($/1,000 gal/yr)	B&V Cost per Thousand Gallons ($/1,000 gal/yr)
< 100	16,000	250,000	16	2,200	7.1	110
101 to 500	26,000	380,000	14	9,100	2.9	42
501 to 1,000	39,000	500,000	13	27,000	1.4	19
1,001 to 3,300	61,000	580,000	9	68,000	0.89	8.5
3,301 to 10,000	130,000	1,200,000	9	210,000	0.64	5.7
10,001 to 50,000	340,000	2,700,000	8	760,000	0.45	3.6
50,001 to 100,000	600,000	4,800,000	8	2,500,000	0.24	2.0
100,001 to 1,000,000	3,200,000	11,000,000	4	7,400,000	0.43	1.5
>1M		51,000,000		44,000,000		1.2

Annualized Treatment Costs

To calculate total annual treatment cost for the proposed rule, the analysis multiplies the cost estimates from B&V by the estimated number of systems requiring treatment from EPA's affected population estimate. Table 13 summarizes the estimated annualized treatment costs by CWS size for systems that will have to install treatment under EPA's proposed rule. Treatment costs are greatest for systems serving between 10,000 and 50,000 people ($2.4 billion) and those serving between 100,000 and 1 million people ($1.4 billion). Nationally, across all 4,400 estimated affected systems, costs are estimated at $6.4 billion each year.

Table 13: National Annual Treatment Cost by CWS Size for Affected Systems

CWS Size	Estimated Systems	B&V Annualized Cost ($)	Cost ($M)
< 100	810	250,000	200
101 to 500	1,100	380,000	410
501 to 1,000	380	500,000	190
1,001 to 3,300	580	580,000	330
3,301 to 10,000	370	1,200,000	430

CWS Size	Estimated Systems	B&V Annualized Cost ($)	Cost ($M)
10,001 to 50,000	900	2,700,000	2,400
50,001 to 100,000	150	4,800,000	700
100,001 to 1,000,000	120	11,000,000	1,400
> 1M	6	51,000,000	306
Total	4,400		6,400

Monitoring and Administrative Costs

In its EA, EPA estimates startup, sampling, and treatment administration cost elements that are applied to this estimate of systems per ETPSs for each CWS size.[114] The tables below display each of these cost breakdowns. Implementation startup costs account for labor and costs per system, along with average hours per system to read and adopt the rule and average hours per system to attend one-time trainings provided by primary agencies. Total costs range from $460,000 to $3,600,000. Laboratory analysis costs, labor rate, and the number of samples are used to estimate monitoring and sampling costs per location. Quarterly sampling costs per location are $5,200 for small systems and $5,300 for large systems, while triennial costs are between $710 and $1,500 per location (Table 15).

Multiplying the hourly labor rate by the number of hours per entry point for a system to notify, to consult, and to submit a permit request for treatment installation gives an estimate of the cost per system. Multiplying these figures by the total number of ground water and surface water EPTDSs that exceed one or more MCLs gives the total cost for each system size. This same methodology is used to determine costs per entry point for source water changes or alternative method permitting requests.

Table 14: Implementation Startup Costs

CWS Size	Estimated Systems	Labor Rate ($/ hour)	Avg. Hours per System to Read and Adopt Rule	Cost per CWS ($/one year)	Total Cost to System Class ($/one year)	Avg. Hours per System to Attend One-Time Training	Cost per System ($/one year)	Total Cost to System Class ($/one year)
< 100	810	35	4	140	**110,000**	16	570	**460,000**

[114] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation Appendices," tbl. C-9; Black & Veatch, "PFAS National Cost Model Report," tbl. A-1.

CWS Size	Estimated Systems	Labor Rate ($/ hour)	Avg. Hours per System to Read and Adopt Rule	Cost per CWS ($/one year)	Total Cost to System Class ($/one year)	Avg. Hours per System to Attend One-Time Training	Cost per System ($/one year)	Total Cost to System Class ($/one year)
101 to 500	1,100	35	4	140	**150,000**	16	570	**620,000**
501 to 1,000	380	35	4	140	**54,000**	16	570	**210,000**
1,001 to 3,300	580	35	4	140	**82,000**	16	570	**330,000**
3,301 to 10,000	370	38	4	150	**56,000**	32	1,200	**440,000**
10,001 to 50,000	900	40	4	160	**140,000**	32	1,300	**1,100,000**
50,001 to 100,000	150	42	4	170	**25,000**	32	1,300	**200,000**
100,001 to 1,000,000	120	49	4	190	**24,000**	32	1,600	**190,000**
> 1M	6	49	4	190	**1,200**	32	1,600	**9,400**
Total	4,400				**650,000**			**3,600,000**

Table 15: Sampling Costs

CWS Size	Est. Systems	Est. EPTDSs That Exceed One or More MCLs - GW	Est. EPTDSs That Exceed One or More MCLs - SW	Labor Rate/ Hour for Systems	GW Systems ≤10,000	All Other Systems	Quarterly Samples	Triennial Samples	Hrs/ Sample	Lab Analysis Cost/ Sample for EPA Method 533	Lab Analysis Cost/ Sample for EPA Method 537.1	Lab Analysis Cost/ Sample [115]	Lab Analysis Cost/ Sample [116]	Initial 12-Month Monitoring Period Labor Costs/ Sampled Location - GW	Initial 12-Month Monitoring Period Labor Costs/ Sampled Location (All Other Systems)	Total Cost to System of Initial Period per Sampled Location	Cost of Quarterly Samples/ Location	Cost of Triennial Sampling/ Location
< 100	810	1,000	72	35	2	4	4	1	1	$380	$300	$330	$270	$71	$140	**$84,000**	**$5,200**	**$710**
101 to 500	1,100	1,300	200	35	2	4	4	1	1	$380	$300	$330	$270	$71	$140	**$120,000**	**$5,200**	**$710**
501 to 1,000	380	400	120	35	2	4	4	1	1	$380	$300	$330	$270	$71	$140	**$45,000**	**$5,200**	**$710**
1,001 to 3,300	580	540	240	35	2	4	4	1	1	$380	$300	$330	$270	$71	$140	**$72,000**	**$5,200**	**$710**
3,301 to 10,000	370	270	220	38	2	4	4	2	1	$380	$300	$330	$270	$76	$150	**$53,000**	**$5,200**	**$1,400**
10,001 to 50,000	900	1,000	1,500	40		4	4	2	1	$380	$300	$330	$270		$160	**$250,000**	**$5,200**	**$1,400**
50,001 to 100,000	150	120	320	42		4	4	2	1	$380	$300	$330	$270		$170	**$53,000**	**$5,300**	**$1,400**
100,001 to 1,000,000	120	56	260	49		4	4	2	1	$380	$300	$330	$270		$190	**$51,000**	**$5,300**	**$1,500**
> 1M	6	2	17	49		4	4	2	1	$380	$300	$330	$270		$190	**$3,400**	**$5,300**	**$1,500**
Total	4,400															**$730,000**	**$47,000**	**$10,000**

[115] Lab analysis cost per sample for the field reagent blank under EPA Method 533.

[116] Lab analysis cost per sample for the field reagent blank under EPA Method 537.1

Table 16: Treatment Administration Costs

CWS Size	Est.CWSs	Est. EPTDSs	Labor Rate/ Hour	Hour per EPTDSs to Notify, Consult, & Submit Permit Request for Treatment Installation	Cost/ System per EPTDS	Total Cost ($)
< 100	810	1,107	$35	3	$110	**$120,000**
101 to 500	1,100	1,466	$35	5	$180	**$260,000**
501 to 1,000	380	517	$35	7	$250	**$130,000**
1,001 to 3,300	580	775	$35	12	$430	**$330,000**
3,301 to 10,000	370	488	$38	22	$830	**$410,000**
10,001 to 50,000	900	2,580	$40	22	$900	**$2,300,000**
50,001 to 100,000	150	438	$42	42	$1,800	**$770,000**
100,001 to 1,000,000	120	319	$49	42	$2,000	**$650,000**
> 1M	6	19	$49	42	$2,000	**$39,000**
Total	4,400	7710				**$5,000,000**

Economy-Wide Effects

The social costs extend beyond the water sector. EPA's proposed rule increases the price of a fundamental good. Businesses and households consume water and will pay price increases for the same good. Therefore, society will incur additional costs of the proposed rule as business and household costs rise. These effects are characterized as additional (or reduced) spending by other industries and households as a result of the activities of the water sector. To provide an example, the food and beverage industry uses large quantities of water; the demand for water will remain constant as the price increases under the proposed regulation. As the food industry spends more on water, it must spend less on other equipment and inputs. These shifts in spending are part of the economy-wide effects of a rulemaking. The more a regulation affects the price and the quantity of a good used as a factor of production, the greater the economy-wide effects across other sectors. In addition, the more a regulation affects demand for a good (like capital goods in this regulatory action) whose market is distorted by tax or other government policies, the greater the economy-wide effects.

This section describes existing methods for quantifying these effects and presents an estimate of the economy-wide social costs for EPA's proposed rule.

Economy-Wide Modeling (EWM)

The social costs are greater than the direct resource costs to achieve compliance. To be complete, an estimate of social cost should include both the opportunity cost of current consumption that will be foregone due to regulation, and the loss that may result if the regulation reduces capital investment and thus future consumption. To provide an example, the capital that will go to build PFAS treatment systems will no longer be available to build computers. The forgone productivity gains and economic growth given up because society invests in PFAS treatment rather than computers, for example, is the opportunity cost.

EPA asked its Science Advisory Board in 2015 as to the relevance and the use of economy-wide modeling (or "general equilibrium [GE]") for regulatory analysis. The SAB in its 2017 report endorsed EPA's use of these models since they "offer a more comprehensive assessment of the benefits and costs."[117] EPA sought the SAB's advice on the proper times to conduct such an analysis. "The SAB panel's advice was that a GE analysis is most likely to add value when the cross-price effects and pre-existing distortions (e.g., taxes, market power, other regulations) are significant."[118] EPA sought to investigate those conditions when shifting capital and labor to regulatory compliance and when existing market distortions increased the social costs. EPA concluded:

> We find that even for small regulations both the output substitution and tax interaction effects are significant, and ex ante compliance cost estimates tend to substantially underestimate the social cost of regulation independent of the sector subject to regulation or the composition of inputs required for compliance. This result is robust across a large number of regulatory scenarios and a series of sensitivity analyses over parametric and structural assumptions.[119]

EPA's National Center for Environmental Economics (NCEE) has recognized that social costs include the effect when consumption and investment shifts due to large-scale environmental regulations.[120] The total market costs of a regulatory action equals the sum of all opportunity costs incurred as defined by "the lost value of all goods and services that will not be produced and consumed as resources are moved away from production and consumption activities" toward treatment.[121] Using an inter-temporal computable general equilibrium model of the

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[117] U.S. Environmental Protection Agency Science Advisory Board, "SAB Advice on the Use of Economy-Wide Models in Evaluating the Social Costs, Benefits, and Economic Impacts of Air Regulations," September 2017, iv.

[118] Alex Marten, Richard Garbaccio, and Ann Wolverton, "Exploring the General Equilibrium Costs of Sector-Specific Environmental Regulations" (U.S. Environmental Protection Agency National Center for Environmental Economics, April 2019), 2.

[119] Marten, Garbaccio, and Wolverton, 2.

[120] Marten, Garbaccio, and Wolverton, 1.

[121] Marten, Garbaccio, and Wolverton, 2.

U.S. economy known as SAGE, EPA measures the relationship between these broader social costs and ex ante engineering compliance costs. These additional costs are also known as the general equilibrium effects that capture the supply and demand impacts across other sectors and markets.

EPA modeled the GE effects of a $100 million regulation in different sectors of the economy to measure how higher prices and capital shifts affected the entire economy. For the water sector, the report found the economy-wide reduction in consumption is 15 to 18 percent. In other words, the social costs of a regulation in the water sector are expected to be 15 to 18 percent higher than the engineering costs.

In the recently signed proposed rule for greenhouse gas standards for new and existing fossil fuel-fired electricity generating units (EGU), EPA applied SAGE in its proposed economic analysis.[122] EPA found that social costs including economy-wide effects are 35 percent greater than its engineering cost estimates. EPA's annualized engineering costs for the EGU proposal ($900 million) are comparable to EPA's annualized engineering costs for proposed MCLs. Therefore, the economy-wide costs of this regulatory action are also likely to be significant.

The analysis applies this range of additional social costs from NCEE's runs of EPA's SAGE model for the water sector to the estimated economic cost of the proposal. The annual GE effects amount to $1.1 B per year. Ultimately, consumers pay this cost through higher prices for goods and services and less income from lower economic growth.

3. Non-Market Social Costs

Social Costs from Electricity/Energy Use of Treatment Systems

Complying with the proposed MCL will increase demand for electricity and other energy sources. Since some sources of electricity emit greenhouse gases (GHGs), increasing demand for electricity through this proposed regulatory action will incrementally increase total GHG emissions. EPA recently acknowledged this social cost of a proposed regulation in the Hazardous Organic NESHAP proposed rule and quantified the social costs.[123] This analysis applies a similar methodology to estimate the social costs from increased GHG emissions due to this proposed rule.

The social cost of carbon dioxide (SC-CO_2) is defined as the discounted stream of damages caused by releasing one ton of CO_2 today. EPA's models track the long-term damages from global warming to 2300. Since CO_2 persists in the atmosphere, the value of avoiding a release

[122] U.S. Environmental Protection Agency, "Regulatory Impact Analysis for the Proposed New Source Performance Standards for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units," app. B.

[123] U.S. Environmental Protection Agency, "New Source Performance Standards for the Synthetic Organic Chemical Manufacturing Industry and National Emission Standards for Hazardous Air Pollutants for the Synthetic Organic Chemical Manufacturing Industry and Group I & II Polymers and Resins Industry," Proposed Rule (Federal Register, April 2023), 25197.

today requires tracking the future damages caused by that ton over the next few centuries. Therefore, the SCC value for a given year is the discounted present value of the estimated stream of damages from today to 2300.

EPA's *Report on the Social Cost of Greenhouse Gases*, published as part of its regulatory impact analysis for Docket EPA-HQ-OAR-2021-0317, includes the cost of greenhouse gases by discount rate per year.[124] Costs per metric ton range from $130 to $370 at 2.5 and 1.5 percent discount rates, respectively, in 2026; and $190 to $460 at 2.5 and 1.5 percent discount rates, respectively, in 2046.[125]

EPA's estimation process generates separate distributions of estimates based on different damage modules and near-term target discount rates of the social cost of each gas in each emissions year.[126] Table 16 gives EPA's values.

Table 17: SC-CO_2 by Discount Rate and Emission Year ($/mt)

Emission Year	2.5 percent discount rate	2.0 percent discount rate	1.5 percent discount rate
2026	130	220	370
2027	140	220	370
2028	140	220	380
2029	140	230	380
2030	140	230	380
2031	150	230	390
2032	150	240	390
2033	150	240	400
2034	160	250	400
2035	160	250	410
2036	160	250	410

[124] U.S. Environmental Protection Agency, "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances," September 2022, 120–21.

[125] The SC- CO_2 is the discounted stream of damages caused by releasing one ton of CO_2. EPA's models track the long-term damages to 2300. Since CO_2 persists in the atmosphere, the value of avoiding a release today requires tracking the future damages caused by that ton over the next few centuries. Therefore, the SC- CO_2 value for a given year is the discounted present value of that stream of damages from today to 2300.

[126] U.S. Environmental Protection Agency, "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances," 2.

Emission Year	2.5 percent discount rate	2.0 percent discount rate	1.5 percent discount rate
2037	160	260	420
2038	170	260	420
2039	170	260	430
2040	170	270	430
2041	180	270	440
2042	180	280	440
2043	180	280	450
2044	190	280	450
2045	190	290	460
2046	190	290	460

Energy Consumption Data Sources

In one of EPA's background document for this rulemaking, EPA provides electricity consumption data per system size for three GAC and IX system sizes:

Table 18: Breakdown of Energy Costs in GAC and IX Systems[127]

Category	Annual Cost ($)
GAC, design 0.500 mgd, ave. 0.162 mgd GW	
Energy for backwash pumps (0 Mwh/yr @ $0.1052/kWh)	13
Energy for residuals pumps (0 Mwh/yr @ $0.1052/kwh)	23
Energy for lighting (0 Mwh/yr @ $0.1052/kwh)	8
Energy for ventilation (0 Mwh/yr @ $0.1052/kwh)	40
GAC, design 5.809 mgd, ave. 2.455 mgd	
Energy for backwash pumps (2 Mwh/yr @ $0.1052/kWh)	165
Energy for residuals pumps (3 Mwh/yr @ $0.1052/kwh)	288
Energy for lighting (15 Mwh/yr @ $0.1052/kwh)	1,547

[127] U.S. Environmental Protection Agency, "Technologies and Costs for Removing Per- and Polyfluoroalkyl Substances (PFAS) from Drinking Water," February 2023.

Category	Annual Cost ($)
Energy for ventilation (9 Mwh/yr @ $0.1052/kwh)	955
GAC, design 56.271 mgd, ave. 24.863 mgd	
Energy for booster pumps (1672 Mwh/yr @ $0.1052/kwh)	175,945
Energy for backwash pumps (11 Mwh/yr @ $0.1052/kWh)	1,146
Energy for residuals pumps (19 Mwh/yr @ $0.1052/kwh)	2,003
Energy for lighting (380 Mwh/yr @ $0.1052/kwh)	39,973
IX, design 0.500 mgd, average 0.162 mgd	
Energy for backwash/rinse pumps (0 Mwh/yr @ $0.1052/kwh)	0
Energy for lighting (0 Mwh/yr @ $0.1052/kwh)	2
Energy for ventilation (0 Mwh/yr @ $0.1052/kwh)	9
IX, design 5.809 mgd, average 2.455 mgd	
Energy for backwash/rinse pumps (0 Mwh/yr @ $0.1052/kwh)	0
Energy for lighting (3 Mwh/yr @ $0.1052/kwh)	352
Energy for ventilation (3 Mwh/yr @ $0.1052/kwh)	343
IX, design 56.271 mgd, ave. 24.863 mgd	
Energy for backwash/rinse pumps (0 Mwh/yr @ $0.1052/kwh)	2
Energy for lighting (167 Mwh/yr @ $0.1052/kwh)	17,554
Energy for ventilation (26 Mwh/yr @ $0.1052/kwh)	2,749

Affected Entry Points to System (EPTDSs) and Average Flow

EPA provides an estimate of total entry points to distribution systems (EPTDS) that will be affected by the proposed NPDWR (see Table 19). The analysis extends EPA's estimate further to distribute these EPTDSs by system size categories.

Table 19: Total EPTDSs Impacted

CWS Size	National EPTDSs that Exceed One or More MCL[128]
Small Systems (<10,000)	4,354
Large Systems (>10,000)	3,356

The analysis distributes the EPTDS by CWS size and source water type by applying ratios derived from the CWS inventory (see discussion preceding Table 10). The estimated number of affected EPTDSs by CWS size is summarized in the following table.

Table 20: Total Estimated EPTDSs that Exceed One or More MCL by CWS Size

CWS Size	GW	SW
< 100	1,000	72
101 to 500	1,300	200
501 to 1,000	400	120
1,001 to 3,300	540	240
3,301 to 10,000	270	220
10,001 to 50,000	1,000	1,500
50,001 to 100,000	120	320
100,001 to 1,000,000	56	260
> 1M	2	17

Next, the average flow is calculated by dividing the average flow per CWS by the design flow per CWS. Flow increases with system size, with the largest CWSs having an average flow of 22 MGD for each entry point. Average daily production flow and design flow per system are based on regression equations from EPA's *Geometries and Characteristics of Public Water Supplies* report.[129] The average daily flow and design flow are functions of the population served, with different equations for source water type.

[128] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," tbls. 4-22.

[129] U.S. Environmental Protection Agency, 4-14.

Table 21: Average Flow (MGD per EPTDS)

CWS Size	GW	SW
< 100	0.006	0.006
101 to 500	0.019	0.028
501 to 1,000	0.047	0.063
1,001 to 3,300	0.11	0.15
3,301 to 10,000	0.26	0.36
10,001 to 50,000	0.49	0.69
50,001 to 100,000	0.94	1.3
100,001 to 1,000,000	1.7	3.5
> 1M		22

Estimated Electricity Consumption

Electricity consumption increases with CWS size and is slightly higher for surface water compared to ground water in larger systems. Table 22 summarizes the estimated electricity consumption per EPTDS.

Table 22: GAC and IX Energy Consumption per EPTDS (MWhr/yr)

CWS Size	GAC		IX	
	GW	SW	GW	SW
< 100	3.1	3.1	0.98	0.98
101 to 500	3.1	3.1	0.98	0.98
501 to 1,000	3.1	3.1	0.98	0.98
1,001 to 3,300	3.1	3.1	0.98	0.99
3,301 to 10,000	3.2	3.2	1.0	1.0
10,001 to 50,000	3.3	3.4	1.0	1.1
50,001 to 100,000	3.5	3.6	1.1	1.1

Science Applications International Corporation and The Cadmus Group, "Geometries and Characteristics of Public Water Systems" (U.S. Environmental Protection Agency, December 2000).

CWS Size	GAC		IX	
	GW	SW	GW	SW
100,001 to 1,000,000	3.8	4.7	1.2	1.4
Average (<1M)	**3.3**	**3.4**	**1.0**	**1.1**

Multiplying the averages from Table 22 by the number of entry points that exceed one or more MCLs gives the total energy consumption across all system entry points. To further break this down by treatment method, the analysis assumes 50 percent use GAC and 50 percent use IX. The total estimated electricity consumption for both GAC and IX ranges from 710 MWhr/year for systems serving 100,001-1M people to 26,000 MWhr/year for very large systems serving >1M people.

Table 23: GAC and IX Energy Consumption for All Entry Points that Exceed MCLs (MWhr/year)

CWS Size	GAC		IX		GAC & IX
	GW	SW	GW	SW	GW & SW
< 100	1,700	120	530	39	**2,400**
101 to 500	2,000	340	650	110	**3,200**
501 to 1,000	660	200	200	62	**1,100**
1,001 to 3,300	870	410	270	130	**1,700**
3,301 to 10,000	440	370	140	120	**1,100**
10,001 to 50,000	1,700	2,600	530	820	**5,700**
50,001 to 100,000	200	540	62	170	**970**
100,001 to 1,000,000	91	450	28	140	**710**
> 1M	22	23,000	17	3,100	**26,000**
Total	7,700	28,000	2,400	4,700	**43,000**

Using EPA's emissions rate estimate of 0.000433 metric tons (Mt) of CO_2/kWh, the analysis calculates the annual carbon dioxide emissions produced from both treatment methods. As shown in Table 24, the proposed rule is estimated to induce an additional 19,000 Mt of CO_2 emissions annually.

Table 24: Total Estimated Additional CO_2 Emissions from GAC and IX as a Result of EPA's Proposed Rule

CWS Size	GAC		IX		GAC & IX
	GW	SW	GW	SW	GW & SW
Total consumption for all entry points and CWSs (MWhr/year)	7,700	28,000	2,400	4,700	**43,000**
Emissions (Mt CO_2/year)	3,300	12,000	1,100	2,000	**19,000**

Results

The discounted SC- CO_2 annual figures from Table 17 are multiplied by the annual CO_2 emissions from treatment methods. The resulting costs range from $2.5M to $6.8M at 2.5 and 1.5 percent discount rates, respectively, in 2026; and $3.6M to $8.6M at 2.5 and 1.5 percent discount rates, respectively, in 2046. EPA uses the lower discount rates shown in Table 25 to discount future damages from GHG emissions.

Table 25: Total Estimated Annual Emissions Cost from the Proposed Rule ($ M)

Emission Year	2.5 percent discount rate	2.0 percent discount rate	1.5 percent discount rate
2026	2.5	4.0	6.8
2027	2.5	4.1	6.9
2028	2.6	4.2	7.0
2029	2.6	4.2	7.1
2030	2.7	4.3	7.1
2031	2.7	4.4	7.2
2032	2.8	4.4	7.3
2033	2.8	4.5	7.4
2034	2.9	4.6	7.5
2035	2.9	4.6	7.6
2036	3.0	4.7	7.7
2037	3.1	4.8	7.8
2038	3.1	4.8	7.9
2039	3.2	4.9	7.9
2040	3.2	5.0	8.0

Emission Year	2.5 percent discount rate	2.0 percent discount rate	1.5 percent discount rate
2041	3.3	5.0	8.1
2042	3.3	5.1	8.2
2043	3.4	5.2	8.3
2044	3.5	5.3	8.4
2045	3.5	5.3	8.5
2046	3.6	5.4	8.6

These estimates likely underestimate this social cost since, as with EPA's engineering estimates, they likely understate electricity consumption for necessary buildings and for treatment operations. These estimates also do not include the GHG impacts of mining and using activated carbon and the carbon dioxide emissions of activating the carbon for use. The regulatory action will also require non-electricity energy consumption such as heavy truck transport and disposal of media.

4. Results

As shown in Table 26, the sum of all the annual social costs amounts to approximately $7,500 M.

Table 26: Summary of Annual Estimated Costs

Cost Category	National Annualized Estimate ($ M/ yr)
Treatment Costs	6,400
Administrative/Monitoring Costs (1st year)	9.9
General Equilibrium	1,100
SC-CO_2	4.7*
Total Annual	7,500

**EPA uses a lower discount rate for the social costs of GHG emissions. Therefore, the SC- CO_2 is in different units of value than the other social costs.*

V. ECONOMIC IMPACTS

EPA estimates the average cost per household from the proposed MCLs. EPA uses the cost estimates from its models which underestimate current PFAS treatment costs. This analysis presents revised household cost estimates using the updated treatment cost data.

EPA also found that the severe household impact would be lessened by increased federal spending to water systems to address emerging chemicals such as PFAS. Since federal funds are largely limited to capital expenditures and since the likely costs are much higher than EPA's estimates, this report compares the level of increased federal funding to water systems' compliance needs.

1. Household (HH) Impact

Multiplying the number of systems by the average population by CWS size determines the total population served by system size. Dividing these totals by the average household size [130] gives an estimate the number of households per CWS size. Dividing B&V's annualized costs by the number of households results in total cost per household from treatment costs alone. Household costs range from $110 annually for large systems serving over 1 million people to $10,000 per household for the smallest systems serving less than 100 people (see Table 27). For the largest size categories – CWSs serving between 100,000 to 1 M people – 12 M, households are expected to see a $120 annual increase in drinking water expenses.

Table 28 summarizes these costs as percentages of the annual household income for different income groups. For the lowest quintile income,[131] costs average 15 percent and 0.75 percent of annual income for small and large CWSs respectively. For households at the national median household income ($70,784)[132] costs reach 15 percent of annual income for the smallest systems. For households with income at 200 percent of the poverty level, costs range from 0.2 percent of annual income for large systems to 20 percent for small systems. With households of four, costs are a higher percentage of annual income, averaging 13 percent for small systems and 0.67 percent for large systems. Cost estimates for single households reach up to 81 percent of their annual income at the small CWSs.

[130] U.S. Census Bureau, "Table HH-4. Households by Size: 1960 to Present," November 2022, https://www.census.gov/data/tables/time-series/demo/families/households.html.

[131] A quintile is one of five equal groups (20 percent of all HHs each) ranked by income from lowest to highest. The lowest quintile income used in this analysis is $23,584.

[132] U.S. Census Bureau, "Income in the United States: 2021," September 2022, https://www.census.gov/library/publications/2022/demo/p60-276.html.

Table 27: Annualized Cost per Household (HH) from Treatment Costs

CWS Size	Total Cost for CWS Size ($)	Total Est. HHs	Annual Cost per HH ($/year)
< 100	204,000,000	19,000	10,000
101 to 500	410,000,000	110,000	3,900
501 to 1,000	190,000,000	110,000	1,700
1,001 to 3,300	330,000,000	420,000	780
3,301 to 10,000	430,000,000	820,000	520
10,001 to 50,000	2,400,000,000	8,000,000	300
50,001 to 100,000	7102,000,000	4,100,000	170
100,001 to 1,000,000	1,400,000,000	12,000,000	120
> 1M	310,000,000	2,800,000	110
All affected CWSs	6,400,000,000	28,000,000	230

Table 28: Annualized HH Cost from Treatment Costs as a Percentage of Annual Income

CWS Size	Percent of Median HH Income	Percent of 200% Poverty Line HH Income	Percent of Poverty Line HH-of-4 Income	Percent of Lowest Quintile Income	Percent of Poverty Line Single-HH Income
< 100	15%	20%	40%	44%	81%
101 to 500	5.4%	7.3%	15%	16%	30%
501 to 1,000	2.4%	3.3%	6.6%	7.3%	13%
1,001 to 3,300	1.1%	1.5%	3.0%	3.3%	6.1%
3,301 to 10,000	0.74%	1.00%	2.0%	2.2%	4.1%
10,001 to 50,000	0.42%	0.57%	1.1%	1.3%	2.3%
50,001 to 100,000	0.24%	0.33%	0.70%	0.73%	1.3%
100,001 to 1,000,000	0.17%	0.22%	0.45%	0.50%	0.91%
> 1M	0.15%	0.20%	0.41%	0.46%	0.83%

Due to the initial year that includes up-front administrative startup costs, treatment administration costs, and 12-month monitoring costs, households in the initial year could bear additional economic impacts above those resulting from annualized costs. The following table presents the impacts on households from these administrative costs and includes an estimation of how the lowest quintile of households are impacted.

Table 29: Additional HH Impacts from Administrative Costs

CWS Size	Total Est. HHs	Administrative Cost per HH ($/first year)	Percent of Lowest Quintile Income in First Year from Administrative Costs	Percent of Lowest Quintile Income in First Year from Administrative and Treatment Costs
< 100	19,000	150	0.62%	45%
101 to 500	110,000	120	0.50%	17%
501 to 1,000	110,000	120	0.52%	7.8%
1,001 to 3,300	420,000	130	0.54%	3.9%
3,301 to 10,000	820,000	150	0.62%	2.8%
10,001 to 50,000	8,000,000	270	1.2%	2.4%
50,001 to 100,000	4,100,000	360	1.5%	2.2%
100,001 to 1,000,000	12,000,000	420	1.8%	2.3%
> 1M	2,800,000	570	2.4%	2.9%

2. Federal Funding Analysis

The Drinking Water State Revolving Fund (DWSRF) is a federal-state program that provides funding and financing to CWSs drinking water infrastructure projects.[133] The Infrastructure Investment and Jobs Act (IIJA) provides $4 billion in funding to address emerging contaminants over five years (FY22- FY26). Eligible recipients include public and private community water systems serving at least 15 service connections used by year-round residents or regularly serving at least 25 year-round residents. Nonprofit non-community water systems including schools, publicly owned campgrounds, parks, and churches are also able to receive funding. Comparing the annual treatment cost to available federal funding is important because, while IIJA provides historic investment in PFAS treatment, the proposed rule's estimated costs far exceed this funding.

[133] U.S. Environmental Protection Agency, "Clean Water and Drinking Water State Revolving Funds and the Bipartisan Infrastructure Law," n.d.

The B&V report provides estimated capital expenditure (CAPEX). The analysis subtracts the average O&M costs per system from the annualized per-system cost and multiplies the remainder by the estimated number of systems.[134] Capital cost is lowest among smaller systems, ranging between $150 and $370 million per year, and highest among systems serving 10,000 to 50,000 and 100,000 to 1,000,000 people ($290 million to $2.1 million).

Table 30: Annual Treatment Cost by CWS Size for Affected Systems ($M)

CWS Size	Average CAPEX/PWS	Average O&M/PWS	Annualized PWS Cost	Annualized - O&M	Estimated Systems	Capital Cost
< 100	$1.9	$0.072	$0.25	$0.18	800	$150
101 to 500	$3.4	$0.060	$0.38	$0.32	1,100	$350
501 to 1,000	$4.6	$0.063	$0.50	$0.44	380	$160
1,001 to 3,300	$5.5	$0.057	$0.58	$0.52	580	$300
3,301 to 10,000	$11	$0.18	$1.2	$1.0	370	$370
10,001 to 50,000	$24	$0.37	$2.7	$2.3	900	$2,100
50,001 to 100,000	$46	$0.51	$4.8	$4.3	150	$640
100,001 to 1,000,000	$110	$0.89	$11	$10	120	$1,300
> 1M	$507	$3.0	$51	$48	6	$290

Table 31 below shows funding made available from the IIJA for the Emerging Contaminants Drinking Water State Revolving Fund in FY23 ($764 million) compared to the estimated annualized treatment costs for small and large CWSs.[135] National annualized CAPEX costs equate to 180 percent of the funding made available from the IIJA for small systems treatment and 750 percent for all systems. Even with the substantial increase in federal funding and even if the total amount was allocated to PFAS treatment, water systems and rate payers must pay six times more than the federal funding to purchase treatment systems. Rate payers are also responsible for all of the O&M costs to operate their systems. Therefore, while the federal funding provides some relief, the majority of the severe household effects still are expected to occur.

[134] Black & Veatch, "PFAS National Cost Model Report," tbls. 6-3.

[135] Black & Veatch, "WITAF 56 Technical Memorandum: PFAS National Cost Model Report," tbls. 6-3.

Table 31: Annual Treatment Costs as a Percentage of IIJA Funding for Emerging Contaminants in Drinking Water

	Annualized Cost ($M)	Percentage of IIJA Funding
Small Systems (<10,000)	$1,300	180%
All Systems	$5,600	750%

VI. CONCLUSIONS

This report assessed EPA's approach to estimate the social benefits and costs of its proposed rule to federal requirements for regulatory analysis and best practices in the field. We determine that EPA's cost models substantially underestimate the installation and O&M costs of PFAS treatment systems. We provide data from experts in the water sector engineering field to show how substantial the costs of EPA's proposed rule will actually be. We also provide evidence from actual cost data from AMWA members to show the extent of EPA's underestimation. EPA also fails to account for other social costs such as additional costs from water rate increases and the non-market costs of greater greenhouse gas emissions.

EPA's benefit estimates assume a few possible adverse effects based on scientific findings that other public health organizations do not support. By failing to account for the possibility that these adverse effects may not exist, EPA overstates the social benefits.

We conduct a benefit-cost analysis to produce more accurate estimates. We rely on established NAS recommendations to develop hazard assessments based on recent available scientific information. Rather than EPA's approach to quantify a few adverse effects, this analysis considers a wide range of possible cellular and genomic evidence, animal data, and human epidemiological studies. Since these studies find that biological activity is likely only to occur at the high end of the modeled drinking water exposure, we develop a bounding estimate of the benefits of reducing PFOS in drinking water.

The results of this bounding estimates are shown in Table 32. We show that, whereas EPA estimated, at a seven percent discount rate, the annualized costs and benefits of the proposed rule to be $1,205 M and $908 M, respectively, we estimate them to be $7,500 M and $1,200 M, respectively. Thus, even with many assumptions to increase the social benefits, the results for PFOS are six times lower than the expected social costs. Even if these benefits are doubled to account for reductions in PFOA exposure, the social benefits are well below the social costs.

Table 32: Comparison of Estimated National Annualized Benefits and Costs for EPA's Proposed Rule ($ M)[136]

	EPA's Estimates at Seven Percent Discount Rate	PNG's Estimates at Seven Percent Discount Rate
Benefits ($ M/year)	908	<1,200[137]
Costs ($ M/year)	1,205	7,500

These social costs will fall heavily on rural and low-income households. Despite EPA's claims, recently-enacted federal support for water utilities is insufficient to pay for even the capital costs of the proposal's requirements. As a result, ratepayers may pay a significant portion of the rulemaking until other resources are secured. Ratepayer may pay hundreds of dollars per household.

[136] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation," 1-1.

[137] Even if these benefits are doubled to $2,400 M/year to account for reductions in PFOA exposure, the social benefits would still be well below the social costs.

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Table 33: EPA's List of Uncertainties

Uncertainty	EPA's Notes
The analysis does not include the impacts of COVID-19 on future population health and economic growth.	Impacts of the COVID-19 pandemic have had resulting effects on conception, pregnancy, and birth rates.[138] Some studies suggest that the economic recession caused by the COVID-19 pandemic may impose long-term impacts on fertility.[139] Such impacts are not accounted for in EPA's benefits analysis.
For PWSs with multiple entry points, the analysis assumes a uniform population distribution across the entry points.	Data on the populations served by each entry point are not available and EPA therefore uniformly distributes system population across entry points. Effects of the regulatory alternative may be greater or smaller than estimated, depending on actual populations served by affected entry points. For one large system serving more than one million customers EPA has sufficient data on entry point flow to proportionally assign effected populations.
Valuation of mortality risk reductions assumes that per capita income will grow at the constant rate.	EPA uses Value of Statistical Life (VSL) adjusted for income growth to estimate economic value of the premature mortality avoided in the future. Per capita income growth projections were available through 2050. EPA estimated the compound annual growth rate in per capita income during 2023-2050 and applied it to project VSL over the analysis period 2023-2104.
EPA does not characterize uncertainty associated with the VSL reference value or VSL elasticity.	EPA did not quantitatively characterize the uncertainty for the VSL reference value and income elasticity. Because the economic value of avoided premature mortality comprises the majority of the overall benefits estimate, not considering uncertainty surrounding the VSL is a limitation.

[138] Arnstein Aassve et al., "Early Assessment of the Relationship between the COVID-19 Pandemic and Births in High-Income Countries" 118, no. 36 (2021).

[139] Asad Ullah et al., "Potential Effects of the COVID-19 Pandemic on Future Birth Rate," *Frontiers in Public Health* 8 (2020).

Uncertainty	EPA's Notes
The analysis does not explicitly consider changes in PFOA/PFOS and THM4 concentrations for systems that purchase their drinking water from other PWSs.	Many PWSs purchase their primary source water from PWSs that are likely to implement treatment under the rule. The SDWIS/Fed inventory of PWSs includes these systems with their retail populations instead of allocating those populations to the wholesale systems. The MCMC occurrence analysis outputs for the wholesale system and purchasing system may vary from one another, resulting in either an under- or over-estimate of affected population in any iteration. The net effect on total benefits is uncertain.
The analysis does not account for populations that consume bottled water as their primary drinking water source.	Studies indicate that between 13 percent and 33 percent of the U.S. population consumes bottled water as their primary drinking water source.[140] The benefits models do not consider these populations. This could result in an overestimate of avoided cases of health effects and associated benefits. However, bottled water consumers can also be CWS customers and may still be exposed to PFAS by using water for cooking etc., therefore, would benefit from PFAS removal.[141] Finally, the benefits may also be underestimated because those using bottled water as a primary drinking water source may switch to CWS supply as a result of the proposed rule; EPA did not model this behavioral response and hence the benefits do not account for the potential cost savings to those consuming bottled water at baseline.
EPA assumes that the effects of PFOA and PFOS exposures are independent.	The exposure-response functions used in benefits analyses assume that the effects of serum PFOA/PFOS on the health outcomes considered are independent and therefore additive. Due to limited evidence, EPA does not consider synergies or antagonisms in PFOA/PFOS exposure-response.

[140] Zhihua Hu, Lois Wright Morton, and Robert Mahler, "Bottled Water: United States Consumers and Their Perceptions of Water Quality," *International Journal of Environmental Research and Public Health*, 2011; Asher Rosinger et al., "Disparities in Plain, Tap and Bottled Water Consumption among US Adults: National Health and Nutrition Examination Survey (NHANES) 2007–2014," *Public Health Nutrition* 21, no. 8 (2018); Florent Vieux et al., "Trends in Tap and Bottled Water Consumption among Children and Adults in the United States: Analyses of NHANES 2011–16 Data," *Nutrition Journal* 10 (2020).

[141] U.S. Food and Drug Administration, "Bottled Water Everywhere: Keeping It Safe," April 22, 2022, https://www.fda.gov/consumers/consumer-updates/bottled-water-everywhere-keeping-it-safe; Aquafina, "Aquafina FAQ," 2022, https://www.aquafina.com/en-US/faq.html#:~:text=Aquafina%20originates%20from%20public%20water,can%20affect%20a%20water's%20taste.

Uncertainty	EPA's Notes
The analysis assumes that quantified benefits categories are additive.	EPA did not model birth weight, CVD, RCC, and bladder cancer benefits jointly, in a competing risk framework. Therefore, reductions in health risk in a specific benefits category do not influence health risk reductions in another benefits category. For example, lower risk of CVD and associated mortality implies a larger population that could benefit from cancer risk reductions, because cancer incidence grows considerably later in life.
The scope of the analysis does not include intra- or international migration throughout the evaluation period.	Throughout the analysis period people may migrate from one place to another. If persons migrate to locations with larger decreases in PFOA/PFOS under the regulatory alternative, EPA would be underestimating the impacts. The opposite is true if persons migrate to locations with smaller decreases in PFOA/PFOS under the regulatory alternative.
The analysis considers PFOA/PFOS concentrations from NTNCWSs.	Some SDWIS population served estimates for NTNCWSs represent the both the population that has regular exposure to the NTNCWS' drinking water (e.g., the employees at a location) and the peak day transient population (e.g., customers) who have infrequent exposure to the NTNCWS' drinking water. Estimating the demographic distribution and the share of daily drinking water consumption for these two types of NTNCWS populations would be difficult across many of the industries which operate NTNCWSs. The inclusion of NTNCWS results is an overestimate of benefits because daily drinking water consumption for these populations is also modeled at their residential CWS.
The derivation of PFOA/PFOS exposure-response functions for the relationship between PFOA/PFOS serum and associated health outcomes assumes that there are no threshold serum concentrations below which effects do not occur.	The new data and EPA's proposed MCLGs indicate that the levels at which adverse health effects could occur are much lower than previously understood when EPA issued the 2016 health advisories for PFOA and PFOS (70 parts per trillion or ppt) – including near zero for certain health effects. Therefore, the exposure-response functions used in benefits analyses assume that there are no threshold serum concentrations below which effects do not occur. This could result in a slight overestimate of benefits for certain health endpoints.

Uncertainty	EPA's Notes
The exposure-response functions used to estimate risk assume causality.	Analyses evaluating the evidence on the associations between PFAS exposure and health outcomes are ongoing and EPA has not conclusively determined causality. EPA modeled health risks from PFOA/PFOS exposure for endpoints for which the evidence of association was found to be likely. These endpoints include birth weight, TC, and RCC. While the evidence supporting causality between DBP exposure and bladder cancer has increased since EPA's Stage 2 DBP Rule,[142] causality has not yet been conclusively determined.[143]
EPA has quantified benefits for three health endpoints for PFOA and PFOS.	For various reasons, EPA has not quantified the benefit of removing PFOA and PFOS from drinking water for most of the health endpoints PFOA and PFOS are expected to impact.
EPA has quantified benefits for one co-removed contaminant group.	Treatment technologies that remove PFAS can also remove numerous other contaminants, including some other PFAS compounds, additional regulated and unregulated DBPs, heavy metals, organic contaminants, pesticides, among others. These co-removal benefits may be significant, depending on co-occurrence, how many facilities install treatment and which treatment option they select.
EPA has not quantified benefits for any health endpoint for PFHxS, PFNA, PFBS, and HFPO- DA.	PFHxS, PFNA, PFBS, and HFPO-DA each have substantial health impacts on multiple health endpoints.

[142] U.S. Environmental Protection Agency, "Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation"; Richard Weisman et al., "Estimating National Exposures and Potential Bladder Cancer Cases Associated with Chlorination DBPs in U.S. Drinking Water," *Environmental Health Perspectives* 130, no. 8 (2022).

[143] Stig Regli et al., "Estimating Potential Increased Bladder Cancer Risk Due to Increased Bromide Concentrations in Sources of Disinfected Drinking Waters" (American Chemical Society, October 21, 2015).

Uncertainty	EPA's Notes
The analysis does not take into account population growth and other changes in long-term trends.	The benefits analysis does not reflect the effects of growing population that may benefit from reduction in PFOA/PFOS exposure. Furthermore, EPA uses present- day information on life expectancy, disease, environmental exposure, and other factors, which are likely to change in the future. There are two potential datasets that could inform population growth under the final rule. EPA has described these datasets below. Population projections by year, county, single-year age, sex, and race/ethnicity are available through 2050 from the Woods & Poole Economics Inc. (2021) dataset and could be used for the final rule.[144] This dataset has been used in prior rulemakings, such as the National Ambient Air Quality Standards, the Steam Electric Effluent Limitations Guidelines, and the Federal Recreational Water Quality Criteria Applicable to Certain Waters in New York (unpublished; currently on hold until January 2023 at the earliest). Woods & Poole Economics population growth data are also used in EPA's air quality benefits programs BenMAP-CE and COBRA. EPA could project the county-, sex-, race/ethnicity-, and age-specific distribution of Woods & Poole Economics data from 2051 to 2104 using a transition ratio approach with normalization to obtain population projections throughout the period of analysis relevant to the NPDWR. Additional population projection estimates are available from the Socioeconomic Data and Applications Center (SEDAC) by county, age, sex, and race/ethnicity in five- year intervals through the year 2100. These projections were used in EPA's recent Waters of the United States rulemaking. If implemented in the PFAS NPDWR, EPA would need to distribute population within five-year intervals and project population estimates from 2101 to 2104.
WBS engineering cost model assumptions and component costs	The WBS engineering cost models require many design and operating assumptions to estimate treatment process equipment and operating needs. The Technologies and Costs document and individual WBS models in the rule docket provide additional information.[145] The component-level costs approximate national average costs, which can over- or under-estimate costs at systems affected by the proposed rule.

[144] Woods & Poole Economics Inc, "Complete Demographic Database," 2021, https://www.woodsandpoole.com/our-databases/united-states/all-geographies/.

[145] U.S. Environmental Protection Agency, "Technologies and Costs for Removing Per- and Polyfluoroalkyl Substances (PFAS) from Drinking Water."

Uncertainty	EPA's Notes
Compliance forecast	The forecast probabilities are based on historical full-scale compliance actions. Site-specific water quality conditions, changes in technology, and changes in market conditions can result in future technology selections that differ from the compliance forecast.
Total organic carbon concentration	The randomly assigned values from the two national distributions are based on a limited dataset. Actual TOC concentrations at systems affected by the proposed rule can be higher or lower than the assigned values.
POU not included in compliance forecast	If POU devices can be certified to meet concentrations that satisfy the proposed rule, then small systems may be able to reduce costs by using a POU compliance option instead of centralized treatment or source water changes.
National occurrence data for HFPO-DA, PFBS, and PFNA not available	The hazard index in the proposed option would regulate PFBS, PFNA, and HFPO-DA in addition to the modeled PFAS. In instances when concentrations of PFBS, PFNA, and/or HFPO-DA are high enough to cause a hazard index exceedance, the modeled costs may be underestimated. If these PFAS occur in isolation at levels that affect treatment decisions, or if they occur in sufficient concentration to result in an exceedance when the concentration of PFHxS alone would be below the HI, then costs would be underestimated. Note that EPA has conducted an analysis of the potential changes in system level treatment cost associated with the occurrence of PFBS, PFNA, and HFPO-DA using a model system approach.
Process wastes not classified as hazardous	The national cost analysis reflects the assumption that PFAS-contaminated wastes are not considered hazardous wastes. As a general matter, EPA notes that such wastes are not currently regulated under federal law as a hazardous waste. To address stakeholder concerns, including those raised during the SBREFA process, EPA conducted a sensitivity analysis with an assumption of hazardous waste disposal for illustrative purposes only. As part of this analysis, EPA generated a second full set of unit cost curves that are identical to the curves used for the national cost analysis with the exception that spent GAC and spent IX resin are considered hazardous. EPA acknowledges that if federal authorities later determine that PFAS-contaminated wastes require handling as hazardous wastes, the residuals management costs in the WBS treatment cost models are expected to be higher. The estimated costs are consistent with EPA OLEM's "Interim Guidance on the

Uncertainty	EPA's Notes
	Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances."[146]

[146] "Designation of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) as CERCLA Hazardous Substances."

APPENDIX B

Table 34: PFOA & Birthweight

	EPA[147]	Health Canada[148]	EFSA[149]	WHO[150]
Findings	Decreased survival in mice offspring exposed to PFOA in utero related to PPARα-related hepatotoxicity. Alterations to the gene expression related to growth and development in vivo in zebrafish. Inconsistent results for PFOA-related alterations to DNA methylation in human cord blood.	The data currently available regarding an association between PFOA and reduced birth weight are not consistent.	Relatively modest but consistent inverse associations with birth weight were observed for both PFOA & PFOS.	Odds ratios were 1.44, 2.33, and 1.04 for all infants, girls, and boys, respectively.[151] Odds ratio was 0.94 per unit increase in maternal serum PFOA.[152]
Interpretation	PFOA exposure during development can alter the epigenome and the expression of genes that control regular growth and development. It is possible that such changes are related, although the relationship has not been directly measured.	Cross-sectional studies or highly exposed communities do not show a significant association between PFOA water concentrations.	The studies they reviewed do not contradict the previous conclusion from their 2018 opinion that "there may well be acausal association between PFOS and PFOA and birth weight."	Studies collectively suggest that an increase of 1 ng PFOA per mL maternal serum is associated with a reduced birthweight of approximately 10 grams.

[147] U.S. Environmental Protection Agency, "2023b."

[148] Health Canada, "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Perfluorooctanoic Acid (PFOA)."

[149] Schrenk et al., "Risk to Human Health Related to the Presence of Perfluoroalkyl Substances in Food."

[150] World Health Organization, "PFOS and PFOA in Drinking-Water: Background Document for Development of WHO Guidelines for Drinking-Water Quality."

[151] Sverre Wikstrom et al., "Maternal Serum Levels of Perfluoroalkyl Substances in Early Pregnancy and Offspring Birth Weight," *Pediatric Research*, 2020.

[152] Lyndsey Darrow, Cheryl Stein, and Kyle Steenland, "Serum Perfluorooctanoic Acid and Perfluorooctane Sulfonate Concentrations in Relation to Birth Outcomes in the Mid-Ohio Valley, 2005-2010," *Environmental Health Perspectives*, 2013.

	EPA[147]	Health Canada[148]	EFSA[149]	WHO[150]
Limitations	Very limited database. The role of epigenetic mechanisms in changes at the mRNA level is not clear, nor is the relationship between molecular changes and apical developmental outcomes.	The studies presented risk of selection bias, recall bias, chance findings, uncontrolled covariates, and absence of dose-response pattern.	The association might be partly confounded by physiological changes in pregnancy, and the lack of association with low birthweight or small for gestational age.	Reverse causality related to the magnitude of plasma volume expansion and glomerular filtration rate may contribute to the association.

Table 35: PFOS & Birthweight

	EPA[153]	HA[154]	EFSA[155]	WHO[156]
Findings	Evidence from zebrafish embryo assays demonstrate that PFOS exposure can lead to embryo and/or larva malformation and delays/reduction in hatching. Alterations to the expression of genes related to growth and development in vivo in zebrafish and rodents, and in human embryonic cell lines.	Inverse associations between PFOS at early pregnancy and birth weight have been reported in different general population studies.	Consistent but relatively modest inverse associations with birth weight were observed for both PFOA & PFOS.	Odds ratios were 1.56, 2.05, and 1.30 for all infants, girls, and boys, respectively (with upper quartile of exposure).[157] Odds ratio was 1.12. per unit increase in

[153] U.S. Environmental Protection Agency, "Toxicity Assessment and Proposed Maximum Contaminant Level Goal for Perfluorooctane Sulfonic Acid (PFOS) in Drinking Water," March 2023.

[154] Health Canada, "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Perfluorooctane Sulfonate (PFOS)."

[155] Schrenk et al., "Risk to Human Health Related to the Presence of Perfluoroalkyl Substances in Food."

[156] World Health Organization, "PFOS and PFOA in Drinking-Water: Background Document for Development of WHO Guidelines for Drinking-Water Quality."

[157] Wikstrom et al., "Maternal Serum Levels of Perfluoroalkyl Substances in Early Pregnancy and Offspring Birth Weight."

	EPA[153]	HA[154]	EFSA[155]	WHO[156]
	Alterations to DNA methylation in human cord blood and in placenta from rodent studies.			maternal serum PFOS.[158]
Interpretation	PFOS exposure during development can alter the epigenome and the expression of genes that control regular growth and development; it is possible that such changes are related, although the relationship has not been directly measured.	The evidence supporting a link between early-life exposure to PFOS, and developmental toxicity is equivocal because most studies were not designed to allow causal inference.	There may be a causal association between PFOS and PFOA and birth weight.	Each increase in the quartile of exposure for PFOS and PFOA was associated with a mean reduction in birthweight.
Limitations	The role of epigenetic mechanisms in changes at the mRNA level is not clear, nor is the relationship between molecular changes and apical developmental outcomes.	Larger studies would be needed to support the results due to the poor precision of the point estimate, the relatively small size of the studies, and the risk of confounding and bias.	The association might be partly confounded by physiological changes in pregnancy, and the lack of association with low birthweight or small for gestational age.	Some findings were from different quartiles of exposure. There were also inconsistent results, with the Agency for Toxic Substances and Disease Registry concluding "no studies found increases in the risk of low-birthweight infants" associated with maternal PFOS serum levels.

[158] Darrow, Stein, and Steenland, "Serum Perfluorooctanoic Acid and Perfluorooctane Sulfonate Concentrations in Relation to Birth Outcomes in the Mid-Ohio Valley, 2005-2010."

Table 36: PFOA & CVD

	EPA[159]	Health Canada[160]	EFSA[161]	WHO[162]
Findings	Alterations in lipid metabolism results in alterations in serum levels of TG and TC via: PFOA accumulation in liver activates nuclear receptors, including PPARα.[163] Nuclear receptor activation alters the expression of genes involved in lipid homeostasis and metabolism.	CVD outcomes were not consistently found to be associated with PFOA in cohort and cross-sectional studies.	Five cross-sectional and four longitudinal studies did not show any clear association between PFOS & PFOA and cardiovascular disease.	One study's finding may have clinical significance, as an increase in LDL cholesterol is associated with an increase in cardiovascular risk.
Interpretation	Findings support plausibility that cardiovascular effects, specifically changes to serum TG and TC levels, can occur through changes in lipid metabolism related to PFOA exposure.	There is not a probable link between exposure to PFOA and diagnosed high blood pressure and coronary artery disease (including myocardial infarction, angina, and coronary bypass surgery).[164]	While some studies suggest an association between exposure to PFAS other than PFOA & PFOS and cardiovascular disease, the evidence is insufficient to use as a basis for a health-based guidance value.	Regardless of gender, age group, or quintile of exposure, there was no significant correlation between PFOA exposure and onset of hypertension or cardiovascular heart disease.

[159] U.S. Environmental Protection Agency, "2023b."

[160] Health Canada, "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Perfluorooctanoic Acid (PFOA)."

[161] Schrenk et al., "Risk to Human Health Related to the Presence of Perfluoroalkyl Substances in Food."

[162] World Health Organization, "PFOS and PFOA in Drinking-Water: Background Document for Development of WHO Guidelines for Drinking-Water Quality."

[163] PPARα is a major transcription factor affecting expression of genes that regulate fatty acid oxidation and triglyceride and total cholesterol levels.

[164] C8 Science Panel, "C8 Probable Link Reports."

	EPA[159]	Health Canada[160]	EFSA[161]	WHO[162]
Limitations	Only a single study demonstrating PFOA accumulation in platelets in vitro. Results are inconsistent and conflicting regarding effects on indicators or mechanisms related to atherosclerosis, primarily related to clot formation.	Studies showing an association with cardiovascular, peripheral arterial disease, and systolic blood pressure are equivocal and were not confirmed in other occupational cohort studies.	The longitudinal studies could not demonstrate a very small increase of the relative risk.	It is unclear whether the effect of exposure on serum cholesterol levels results in an increased risk of cardiovascular disease.

Table 37: PFOS & CVD Findings

	EPA	Canada	EFSA	WHO
Findings	PFOS exposure was associated with changes in the expression of genes involved in cholesterol metabolism, mobilization, or transport in whole blood of adult humans. PFOS induced oxidative stress and upregulated inflammatory response genes in human umbilical vein endothelial cells exposed in vitro, which can lead to vascular inflammation. PFOS can bind to human FXII in vitro, which is the initial zymogen of plasma KKS activation, a regulator of inflammation, blood pressure, coagulation, and vascular permeability.	Overall, associations between PFOS and alterations in lipid parameters have been observed, although the conclusions face limitations.	Five cross-sectional and four longitudinal studies did not show any clear association between PFOS & PFOA and cardiovascular disease.	Statistically significant positive associations between exposure to PFOS and/or PFOA and total serum cholesterol are reported. Similar findings were reported for LDL cholesterol but not for HDL cholesterol.

	EPA	Canada	EFSA	WHO
Interpretation	Findings support the plausibility that PFOS exposure can lead to changes in the expression of genes involved in cholesterol regulation, as well as molecular and cellular changes that are related to atherosclerosis, although no association was observed between PFOS exposure and atherosclerosis in human epidemiological studies.	The clinical significance of some of the studies is uncertain given the low number of participants changing from the high to the normal level of cholesterol categories, the unknown mechanism of action, and the low magnitude of the changes.	While some studies suggest an association between exposure to PFAS other than PFOA & PFOS and cardiovascular disease, the evidence is insufficient to use as a basis for a health-based guidance value.	These findings may have clinical significance, as an increase in LDL cholesterol is associated with an increase in cardiovascular risk.
Limitations	Small database; the only in vivo evidence is reported in two human studies with conflicting results for markers of platelet activation. Results regarding the association between PFOS exposure and carotid artery atherosclerotic plaques or CIMT, which are mechanisms of atherosclerosis, are inconsistent in human epidemiological studies.	Lack of consistency across studies, study designs, the possibility of selection bias, and chance finding from the high number of testing conducted.	The longitudinal studies could not demonstrate a very small increase of the relative risk.	It is unclear whether the effect of exposure on serum cholesterol levels results in an increased risk of cardiovascular disease.

Table 38: PFOA & Cancer

	EPA	Canada	EFSA	WHO
Findings	Available PFOA data are consistent with four descriptions of data that support the "Likely to Be Carcinogenic to Humans" descriptor as part of the	It would be premature to base a guideline on a cancer risk in epidemiology studies, without a stronger	Reviewed studies provided insufficient support for	Two studies focused on emissions from a West Virginia plant showed a positive association between plasma PFOA levels and self-reported

	EPA	Canada	EFSA	WHO
	Guidelines for Carcinogen Risk Assessment. These include tumor presence and plausible association between exposure and cancer.	understanding of the potential causality between PFOA and the observed cancers.	carcinogenicity of PFOS and PFOA in humans.	cases of kidney and testicular cancers.
Interpretation	PFOA has carcinogenic potential in humans and at least one animal model. A plausible, though not definitively causal, association exists between human exposure to PFOA and kidney and testicular cancers in the general population and highly exposed populations.	It is suggested to continue monitoring the epidemiological evidence to understand better the relationship between PFOA and cancer risk.	This is in line with the conclusion from the IARC report on PFOA, which found that there was limited evidence for carcinogenicity. Additional studies have not changed the previous conclusion for PFOS and PFOA.	There is suggestive evidence of carcinogenic potential for PFOA, based on the availability of studies that demonstrate an association between PFOA exposure and kidney and testicular tumors among highly exposed individuals.
Limitations	There are significant uncertainties regarding the MOAs for tumor types observed in humans.	In studies showing some cancer associations with PFOA exposure, there was a high variability of the risk estimates, low case number, and multiple endpoints calculated with two modelling approaches.	Studies among background and occupationally exposed individuals provide limited evidence to suggest that exposure to PFOA and PFOS are associated with increased cancer risk.	The relevance of these findings to interpreting the risk of cancer in the general population following exposure to these chemicals remains unclear.

Table 39: PFOS & Cancer

	EPA	Canada	EFSA	WHO
Findings	Available PFOS data are consistent with three descriptions of data that support the “Likely to Be	Some associations between PFOS and risk of certain cancers were observed.	Reviewed studies provided insufficient support for	Epidemiological studies in occupationally exposed cohorts and case-control studies found mixed associations between

	EPA	Canada	EFSA	WHO
	Carcinogenic to Humans" descriptor as part of the *Guidelines for Carcinogen Risk Assessment*. These include tumor presence and positive tests in animal experiments.	However, the evidence does not support the carcinogenicity of PFOS.	carcinogenicity of PFOS and PFOA in humans.	PFOS exposure and cancers of the breast, bladder, kidney, colon, liver, pancreas, or prostate.
Interpretation	While the association between PFOS and cancer found mixed results across tumor types, the available study findings support a plausible correlation between PFOS exposure and carcinogenicity in humans.	Although some evidence of an association between PFOS and the risk of cancer has been observed, the effects were equivocal, and no clear trend could be determined.	This is in line with the conclusion from the IARC report on PFOA, which found that there was limited evidence for carcinogenicity. Additional studies have not changed the previous conclusion for PFOS and PFOA.	While some studies found higher incidence ratios, others concluded there is insufficient support for carcinogenicity of PFOS in humans.
Limitations	The study designs, analyses, and mixed results do not allow for a definitive conclusion on the relationship between PFOS exposure and cancer outcomes in humans.	Study limitations included a small number of cases, confounding, and participant selection bias.	Studies among background and occupationally exposed individuals provide limited evidence to suggest that exposure to PFOA and PFOS are associated with increased cancer risk.	Temporal changes in cancer incidence rates, risk factors, survivability, and diagnostic criteria may result in biased non-comparable outcomes incidence reported between the 1950s and 2000.

Attachment 2

The PFAS Challenge – May 2023

Monitoring and Planning for PFAS Treatment

Fairfax Water has been voluntarily monitoring for PFAS on a quarterly basis since 2021 and has posted its PFAS results on its website. Water treated from the Potomac River has so far tested below the proposed MCL's for PFOA and PFOS. Water from the Griffith plant slightly exceeds the proposed MCL's for PFOA and PFOS. Data from both plants is below the proposed HI.

Treatment Plant	PFOA Range (ppt)	PFOA Average (ppt)	PFOS Range (ppt)	PFOS Average (ppt)
Griffith (Occoquan Reservoir)	3.7 to 5.8	5.1	3.0 to 5.1	4.1
Corbalis (Potomac River)	ND to 1.9	0.6	ND to 2.6	1.3

The Griffith Water Treatment Plant (120 MGD) is sourced by the Occoquan Reservoir. The plant became operational in 2006, replacing three older treatment plants that were unable to meet the requirements of the D/DBP rule. Conventional treatment processes with the addition of ozone and biologically active carbon filtration were chosen for the Griffith Plant to meet D/DBP rules. An initial evaluation by engineering consultants has determined that additional treatment trains are necessary to remove PFOA and PFOS to the proposed MCL. Construction cost estimates for GAC or Ion Exchange are initially estimated at between $180 and $250 million, with annual operating costs of between $10 and $45 million. A mid-range value of $215 million (capital) represents a 21% increase in Fairfax Water's 10-year capital improvement program. A mid-range value of $22.5 million for annual operating costs for PFAS treatment represents an increase of 20% in Fairfax Water's total annual operating budget.

Eliminating the Sources

Eliminating sources is the ultimate solution to removing PFAS from the environment. Providing time and a regulatory framework that supports the elimination of PFAS sources would place the cost for remediation where it belongs – on the polluter instead of the public. The Occoquan Reservoir is an indirect potable reuse system with some industrial discharges to the POTW. The state has conducted some sampling for PFAS in the watershed and Fairfax Water is planning to do more. There are potential opportunities to remove these PFAS sources from the water supply.

Significant Cost Increases for Current Operations

The potential increase in operating expenses for PFAS treatment comes at a time when Fairfax Water has seen double- and triple-digit percentage increases in essential supplies such as chemicals and ductile iron pipe. While Fairfax Water's production has been essentially flat, since January 2020, its chemical budget has increased 52%. Costs for sodium hypochlorite (disinfectant) in that time have increased 175% and costs for poly-aluminum chloride (coagulant) have increased 67%. Costs for ductile iron pipe, used in the distribution system to replace aging infrastructure, have on average increased 54% for 4-inch to 36-inch pipe and 128% for 42-inch and 48-inch pipe. Purchased power costs have increased 31% since July 2022. Costs for GAC have increased 17% in two years.

Time Required to Implement PFAS Treatment

The proposed rule provides only three years for compliance from final rulemaking. While utilities can apply for a two-year extension from their primacy agency, extensions are not guaranteed. Fairfax Water, like many utilities, must go through several local government approval processes and permitting by our primacy agency before construction can proceed. Fairfax Water, like most public utilities, must also comply with public procurement laws that add time to the process to secure design and construction services. PFAS treatment will be a new train to an existing treatment plant. Properly sequenced construction that maintains plant operations and ensures an adequate supply of drinking water to the public will be critical and take longer than a "greenfield" construction project. Realistically, 7 to 10 years is required to implement PFAS treatment.

Activity	**Duration**
Develop Request for Proposals (RFP) for piloting and design, receive/review proposals, negotiate fee and award contract	6 to 9 months
Piloting (study design, equipment acquisition, review of results)	15 to 18 months
Local government land use approval process (zoning)	6 to 12 months
Development of detailed design and specifications (bid package)	12 to 18 months
Local government site plan and building permit approvals; construction permit from Virginia Department of Health	6 to 12 months
Invitation for bids, award of contract, construction, commissioning	36 to 48 months
Total Project Duration	**81 to 117 months or 7 to 10 years**

Attachment 3

03 MAY 2023

PFAS Compliance Challenges

Schedule

Delivering water treatment-related infrastructure projects requires extensive testing and design to ensure the full spectrum of variations in source waters and treatment processes are fully considered and tested prior to bidding and construction. For many utilities in the South, this includes the variation of dissolved organic carbon (DOC) and a possible mix of potentially hundreds of PFAS compounds. Equipment installation must be staggered and scheduled during low demand seasons to reduce overall risks and maintain continuity of operations of water treatment plants.

Another challenge to delivery of treatment-related projects includes coordination with Virginia Department of Health (VDH) who are considered project partners during the testing, design, permitting, and construction phases. Delays during the review and approval process are normal, and with multiple water (and wastewater) utilities undergoing PFAS projects simultaneously, delays in VDH review and approval could be substantial.

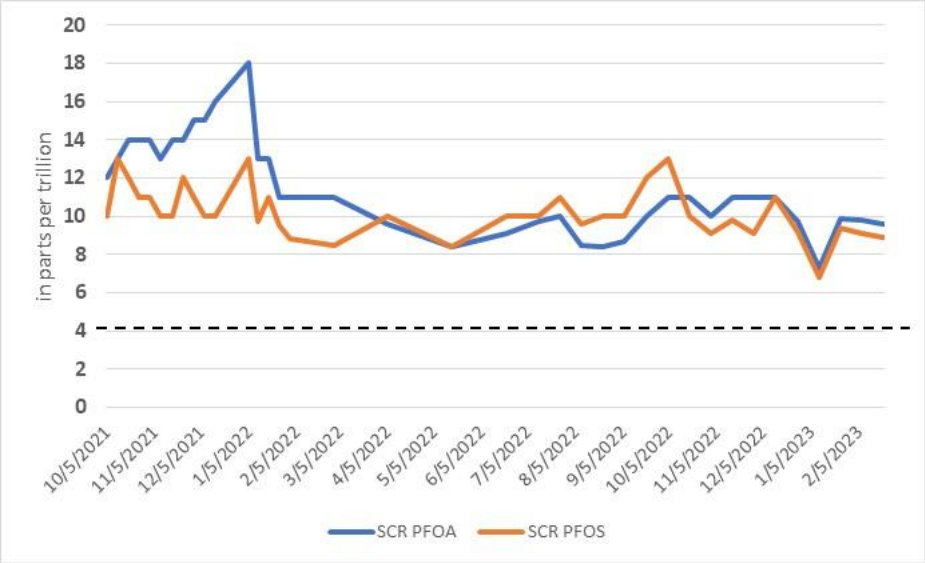
The chart below provides a general estimate for a medium-sized municipal water utility with 2 treatment facilities, limited staff, and a fully engaged primacy agency (VDH). Testing, design, bidding, construction, start up, and permitted operations of the new facilities will take at least 4 years and likely closer to 5 years from the establishment of the final MCLs.

	Task	Months																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1	Scope, compete, and select engineering support																				
2	Perform study/evaluation, Conduct pilot study, Develop design criteria																				
3	Prepare PER, Complete final design in conjunction with VDH permitting (2 WTPs)																				
4	Prepare IFB, Bid construction contracts, and Bid (2 WTPs)																				
5	Secure funding from local government/grants if available																				
6	Award and construct improvements to both WTP's																				
7	Construction contingency																				
8	Final testing, Startup, VDH CTO																				
	*this schedule excludes supply chain issues/equiptment lead times, lab																				

Water Quality

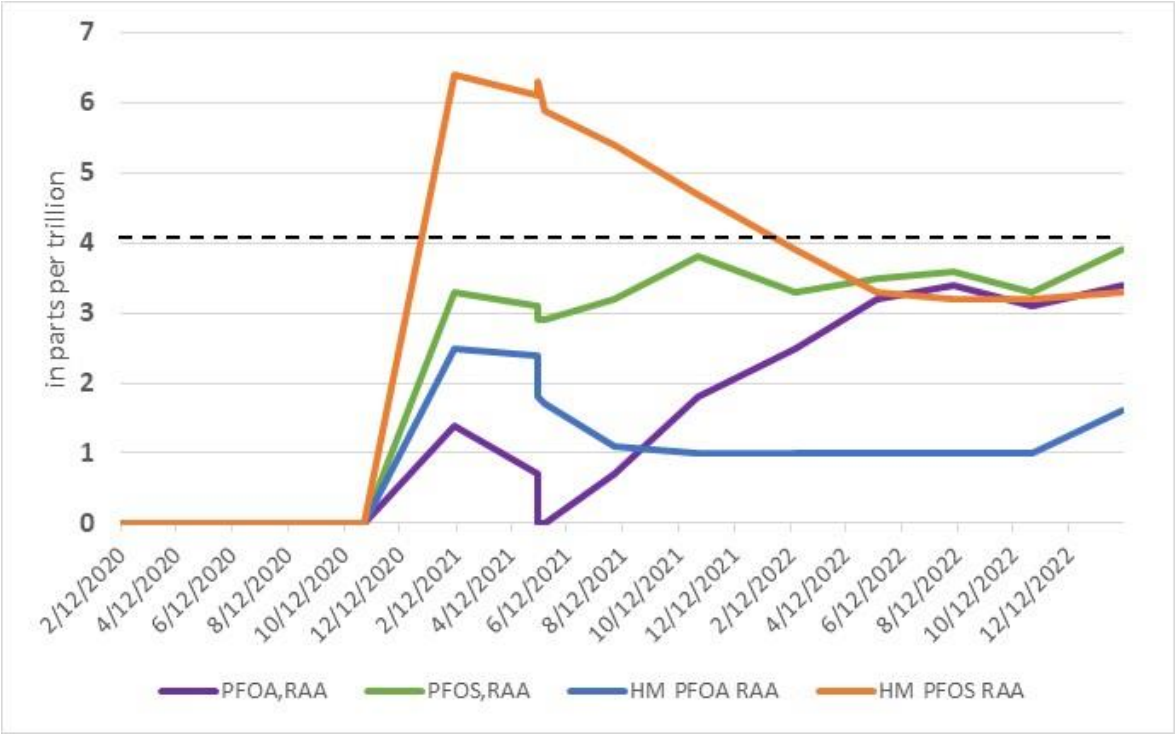
Aside from complying with UCMR3, which included monitoring for PFOA and PFOS, Newport News Waterworks (NNWW) began screening source waters and finished water for PFAS in 2019 in

preparation for potential new MCLs. Data was needed to understand the sources, determine possible operational changes, and plan for treatment approaches in a highly variable coastal plain surface water system. Investigations confirmed multiple sources of PFAS in 4 of the 6 watersheds that supply water to the regional system. Years of data are beginning to yield basic trends and ranges for these contaminants, and the variability will be a challenge for operations, treatment, and compliance. An example from one of the storage reservoirs is provided below.



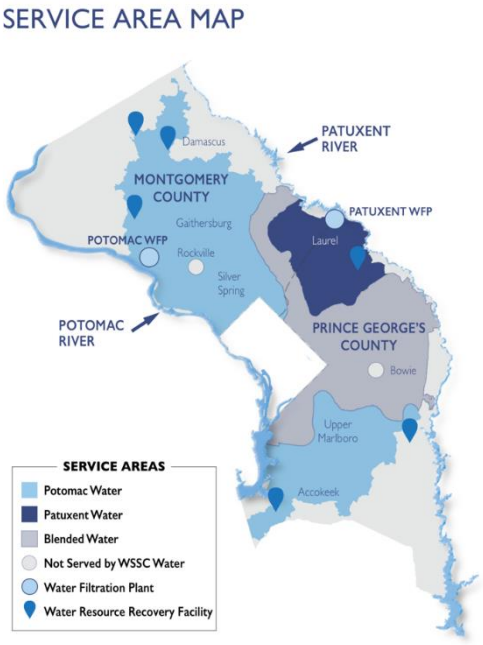
With water quality variability within each of 4 watersheds (left graph is for Skiffes Creek Reservoir), the resulting variations at the WTP intakes will require extensive testing and modeling to ensure compliance with MCLs set at the analytical threshold.

The running annual average (RAA) for PFOA and PFOS in the finished water from both WTPs is depicted below and confirms that compliance at threshold-level MCLs will be difficult, even for diligent utilities, and will require substantial investment in PFAS-removing technologies (e.g., GAC).


7
6
5
4
3
2
1
0
in parts per trillion
2/12/2020
4/12/2020
6/12/2020
8/12/2020
10/12/2020
12/12/2020
2/12/2021
4/12/2021
6/12/2021
8/12/2021
10/12/2021
12/12/2021
2/12/2022
4/12/2022
6/12/2022
8/12/2022
10/12/2022
12/12/2022
PFOA,RAA
PFOS,RAA
HM PFOA RAA
HM PFOS RAA

Attachment 4

PFAS in Drinking Water – Compliance Outlook
May 2023

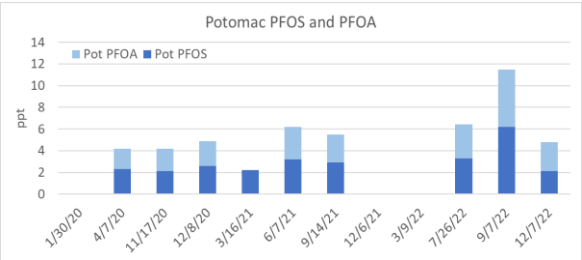


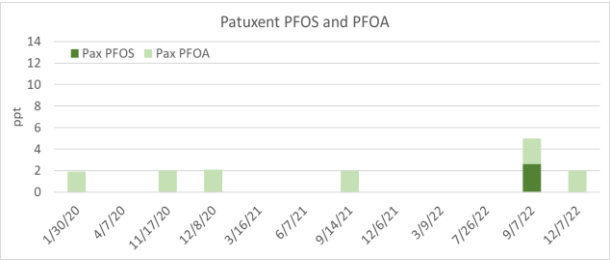
WSSC Water's mission is to protect public health and safety by supplying safe, clean and reliable water to our 1.9 million customers. We are proud of **our 105-year history of zero drinking water quality violations** and remain committed to continuing this exceptional level of excellence.

We draw the water we treat from two sources: the Patuxent and Potomac rivers. On the Patuxent River, we operate and maintain two reservoirs - Triadelphia and T. Howard Duckett. Our Patuxent Water Filtration Plant (WFP) draws water from the Duckett Reservoir and produces approximately 60 million gallons per day (MGD). Our Potomac WFP draws water straight from the Potomac River, producing between 100 and 120 MGD.

For several years, WSSC Water has been proactively testing for PFAS compounds in our drinking water, testing that went above and beyond federal and state requirements. In January of 2020 WSSC Water began monitoring for 18 PFAS compounds and expanded the monitoring in September of 2022 for 29 PFAS compounds that are included under the EPA's Fifth Unregulated Contaminant Monitoring Rule, also known as UCMR 5. The results of our testing are posted online (wsscwater.com/pfas).

	Potomac Average (ppt)	Patuxent Average (ppt)
PFOS	2.24	0.22
PFOA	1.92	1.03





While results indicate very low levels of PFAS in our drinking water on average, the variability in testing results demonstrate vulnerability to potential non-compliance. The utility and our customers are faced with significant capital and operations cost burden. The only known methods to remove PFAS from drinking water are granular activated carbon, ion exchange, and reverse osmosis. The appropriate treatment options for WSSC Water's plants are being evaluated as part of our Water Quality and Treatment Master Plan that is currently under development where we are assessing the treatment measures to meet multiple and simultaneous compliance requirements. Initial estimates suggest that potential treatment changes are **estimated to cost from $1.4 billion to $2.9 billion** just for WSSC Water alone, and this does not include annual operating costs.

	GAC	IEX	Nano/RO
Capital Cost	$1.4 billion	$1.4 billion	$2.9 billion

One Size Does Not Fit All

There are pros and cons to the different treatment alternatives. Without a comprehensive holistic approach to regulatory compliance based on science, the cost burden will increase exponentially for both SDWA and CWA compliance. Utilities need the time to plan, design, and implement solutions including the time to deal with existing plant constraints and the readiness for operations.

Technology	CAPEX	OPEX	Pros	Cons
GAC	$$	$ - $$ Varies with replacement	• Removes wide range of organics, including DBP precursors • May improve chlorine residuals in the distribution system • More controlled contaminant disposal than RO • Media can be reactivated	• More frequent replacement • Lower adsorption capacity • Early breakthrough of short-chain PFAS • Lower Surface Loading Rate than IX resin, resulting in more contactors
IX	$$	$ - $$ Varies with replacement	• Targeted removal of PFAS • Higher adsorption capacity • More controlled contaminant disposal than RO • Less frequent replacement	• Single use media • Early breakthrough of short chain PFAS • Removes few other contaminants
RO	$$$	$$ - $$$ Varies with effluent goal	• High level of PFAS removal • Indiscriminately removes nearly all contaminants	• High volume of concentrated waste stream • High water loss • Requires pre-treatment • Requires post-treatment stabilization

Source: Considering PFAS Treatment Alternatives with PFAS Rule in Mind, Adam Feffer, AWWA Webinar, 2023.

Partnering to Protect

WSSC Water plays a key role in the Potomac River Basin Drinking Water Source Protection Partnership and the Patuxent Reservoirs Watershed Protection Group. Given the magnitude of costs for individua utilities, it makes sense to focus on controlling PFAS at the source.

Attachment 5

ASSOCIATION OF METROPOLITAN WATER AGENCIES

LEADERS IN WATER

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April 25, 2022

Dr. Jennifer L. McLain
Director
Office of Ground Water and Drinking Water
U.S. Environmental Protection Agency

Via Email

Re: Docket ID No. EPA-HQ-OW-2022-0114, federalism consultation for proposed PFAS National Primary Drinking Water Regulation

Dear Dr. McLain,

The Association of Metropolitan Water Agencies (AMWA) is pleased to have the opportunity to provide comments on the federalism consultation for proposed per- and polyfluoroalkyl substances (PFAS) National Primary Drinking Water Regulation (NPDWR). AMWA is an organization of the general managers and CEOs of large, publicly owned drinking water utilities. Members serve communities of more than 100,000 people and work hard to provide safe, clean drinking water to the public. The association appreciates the work EPA has done to evaluate risks of PFAS in drinking water but continues to urge the agency to increase transparency and ensure it uses the best available data when making determinations.

AMWA has consistently provided comments regarding EPA's work under the agency's PFAS Action Plan. AMWA has supported EPA's decision to regulate PFOA and PFOS because of the significant risks of severe health effects associated with high levels of both substances and their persistent nature. When proposing NPDWRs for PFAS, it is critical that EPA be transparent about the state of the science, health impacts, available treatment and cost, and the source(s) of the contamination.

AMWA also understands that PFAS are a unique set of substances and that there are challenges in addressing dozens, hundreds, or even thousands of these substances, and these challenges may need creative solutions. The association continues to believe that if EPA determines that regulatory action is needed beyond PFOA and PFOS, the agency should use the Negotiated Rulemaking Procedure ("Reg-Neg"). To implement a "Reg-Neg", the agency must decide there is a need for a rule, determine that there is a limited number of identifiable interests that will be significantly affected by the rule, and conclude that there is a reasonable likelihood that a

committee could be convened which would consist of a balanced representation of the interests involved.

Due to the unique circumstances surrounding PFAS as a family, AMWA believes this would meet the criteria for a "Reg-Neg" and would save the agency time as all key stakeholder concerns would be discussed during a process that would bring those stakeholders into a risk-risk tradeoff discussion to help the agency come to a proposal with a higher likelihood of success. Throughout any regulatory process to address PFAS, it is imperative that the agency consider any future actions within the context that whatever path EPA chooses will set the stage for how the agency addresses other PFAS and other emerging contaminants going forward.

AMWA firmly believes that EPA should continue to focus on stopping PFAS at the source, rather than treating it after release into the environment. It is generally most effective to control pollutants at their source, where they are highly concentrated, rather than remove them at the consumer's expense after entering a water body or supply source. For example, AMWA supports EPA's plan, laid out in the PFAS Strategic Roadmap, to restrict PFAS discharges from industrial categories including revising guidelines for organic chemicals, plastics and synthetic fibers (OCPSF), metal finishing, and electroplating. These kinds of proactive approaches help ensure that those who pollute our natural resources are not allowed to pass the cost of cleanup onto public drinking water utilities and their customers.

Treatment

Research and advancements in technology have greatly improved our understanding of PFAS, such as new developments in treatment techniques and detection limits. Should EPA consider establishing a treatment technique to control PFAS in drinking water, AMWA urges the agency to carefully consider the following questions:

- What would trigger application of a treatment technique, a quantitative or a qualitative measure?
- What would be recognized as a successful implementation of a treatment technique and what would be considered a failure?
- What would a treatment technique mean for utilities already complying with state regulations that may measure compliance based on an MCL?
- What will the disposal costs and liabilities be if PFAS is designated as a hazardous substance under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)?

Community Water Systems (CWSs) have significant differences in the composition of their source waters, as well as different environmental factors, which can influence a system's water quality. For example, source water composition is different depending on climate, region of the country, and type of water source, among other issues, including climate change impacts. Because of the unique characteristics of source waters and water systems themselves, AMWA strongly believes there is not a "one size fits all" approach to treatment of PFAS in drinking water. EPA must recognize that treatment techniques that would be effective at one utility may not be as effective for other systems. Therefore, should EPA move forward with considering a

treatment technique rule for PFOA and PFOS, the agency should leave flexibility for utilities on both the type of treatment and the potential for new advances in treatments options that would arise in the near future.

EPA's expectations for the treatment technique need to be explicitly stated in any proposed rule. For example, during the consultation presentation in January, EPA provided approximate percentages of PFOA and PFOS removal for three different treatment techniques. If EPA were to move forward with a treatment technique approach, would utilities need to maintain the percentage of the implemented technique, or would they need to reduce concentrations to a specific quantity? Similarly, if a treatment is not able to maintain these percentages or achieve the required concentration, what would the next steps be for a utility to maintain compliance? These are questions EPA must address when crafting the proposed rule.

Another source of uncertainty for a future rule is the disposal of treatment byproducts that contain PFAS. EPA Office of Land and Emergency Management is also in the process of considering the designation of PFAS as a hazardous substance under CERCLA. If EPA takes this action, wastes of these substances would no longer be allowed to be disposed of in industrial solid waste or municipal landfills. Instead, these waste streams would have to be sent to specified hazardous waste landfills. This would increase the cost of disposal of waste from treatment for PFAS, with the financial burdens likely falling on ratepayers rather than those directly responsible for the pollution.

AMWA and other drinking water and wastewater organizations have consistently asserted that any such hazardous substance designation for PFAS must be accompanied by a targeted liability exemption for water systems. In the case of drinking water systems that filter PFAS from their water supplies, a hazardous substance designation without a liability exemption could put these systems at risk after they dispose of water treatment byproducts at an appropriate landfill. Should that landfill ever be designated as a Superfund site because of PFAS contamination, the water system could be held liable as a potentially responsible party even if it followed all legal requirements when disposing of the byproducts. Because of this, the cost analysis of this rulemaking cannot be accurately calculated.

Finally, if considering an MCL for this rulemaking, EPA must consider the role that a potential future grouping of PFAS under an MCL can play.

Public communication

Many drinking water utilities are already required to include PFAS in their Consumer Confidence Report (CCR). Therefore, AMWA supports the inclusion of PFAS monitoring data in the CCR. As PFAS current designated a chronic contaminant, AMWA supports consistency in EPAs treatment of these kinds of contaminants. EPA should give utilities time to confirm and understands PFAS concentration data, as well as identify proper messaging for the public as to not create unnecessary panic.

Additionally, the use of resources to issue a tier 1 or 2 notification for violations, especially when just slightly above the threshold, are difficult to justify if there is not an immediate threat to the

public. The idea that 1 ppt could be the difference between no violation and having to issue a public notice could not only be costly but result in widespread fear and anxiety in communities. While AMWA supports proposing NPDWRs for PFOA and PFOS, cost balances must be assessed to ensure resources that could be used to fix the violation are not wasted on notification when no immediate threat to the public exists. Using the same public notification requirement for all violations above the determined level is not always necessary when data suggest the public health concerns can vary widely with increased concentrations. EPA should continue to collect and analyze data to further understand how PFAS enter the body, are metabolized, and the full extent of health effects they cause at various concentrations.

Monitoring

Regardless of whether EPA proposes a treatment technique or an MCL, AMWA supports using similar monitoring requirements already set for Synthetic Organic Contaminants under the Standardized Monitoring Framework. This includes continued issuances of monitoring waivers by the primacy agency if it is shown that the contaminant has not been used in the area or proven a water source in not susceptible to PFAS contamination. There is no need to create a different set of rules for PFAS or other chemicals as they appear.

Under a possible treatment technique approach, for those utilities who do not receive monitoring waivers, EPA must set a reasonable "trigger level" based on the best available science and data that does not rely solely on the lowest detection limit. As technology improves at exponential rates, detections limits of parts per quadrillion should not be grounds for triggering increased monitoring.

AMWA also supports using Unregulated Contaminant Monitoring Rule 5 (UCMR 5) data as an option for the initial sampling for utilities under a potential treatment technique framework. This would help save money on additional analysis of PFAS, which can be very expensive. However, UCMR data should not be used against a PWS, as the primary mission of UCMR is data gathering. The fact that the timing of the rule and release of UCMR data may coincide should not change the overall purpose of UCMR.

Affordability

Affordability is a critical topic and many utilities across the U.S. are struggling with the ability to maintain affordable rates in light of required capital and regulatory projects. It is crucial that future regulations do not put unnecessary or significant financial burdens on ratepayers. As the nation still struggles to cope with and recover from the COVID-19 pandemic and respond to the increasing negative effects of climate change, large portions of communities still struggle to keep up with their water and other utility bills. Access to safe, clean drinking water is a necessity, and we should be working to ensure this access is affordable and equitable. Therefore, a thorough and accurate cost analysis is needed as any treatment and disposal costs will likely lead to increased rates for communities.

Conclusion

As specified in our May 24, 2021 letter supporting EPA's decision to regulate PFOA and PFOS, the association stresses that any actions the agency takes to address PFAS must be forthcoming about the state of the science, health impacts, available treatment and cost, and the source(s) of the contamination. As stated earlier, the association continues to support the process laid out under SDWA and encourages EPA to obtain the most relevant, reliable, and recent health effects data possible before making regulatory decisions.

The top concern of AMWA member utilities is providing the public with safe drinking water that is affordable to its customers. AMWA strongly urges EPA to consider the questions and concerns laid out in this letter when developing NPDWR for PFAS. It is important for EPA to consider the implementation challenges and any unintended consequences of its regulatory actions. AMWA looks forward to its continued partnership with EPA as we work toward the common goal of protecting public health. If you have any questions, please contact AMWA's Manager of Regulatory and Scientific Affairs, Brian Redder (Redder@amwa.net).

Sincerely,

Michael Arceneaux
Acting Chief Executive Officer

cc: Radhika Fox, OW
Anita Thompkins, OGWDW
Eric Burneson, OGWDW
Ashley Greene, OGWDW

Attachment 6

ASSOCIATION OF METROPOLITAN WATER AGENCIES

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April 20, 2022

Dr. Jennifer L. McLain
Director
Office of Ground Water and Drinking Water
U.S. Environmental Protection Agency
1201 Constitution Ave NW
Washington, DC 20004

Re: Docket ID No. EPA-HQ-OW-2022-0114, Environmental Justice Considerations for the Development of the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation

Dear Dr. McLain,

The Association of Metropolitan Water Agencies (AMWA) is pleased to have the opportunity to provide comment on environmental justice considerations for proposed per- and polyfluoroalkyl substances (PFAS) National Primary Drinking Water Regulations (NPDWR). AMWA is an organization of the general managers and CEOs of large publicly owned drinking water utilities. Members serve communities of more than 100,000 people and work hard to provide safe, clean drinking water to the public. The association applauds the administration's efforts to advance equity, environmental justice, and civil rights compliance, and urges the agency to consider how regulatory actions will affect water affordability for disadvantaged communities.

Affordability is a critical topic, and many utilities across the U.S. are struggling to maintain affordable rates in light of required capital and regulatory projects. Future regulations must not put unnecessary or significant financial burdens on ratepayers. As the nation continues to recover from the COVID-19 pandemic and respond to the increasing effects of climate change, large portions of communities still have difficulty with paying their water and other utility bills. Access to safe, clean drinking water is a necessity, and the sector should be working to ensure this access is affordable and equitable. Therefore, a thorough and accurate cost analysis is needed when developing a PFAS regulation as any treatment and disposal costs will likely lead to increased rates for communities.

AMWA also encourages EPA to maximize the opportunities for states and municipalities to spend funds from the Bipartisan Infrastructure Law (BIL) in a way that delivers the most benefit to low-income households and communities, particularly those set aside for PFAS. However,

AMWA has concerns that EPA's implementation memorandum suggests that the agency is not prepared to use the full scope of authority granted by Congress to ensure that additionally subsidized State Revolving Fund (SRF) dollars reach low-income communities, no matter where they are. As stated in AMWA's letter to EPA on February 11 (attached below), the association applauds the Biden Administration's prioritizing the delivery of funds to low-income or disadvantaged communities but believes this objective can best be attained by allowing a spectrum of water systems with underserved populations to access the additionally subsidized funds set aside for "eligible recipients."

It continues to remain unclear how EPA and other agencies will track federal dollars spent to benefit disadvantaged communities concerning stipulations in the BIL and the administration's Justice40 initiative, specifically, where a disadvantaged community exists within a utility's larger overall service area. For utilities with pockets of disadvantaged communities within their service areas, will the utility be eligible to receive funds dedicated for use in disadvantaged communities, and will money they spend count towards the Justice40 initiative? The main concern is that the multitude of definitions of "disadvantaged community" throughout states and federal agencies will lead to confusion, potentially excluding targeted populations from funds, because they reside within a large utility service area.

AMWA supports the actions detailed in the Equity Action Plan, released by EPA on April 12, and believes that addressing the topics laid out in this letter will help EPA achieve the overall goals of the plan. Specifically, ensuring that water is affordable, and all communities benefit from federal funding will help EPA with Priority Action 2, build the capacity of underserved communities to provide their experience to EPA and implement community-led projects. EPA acknowledges the economic disadvantages many communities face and that allowing funding to help entire utility service areas would benefit populations that could otherwise be overlooked. Limiting the additionally subsidized BIL SRF dollars to only these state-defined disadvantaged communities would exacerbate inequities, as metropolitan utilities in some states would be eligible for the funding, while others would be excluded.

The Equity Action Plan also mentions several metrics EPA will use when evaluating its progress towards stated goals. AMWA applauds EPA for increased accountability but asks for further clarification on how the agency will use these metrics. For example, EPA mentions trying to go beyond the requirements laid out in Justice40; however, there remain significant questions about what actions will count toward Justice40. For SRF, the definition is determined by the state administering the funds. However, many federal agencies have different tools for identifying disadvantaged communities, like EPAs EJScreen and CEQs Climate and Economic Justice Screening tool. AMWA requests more information on how EPA and other federal agencies will track progress of environmental justice efforts, particularly when it comes to Justice40.

AMWA thanks the agency for its continued work towards environmental justice and its dedication to assisting low-income communities. If you have any questions, please contact AMWA's Manager of Regulatory and Scientific Affairs, Brian Redder (Redder@amwa.net).

Sincerely,

Michael Arceneaux
Acting Chief Executive Officer

Attachment

cc: Radhika Fox, OW
Anita Thompkins, OGWDW
Eric Burneson, OGWDW

ASSOCIATION OF METROPOLITAN WATER AGENCIES
40 YEARS LEADERS IN WATER

LEADERS IN WATER

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February 11, 2022

The Honorable Radhika Fox
Assistant Administrator
Office of Water
U.S. Environmental Protection Agency
1204 Constitution Ave. NW
Washington, DC 20004

Dear Assistant Administrator Fox,

On behalf of the nation's largest publicly owned drinking water systems, AMWA appreciates EPA's ongoing effort to develop guidance for implementation of the Bipartisan Infrastructure Law (BIL). As you know, AMWA supported passage of this landmark legislation and its infusion of nearly $50 billion for the State Revolving Funds (SRFs) and initiatives to replace lead service lines and address emerging drinking water contaminants like PFAS.

As EPA formulates guidance related to the distribution of the law's SRF dollars, we urge the agency to maximize the opportunities for states and municipalities to spend funds in a way that delivers the most benefit to low-income households and communities. This approach would be consistent with the Biden Administration's Justice40 Initiative, as well as the law's direction to distribute 49 percent of the SRF funds as grants or principal forgiveness loans.

Specifically, we believe EPA's guidance must clarify which entities are eligible to receive this set-aside of grant and principal forgiveness funding. Division J, Title VI of the BIL specifies that 49% of the Drinking Water and Clean Water SRF appropriations provided through the measure for public health projects and lead service line replacements, and all of Drinking Water SRF appropriations provided to address emerging contaminants, must go to "eligible recipients" in the form of additional subsidy such as grants or 100% principal forgiveness loans. But because the BIL does not define the term "eligible recipients," EPA's guidance needs to clarify which entities are eligible to benefit from this funding.

To maximize considerations of equity and the provision of assistance to a wide range of low-income communities and ratepayers, AMWA urges EPA to define "eligible recipients" as any community water system or treatment works that is eligible to receive SRF aid, and which will use these grant or principal forgiveness loan funds on projects that will significantly benefit low-income communities.

Importantly, EPA should not simply rely on the Safe Drinking Water Act's definition of a "disadvantaged community" when identifying the universe of water systems that may be eligible for this additional subsidy. The SDWA section 1452(d)(3) definition of "disadvantaged community" is limited to "the service area of a public water system that meets affordability criteria established … by the State in which the public water system is located." In practice, many states apply this definition in such a way as to focus on small and rural water systems with relatively uniform income demographics, as opposed to metropolitan utilities whose service area includes both low-income neighborhoods and more affluent areas. This means that the metropolitan water systems in many states, despite serving significant numbers of minority and low-income households, are ineligible for additionally subsidized DWSRF funds provided through regular appropriations.

Similarly limiting the additionally subsidized BIL SRF dollars to only these state-defined disadvantaged communities would exacerbate inequities, as metropolitan utilities in some states would be eligible for the funding while similar metropolitan utilities in other states would be excluded. Instead, it would be much more equitable for EPA to broadly define "eligible recipients" in the BIL as any community water system or treatment works, thus making a wide range of communities with different demographic profiles eligible to compete for the funds. This should be accompanied by a requirement that, as a condition of accessing the 49% of funds set aside for additional subsidization, any utility must ensure that those BIL funds are spent on projects that significantly benefit low-income communities or ratepayers in the service area. This will deliver benefits to low-income areas that do not fall within traditionally defined "disadvantaged communities," but also will not preclude those communities from receiving funds.

The BIL represents a major infusion of funding for drinking water and wastewater infrastructure, and we applaud the Biden Administration's prioritizing the delivery of funds to low-income and/or disadvantaged communities. AMWA believes this objective can best be attained by allowing a broad universe of water systems with these underserved populations to access the additionally subsidized funds set aside for "eligible recipients."

Thank you again for your efforts to develop this guidance, and your dedication to assisting low-income communities. AMWA looks forward to continuing to work with you on this important issue.

Sincerely,

Diane VanDe Hei
Chief Executive Officer

cc: Michael Regan, U.S. EPA
Jennifer McLain, U.S. EPA
Andrew Sawyers, U.S. EPA