

# PFAS Strategic Roadmap: EPA's Commitments to Action 2021–2024





# A Note from EPA Administrator Michael S. Regan

For far too long, communities across the United States have been suffering from exposure to PFAS pollution. As the science has continued to develop, we know more now than ever about how PFAS build up in our bodies over long periods of time, and how they can cause adverse health effects that can devastate families. As Secretary of the North Carolina Department of Environmental Quality, I saw this devastation firsthand. For years, the Cape Fear River had been contaminated by these persistent “forever” chemicals. As I spoke with families and concerned citizens, I could feel their suffering and frustration with inaction. I knew my job was going to be trying and complex. But we were able to begin to address this pervasive problem by following the science, following the law, and bringing all stakeholders to the table.

As one of my earliest actions as EPA Administrator, I established the EPA Council on PFAS and charged it with developing an ambitious plan of action to further the science and research, to restrict these dangerous chemicals from getting into the environment, and to immediately move to remediate the problem in communities across the country. EPA’s PFAS strategic roadmap is our plan to deliver tangible public health benefits to all people who are impacted by these chemicals—regardless of their zip code or the color of their skin.

Since I’ve been EPA Administrator, I have become acutely aware of the invaluable and central role EPA has in protecting public health in America. For more than 50 years, EPA has implemented and enforced laws that protect people from dangerous pollution in the air they breathe, the water they drink, and the land that forms the foundation of their communities. At the same time, my experience in North Carolina

reinforced that EPA cannot solve these challenges alone. We can only make progress if we work in close collaboration with Tribes, states, localities, and stakeholders to enact solutions that follow the science and stand the test of time. To affect meaningful change, engagement, transparency, and accountability will be critical as we move forward.

This roadmap will not solve our PFAS challenges overnight. But it will turn the tide by harnessing the collective resources and authority across federal, Tribal, state, and local governments to empower meaningful action now.

I want to thank the co-chairs of the EPA Council on PFAS—Radhika Fox, Assistant Administrator for Water, and Deb Szaro, Acting Regional Administrator in Region 1—for their leadership in guiding the development of this strategy.

**Let’s get to work.**



**Administrator Michael S. Regan**

# PFAS Council Members

The following policy and technical leaders serve as members of the EPA Council on PFAS. They have been instrumental in working with their respective offices to develop the Agency's strategy. The Council will continue to coordinate across all EPA offices and Regions to accelerate progress on PFAS.

## Co-Chairs

**Radhika Fox**, Assistant Administrator for Water

**Deb Szaro**, Acting Regional Administrator,  
Region 1

## Office of the Administrator

**John Lucey**, Special Assistant to the  
Administrator

**Andrea Drinkard**, Senior Advisor to the Deputy  
Administrator

## Office of Air and Radiation

**John Shoaff**, Director, Air Policy and Program  
Support

## Office of Chemical Safety and Pollution Prevention

**Jeffrey Dawson**, Science Advisor

**Tala Henry**, Deputy Director, Pollution Prevention  
and Toxics

## Office of Enforcement and Compliance Assurance

**Cyndy Mackey**, Director, Site Remediation  
Enforcement

**Karin Leff**, Director, Federal Facilities  
Enforcement

## Office of General Counsel

**Dawn Messier**, Deputy Associate General  
Counsel, Water

**Jen Lewis**, Deputy Associate General Counsel,  
Solid Waste and Emergency Response

## Office of Land and Emergency Management

**Dana Stalcup**, Deputy Director, Superfund  
Remediation and Technology Innovation

**Dawn Banks**, Director, Policy Analysis and  
Regulatory Management

## Office of Research and Development

**Tim Watkins**, Acting Director, Center for Public  
Health and Environmental Assessment

**Susan Burden**, PFAS Executive Lead

## Office of Water

**Jennifer McLain**, Director, Ground Water and  
Drinking Water

**Deborah Nagle**, Director, Science and  
Technology

**Zachary Schafer**, Senior Advisor to the Assistant  
Administrator

## EPA Regions

**John Blevins**, Acting Regional Administrator,  
Region 4

**Tera Fong**, Water Division Director, Region 5

# Contents

**Introduction . . . . . 5**

**The Agency’s Approach . . . . . 6**

**Goals and Objectives . . . . . 9**

**Key Actions . . . . . 10**

**Conclusion . . . . . 22**

**Endnotes . . . . . 23**



# Introduction

Harmful per- and poly-fluoroalkyl substances (PFAS) are an urgent public health and environmental issue facing communities across the United States. PFAS have been manufactured and used in a variety of industries in the United States and around the globe since the 1940s, and they are still being used today. Because of the duration and breadth of use, PFAS can be found in surface water, groundwater, soil, and air—from remote rural areas to densely-populated urban centers. A growing body of scientific evidence shows that exposure at certain levels to specific PFAS can adversely impact human health and other living things. Despite these concerns, PFAS are still used in a wide range of consumer products and industrial applications.

Every level of government—federal, Tribal, state, and local—needs to exercise increased and sustained leadership to accelerate progress to clean up PFAS contamination, prevent new contamination, and make game-changing breakthroughs in the scientific understanding of PFAS. The EPA Council on PFAS developed this strategic roadmap to lay out EPA’s whole-of-agency approach to addressing PFAS. To deliver needed protections for the American people, the roadmap sets timelines by which the Agency plans to take specific actions during the first term of the Biden-Harris Administration. The strategic roadmap builds on and accelerates implementation of policy actions identified in the Agency’s 2019 action plan and

commits to bolder new policies to safeguard public health, protect the environment, and hold polluters accountable.

The risks posed by PFAS demand that the Agency attack the problem on multiple fronts at the same time. EPA must leverage the full range of statutory authorities to confront the human health and ecological risks of PFAS. The actions described in this document each represent important and meaningful steps to safeguard communities from PFAS contamination. Cumulatively, these actions will build upon one another and lead to more enduring and protective solutions.

EPA’s integrated approach to PFAS is focused on three central directives:

- **Research.** Invest in research, development, and innovation to increase understanding of PFAS exposures and toxicities, human health and ecological effects, and effective interventions that incorporate the best available science.
- **Restrict.** Pursue a comprehensive approach to proactively prevent PFAS from entering air, land, and water at levels that can adversely impact human health and the environment.
- **Remediate.** Broaden and accelerate the cleanup of PFAS contamination to protect human health and ecological systems.

# The Agency's Approach

EPA's approach is shaped by the unique challenges to addressing PFAS contamination. EPA cannot solve the problem of “forever chemicals” by tackling one route of exposure or one use at a time. Rather, EPA needs to take a lifecycle approach to PFAS in order to make meaningful progress. PFAS pollution is not a legacy issue—these chemicals remain in use in U.S. commerce. As such, EPA cannot focus solely on cleaning up the downstream impacts of PFAS pollution. The Agency needs to also look upstream to prevent new PFAS contamination from entering air, land, and water and exposing communities. As the Agency takes tangible actions both upstream and downstream, EPA will continue to pursue a rigorous scientific agenda to better characterize toxicities, understand exposure pathways, and identify new methods to avert and remediate PFAS pollution. As EPA learns more about the family of PFAS chemicals, the Agency can do more to protect public health and the environment. In all this work, EPA will seek to hold polluters accountable for the contamination they cause and ensure disadvantaged communities equitably benefit from solutions.

## Consider the Lifecycle of PFAS

*EPA will account for the full lifecycle of PFAS, their unique properties, the ubiquity of their uses, and the multiple pathways for exposure.*

PFAS are a group of synthetic chemicals that continue to be released into the environment throughout the lifecycle of manufacturing, processing, distribution in commerce, use, and disposal. Each action in this cycle creates environmental contamination and human and ecological exposure. Exacerbating this challenge is that some PFAS persist in the environment. PFAS are synthesized for many different uses, ranging from firefighting foams, to coatings for clothes and furniture, to food contact substances. Many PFAS are also used in industrial processes and applications, such as in the manufacturing of other chemicals and products. PFAS can be released into the environment during manufacturing and processing as well as during industrial and commercial use. Products known to contain PFAS are regularly disposed of in landfills and by incineration, which can also lead to the release of PFAS. Many PFAS have unique properties that prevent their complete breakdown in the environment, which means that even removing PFAS from contaminated areas can create PFAS-contaminated waste. This is currently unregulated in most cases.

## Get Upstream of the Problem

*EPA will bring deeper focus to preventing PFAS from entering the environment in the first place—a foundational step to reducing the exposure and potential risks of future PFAS contamination.*

Intervening at the beginning of the PFAS lifecycle—before they have entered the environment—is a foundational element of EPA's whole-of-agency approach. While hundreds of individual PFAS compounds are in production and use,<sup>i</sup> a relatively

modest number of industrial facilities produce PFAS feedstock,<sup>ii</sup> and a relatively narrow set of industries directly discharge PFAS into water or soil or generate air emissions in large quantities.<sup>iii</sup> This context helps to pinpoint clear opportunities to restrict releases into the environment. EPA will use its authorities to impose appropriate limitations on the introduction of new unsafe PFAS into commerce and will, as appropriate, use all available regulatory and permitting authorities to limit emissions and discharges from industrial facilities. This approach does not eliminate the need for remediation where releases and exposures have already occurred, but it is a critical step to preventing ongoing concentrated contamination of soil and surface and groundwaters.

## Hold Polluters Accountable

*EPA will seek to hold polluters and other responsible parties accountable for their actions and for PFAS remediation efforts.*

Many communities and ecosystems are continuously exposed to PFAS in soil, surface water, groundwater, and air. Areas can be exposed due to their proximity to industrial sites, airports, military bases, land where biosolids containing PFAS have been applied, and other sites where PFAS have been produced or used and disposed of for specific and repeated purposes. When EPA becomes aware of a situation that poses a serious threat to human health or the environment, the Agency will take appropriate action. For other sites where contamination may have occurred, the presence of certain PFAS in these environments necessitates coordinated action to understand what specific PFAS have been released, locations where they are found, where they may be transported through air, soil, and water in the future, and what remediation is necessary. EPA will seek to hold polluters and other responsible parties accountable for their actions, ensuring that they assume responsibility for remediation efforts and prevent any future releases.

## Ensure Science-Based Decision-Making

*EPA will invest in scientific research to fill gaps in understanding of PFAS, to identify which additional PFAS may pose human health and ecological risks at which exposure levels, and to develop methods to test, measure, remove, and destroy them.*

EPA's decisions regarding PFAS will be grounded in scientific evidence and analysis. The current body of scientific evidence clearly indicates that there are real, present, and significant hazards associated with specific PFAS, but significant gaps remain related to the impacts of other PFAS on human health and in the environment. Regulatory development, either at the state or federal level, would greatly benefit from a deeper scientific understanding of the exposure pathways, toxicities, and potential health impacts of less-studied PFAS. The federal government, states, industry, academia, and nonprofit organizations—with appropriate coordination and resources—have the capability to conduct this necessary research.

EPA is conducting new research to better understand the similar and different characteristics of specific PFAS and whether and how to address groups and categories of PFAS. The Agency is focused on improving its ability to address multiple chemicals at once, thereby accelerating the effectiveness of regulations, enforcement actions, and the tools and technologies needed to remove PFAS from air, land, and water.

To break the cycle of contamination and exposure from PFAS, additional research is needed to identify and/or develop techniques to permanently dispose of or destroy these durable compounds. Government agencies, industry, and private laboratories need tools and validated methods to measure PFAS in air, land, and water to identify pollution sources, demonstrate facility compliance, hold polluters accountable, and support communities during and after cleanups.

## Prioritize Protection of Disadvantaged Communities

*When taking action on PFAS, EPA will ensure that disadvantaged communities have equitable access to solutions.*

Many known and potential sources of PFAS contamination (including military bases, airports, industrial facilities, and waste management and disposal sites) are near low-income communities and communities of color. EPA needs to ensure these affected populations have an opportunity to participate in and influence the Agency's decision-making. This may call for the Agency to seek out and facilitate the communities' engagement by providing culturally appropriate information and accommodations for people with Limited English Proficiency, facilitating community access to public meetings and comment periods, and offering technical assistance to build community-based capacity for participation. EPA's actions need to consider the unique on-the-ground conditions in these communities, such as outdated infrastructure, to help ensure they benefit equitably from policy solutions.

EPA will also collect more data and develop new methodologies to understand PFAS exposure pathways in disadvantaged communities; to what extent PFAS pollution contributes to the cumulative burden of exposures from multiple sources in these communities; and how non-environmental stressors, such as systemic socioeconomic disparities, can exacerbate the impacts of pollution exposure and vice versa.

# Goals and Objectives

EPA's comprehensive approach to addressing PFAS is guided by the following goals and objectives.

## RESEARCH

Invest in research, development, and innovation to increase understanding of PFAS exposures and toxicities, human health and ecological effects, and effective interventions that incorporate the best available science.

### Objectives

- Build the evidence base on individual PFAS and define categories of PFAS to establish toxicity values and methods.
- Increase scientific understanding on the universe of PFAS, sources of environmental contamination, exposure pathways, and human health and ecological effects.
- Expand research on current and emerging PFAS treatment, remediation, destruction, disposal, and control technologies.
- Conduct research to understand how PFAS contribute to the cumulative burden of pollution in communities with environmental justice concerns.

## RESTRICT

Pursue a comprehensive approach to proactively prevent PFAS from entering air, land, and water at levels that can adversely impact human health and the environment.

### Objectives

- Use and harmonize actions under all available statutory authorities to control and prevent PFAS contamination and minimize exposure to PFAS during consumer and industrial uses.
- Place responsibility for limiting exposures and addressing hazards of PFAS on manufacturers, processors, distributors, importers, industrial and other significant users, dischargers, and treatment and disposal facilities.
- Establish voluntary programs to reduce PFAS use and release.
- Prevent or minimize PFAS discharges and emissions in all communities, regardless of income, race, or language barriers.

## REMEDiate

Broaden and accelerate the cleanup of PFAS contamination to protect human health and ecological systems.

### Objectives

- Harmonize actions under all available statutory authorities to address PFAS contamination to protect people, communities, and the environment.
- Maximize responsible party performance and funding for investigations and cleanup of PFAS contamination.
- Help ensure that communities impacted by PFAS receive resources and assistance to address contamination, regardless of income, race, or language barriers.
- Accelerate the deployment of treatment, remediation, destruction, disposal, and mitigation technologies for PFAS, and ensure that disposal and destruction activities do not create new pollution problems in communities with environmental justice concerns.

# Key Actions

This section summarizes the bold actions that EPA plans to take from 2021 through 2024 on PFAS, as well as some ongoing efforts thereafter. The actions described in this roadmap are subject to the availability of appropriations and other resources. Each of these actions—led by EPA’s program offices—are significant building blocks in the Agency’s comprehensive strategy to protect public health and ecosystems by researching, restricting, and remediating PFAS contamination. As EPA takes each of these actions, it also commits to transparent, equitable, and inclusive engagement with all stakeholders to inform the Agency’s work.

These are not the only actions underway at EPA, nor will they be the last. As the Agency does more, it will learn more. And as EPA learns more, it will do more. As EPA continues to build the evidence base, as regulatory work matures, and as EPA learns more from its partnerships across the country, the Agency will deliver additional actions commensurate with the urgency and scale of response that the PFAS problem demands.

## Office of Chemical Safety and Pollution Prevention

---

### **Publish national PFAS testing strategy** *Expected Fall 2021*

EPA needs to evaluate a large number of PFAS for potential human health and ecological effects. Most PFAS have limited or no toxicity data. To address this data gap, EPA is developing a national PFAS testing strategy to deepen understanding of the impacts of categories of PFAS, including potential hazards to human health and the environment. This will help EPA identify and select PFAS for which the Agency will require testing using Toxic Substances Control Act (TSCA) authorities. In the 2020 National Defense Authorization Act (NDAA), Congress directed EPA to develop a process for prioritizing which PFAS or classes of PFAS should be subject to additional research efforts based on potential for human exposure to, toxicity of, and other available information. EPA will also identify existing test data for PFAS (both publicly available and submitted to EPA under TSCA) that will be considered prior to requiring further testing to ensure adherence to the TSCA goal of reducing animal testing. EPA will use the testing strategy to identify important gaps in existing data and to select representative chemical(s) within identified categories as priorities for additional studies. EPA expects to exercise its TSCA Section 4 order authority to require PFAS manufacturers to conduct and fund the studies. EPA plans to issue the first round of test orders on the selected PFAS by the end of 2021.

### **Ensure a robust review process for new PFAS** *Efforts Ongoing*

EPA’s TSCA New Chemicals program plays an important gatekeeper role in ensuring the safety of new chemicals, including new PFAS, prior to their entry in U.S. commerce. Where unreasonable

risks are identified as part of the review process, EPA must mitigate those risks before any manufacturing activity can commence. The 2016 TSCA amendments require EPA to review and make a determination regarding the potential risks for each new chemical submission. Since early 2021, EPA has taken steps to ensure that new PFAS are subject to rigorous reviews and appropriate safeguards, including making changes to the policies and processes underpinning reviews and determinations on new chemicals to better align with the 2016 amendments. In addition, EPA has previously allowed some new PFAS to enter the market through low-volume exemptions (LVEs), following an expedited, 30-day review process. In April 2021, the Agency announced that it would generally expect to deny pending and future LVE submissions for PFAS based on the complexity of PFAS chemistry, potential health effects, and their longevity and persistence in the environment. Moving forward, EPA will apply a rigorous premanufacture notice review process for new PFAS to ensure these substances are safe before they enter commerce.

## **Review previous decisions on PFAS**

### ***Efforts Ongoing***

EPA is also looking at PFAS that it has previously reviewed through the TSCA New Chemicals program, including those that it reviewed prior to the 2016 TSCA amendments. For example, EPA recently launched a stewardship program to encourage companies to voluntarily withdraw previously granted PFAS LVEs. EPA also plans to revisit past PFAS regulatory decisions and address those that are insufficiently protective. As part of this effort, the Agency could impose additional notice requirements to ensure it can review PFAS before they are used in new ways that might present concerns.

In addition, EPA plans to issue TSCA Section 5(e) orders for existing PFAS for which significant new use notices (e.g., a new manufacturing process for an existing PFAS, or a new use or user) have recently been filed with EPA. The orders would impose rigorous safety requirements as a condition of allowing the significant new use to commence.

More broadly, EPA is planning to improve approaches for overall tracking and enforcement of requirements in new chemical consent orders and significant new use rules (SNURs) to ensure that companies are complying with the terms of those agreements and regulatory notice requirements.

## **Close the door on abandoned PFAS and uses**

### ***Expected Summer 2022***

Many existing chemicals (i.e., those that are already in commerce and listed on the TSCA Inventory of chemicals), including PFAS, are currently not subject to any type of restriction under TSCA. In some instances, the chemicals themselves have not been actively manufactured for many years. In others, chemicals may have certain past uses that have been abandoned. Absent restriction, manufacturers are free to begin using those abandoned chemicals or resume those abandoned uses at any time. Under TSCA, by rule, EPA can designate uses of a chemical that are not currently ongoing—and potentially *all* uses associated with an inactive chemical—as “significant new uses.” Doing so ensures that an entity must first submit a notice and certain information to EPA before it can resume use of that chemical or use. TSCA then requires EPA to review and make an affirmative determination on the potential risks to health and the environment and to require safety measures to address unreasonable risks before allowing the PFAS use to resume. EPA is considering how it can apply this authority to help address abandoned uses of PFAS as well as future uses of PFAS on the inactive portion of the TSCA Inventory.

## **Enhance PFAS reporting under the Toxics Release Inventory**

### ***Expected Spring 2022***

The Toxics Release Inventory (TRI) helps EPA compile data and information on releases of certain chemicals and supports informed decision-making by companies, government agencies, non-governmental organizations, and the public. Pursuant to the 2020 NDAA, certain industry sectors must report certain PFAS releases to TRI. However, certain

exemptions and exclusions remain for those PFAS reporters, which significantly limited the amount of data that EPA received for these chemicals in the first year of reporting.<sup>iv</sup> To enhance the quality and quantity of PFAS information collected through TRI, EPA intends to propose a rulemaking in 2022 to categorize the PFAS on the TRI list as “Chemicals of Special Concern” and to remove the de minimis eligibility from supplier notification requirements for all “Chemicals of Special Concern.” EPA will also continue to update the list of PFAS subject to TRI and expects to announce an additional rulemaking to add more PFAS to TRI in 2022, as required by the 2020 NDAA.

### **Finalize new PFAS reporting under TSCA Section 8** *Expected Winter 2022*

TSCA Section 8(a)(7) provides authority for EPA to collect existing information on PFAS. In June 2021, EPA published a proposed data-gathering rule that would collect certain information on any PFAS manufactured since 2011, including information on uses, production volumes, disposal, exposures, and hazards. EPA will consider public comments on the proposal and finalize it before January 1, 2023. Ultimately, information received under this rule will enable EPA to better characterize the sources and quantities of manufactured PFAS in the United States and will assist the Agency in its future research, monitoring, and regulatory efforts.

## **Office of Water**

---

### **Undertake nationwide monitoring for PFAS in drinking water** *Final Rule Expected Fall 2021*

The Safe Drinking Water Act (SDWA) establishes a data-driven and risk-based process to assess drinking water contaminants of emerging concern. Under SDWA, EPA requires water systems to conduct sampling for unregulated contaminants every five years. EPA published the proposed Fifth Unregulated Contaminant Monitoring Rule (UCMR 5) in March 2021. As proposed, UCMR 5 would provide new data that is critically needed to improve EPA’s understanding of the frequency that 29 PFAS are found in the nation’s drinking water systems and at what levels. The proposed UCMR 5 would significantly expand the number of drinking water systems participating in the program, pending sufficient appropriations by Congress. The data gathered from an expanded set of drinking water systems would improve EPA’s ability to conduct state and local assessments of contamination, including analyses of potential environmental justice impacts. As proposed, and if funds are appropriated by Congress, all public water systems serving 3,300 or more people and 800 representative public water systems serving fewer than 3,300 would collect samples during a 12-month period from January 2023 through December 2025. EPA is considering comments on the proposed UCMR 5 and preparing a final rule. Going forward, EPA will continue to prioritize additional PFAS for inclusion in UCMR 6 and beyond, as techniques to measure these additional substances in drinking water are developed and validated.

### **Establish a national primary drinking water regulation for PFOA and PFOS** *Proposed Rule Expected Fall 2022, Final Rule Expected Fall 2023*

Under the SDWA, EPA has the authority to set enforceable National Primary Drinking Water Regulations (NPDWRs) for drinking water contaminants and require monitoring of public water

supplies. To date, EPA has regulated more than 90 drinking water contaminants but has not established national drinking water regulations for any PFAS. In March 2021, EPA published the Fourth Regulatory Determinations, including a final determination to regulate Perfluorooctanoic acid (PFOA) and Perfluorooctane sulfonic acid (PFOS) in drinking water. The Agency is now developing a proposed NPDR for these chemicals. As EPA undertakes this action, the Agency is also evaluating additional PFAS and considering regulatory actions to address groups of PFAS. EPA expects to issue a proposed regulation in Fall 2022 (before the Agency's statutory deadline of March 2023). The Agency anticipates issuing a final regulation in Fall 2023 after considering public comments on the proposal. Going forward, EPA will continue to analyze whether NPDR revisions can improve public health protection as additional PFAS are found in drinking water.

### **Publish the final toxicity assessment for GenX and five additional PFAS** *Expected Fall 2021 and Ongoing*

EPA plans to publish the toxicity assessments for two PFAS, hexafluoropropylene oxide dimer acid and its ammonium salt. These two chemicals are known as “GenX chemicals.” GenX chemicals have been found in surface water, groundwater, drinking water, rainwater, and air emissions. GenX chemicals are known to impact human health and ecosystems. Scientists have observed liver and kidney toxicity, immune effects, hematological effects, reproductive and developmental effects, and cancer in animals exposed to GenX chemicals. Completing a toxicity assessment for GenX is essential to better understanding its effects on people and the environment. EPA can use this information to develop health advisories that will help communities make informed decisions to better protect human health and ecological wellness. The Office of Research and Development is also currently developing toxicity assessments for five other PFAS—PFBA, PFHxA, PFHxS, PFNA, and PFDA.

### **Publish health advisories for GenX and PFBS** *Expected Spring 2022*

PFAS contamination has impacted drinking water quality across the country, including in underserved rural areas and communities of color. SDWA authorizes EPA to develop non-enforceable and non-regulatory drinking water health advisories to help Tribes, states, and local governments inform the public and determine whether local actions are needed to address public health impacts in these communities. Health advisories offer a margin of protection by defining a level of drinking water concentration at or below which lifetime exposure is not anticipated to lead to adverse health effects. They include information on health effects, analytical methodologies, and treatment technologies and are designed to protect all lifestages. EPA will publish health advisories for Perfluorobutane sulfonic acid (PFBS) and GenX chemicals based on final toxicity assessments. The Agency will develop accompanying fact sheets in different languages to facilitate access to information on GenX and other PFAS. Going forward, EPA will develop health advisories as the Agency completes toxicity assessments for additional PFAS.

### **Restrict PFAS discharges from industrial sources through a multi-faceted Effluent Limitations Guidelines program** *Expected 2022 and Ongoing*

Effluent Limitations Guidelines (ELGs) are a powerful tool to limit pollutants from entering the nation's waters. ELGs establish national technology-based regulatory limits on the level of specified pollutants in wastewater discharged into surface waters and into municipal sewage treatment facilities. EPA has been conducting a PFAS multi-industry study to inform the extent and nature of PFAS discharges. Based on this study, EPA is taking a proactive approach to restrict PFAS discharges from multiple industrial categories. EPA plans to make significant progress in its ELG regulatory work by the end of 2024. EPA has established timelines for action—whether it is data collection

or rulemaking—on the nine industrial categories in the proposed PFAS Action Act of 2021, as well as other industrial categories such as landfills. EPA’s multi-faceted approach entails:

- Undertake rulemaking to restrict PFAS discharges from industrial categories where EPA has the data to do so—including the guidelines for organic chemicals, plastics and synthetic fibers (OCPSF), metal finishing, and electroplating. Proposed rule is expected in Summer 2023 for OCPSF and Summer 2024 for metal finishing and electroplating.
- Launch detailed studies on facilities where EPA has preliminary data on PFAS discharges, but the data are currently insufficient to support a potential rulemaking. These include electrical and electronic components, textile mills, and landfills. EPA expects these studies to be complete by Fall 2022 to inform decision making about a future rulemaking by the end of 2022.
- Initiate data reviews for industrial categories for which there is little known information on PFAS discharges, including leather tanning and finishing, plastics molding and forming, and paint formulating. EPA expects to complete these data reviews by Winter 2023 to inform whether there are sufficient data to initiate a potential rulemaking.
- Monitor industrial categories where the phaseout of PFAS is projected by 2024, including pulp, paper, paperboard, and airports. The results of this monitoring, and whether future regulatory action is needed, will be addressed in the Final ELG Plan 15 in Fall 2022.

## Leverage NPDES permitting to reduce PFAS discharges to waterways

### *Expected Winter 2022*

The National Pollutant Discharge Elimination System (NPDES) program interfaces with many pathways by which PFAS travel and are released into the environment and ultimately impact people and water quality. EPA will seek to proactively use existing

NPDES authorities to reduce discharges of PFAS at the source and obtain more comprehensive information through monitoring on the sources of PFAS and quantity of PFAS discharged by these sources. EPA will use the effluent monitoring data to inform which industrial categories the Agency should study for future ELGs actions to restrict PFAS in wastewater discharges.

- **Leverage federally-issued NPDES permits to reduce PFAS discharges.**<sup>v</sup> EPA will propose monitoring requirements at facilities where PFAS are expected or suspected to be present in wastewater and stormwater discharges, using EPA’s recently published analytical method 1633, which covers 40 unique PFAS. In addition, EPA will propose, as appropriate, that NPDES permits: 1) contain conditions based on product elimination and substitution when a reasonable alternative to using PFAS is available in the industrial process; 2) require best management practices to address PFAS-containing firefighting foams for stormwater permits; 3) require enhanced public notification and engagement with downstream communities and public water systems; and 4) require pretreatment programs to include source control and best management practices to protect wastewater treatment plant discharges and biosolid applications.
- **Issue new guidance to state permitting authorities to address PFAS in NPDES permits.** EPA will issue new guidance recommending that state-issued permits that do not already include monitoring requirements for PFAS use EPA’s recently published analytical method 1633, which covers 40 unique PFAS, at facilities where PFAS is expected or suspected to be present in wastewater and stormwater discharges. In addition, the new guidance will recommend the full suite of permitting approaches that EPA will use in federally-issued permits. The guidance will enable communities to work closely with their state permitting authorities to suggest monitoring at facilities suspected of containing PFAS.

## **Publish multi-laboratory validated analytical method for 40 PFAS**

*Expected Fall 2022*

In September 2021, EPA (in collaboration with the Department of Defense) published a single-laboratory validated method to detect PFAS. The method can measure up to 40 specific PFAS compounds in eight environmental matrices (including wastewater, surface water and biosolids) and has numerous applications, including NPDES compliance monitoring. EPA and DOD are continuing this collaboration to complete a multi-laboratory validation of the method. EPA expects to publish the multi-lab validated method online by Fall 2022. Following the publication of the method, EPA will initiate a rulemaking to propose the promulgation of this method under the Clean Water Act (CWA).

## **Publish updates to PFAS analytical methods to monitor drinking water**

*Expected Fall 2024*

SDWA requires EPA to use scientifically robust and validated analytical methods to assess the occurrence of contaminants of emerging concern, such as an unidentified or newly detected PFAS chemical. EPA will update and validate analytical methods to monitor additional PFAS. First, EPA will review reports of PFAS of concern and seek to procure certified reference standards that are essential for accurate and selective quantitation of emerging PFAS of concern in drinking water samples. EPA will evaluate analytical methods previously published for monitoring PFAS in drinking water (EPA Methods 533 and 537.1) to determine the efficacy of expanding the established target PFAS analyte list to include any emerging PFAS. Upon conclusion of this evaluation, EPA will complete multi-laboratory validation studies and peer review and publish updated EPA PFAS analytical methods for drinking water, making them available to support future drinking water monitoring programs.

## **Publish final recommended ambient water quality criteria for PFAS**

*Expected Winter 2022 and Fall 2024*

EPA will develop national recommended ambient water quality criteria for PFAS to protect aquatic life and human health. Tribes and states use EPA-recommended water quality criteria to develop water quality standards to protect and restore waters, issue permits to control PFAS discharges, and assess the cumulative impact of PFAS pollution on local communities. EPA will publish recommended aquatic life criteria for PFOA and PFOS and benchmarks for other PFAS that do not have sufficient data to define a recommended aquatic life criteria value. EPA will first develop human health criteria for PFOA and PFOS, taking into account drinking water and fish consumption. This initiative will consider the latest scientific information and will develop human health criteria for additional PFAS when final toxicity assessments are available. Additionally, EPA will support Tribes in developing water quality standards that will protect waters under Tribal jurisdiction under the same framework as waters in adjacent states. Aquatic life criteria are expected in Winter 2022, and human health criteria are expected Fall 2024.

## **Monitor fish tissue for PFAS from the nation's lakes and evaluate human biomarkers for PFAS**

*Expected Summer 2022*

States and Tribes have highlighted fish tissue data in lakes as a critical information need. Food and water consumption are important pathways of PFAS exposure, and PFAS can accumulate in fish tissue. In fact, EPA monitoring to date shows the presence of PFAS, at varying levels, in approximately 100 percent of fish tested in the Great Lakes and large rivers. In Summer 2022, EPA will collect fish tissue in the National Lakes Assessment for the first national study of PFAS in fish tissue in U.S. lakes. This will provide a better understanding of where PFAS fish tissue contamination is occurring, which

PFAS are involved, and the severity of the problem. The new data will complement EPA's analyses of PFAS in fish tissue and allow EPA to better understand unique impacts on subsistence fishers, who may eat fish from contaminated waterbodies in higher quantities. EPA's preliminary analysis on whether concentrations of certain PFAS compounds in human blood could be associated with eating fish using the Centers for Disease Control and Prevention's National Health and Nutrition Examination Survey (NHANES) data found a positive correlation. Completing this analysis will help make clear the importance of the fish consumption pathway for protecting communities. EPA will continue to pursue collaboration with Tribal and federal partners to investigate this issue of mutual interest.

### **Finalize list of PFAS for use in fish advisory programs**

*Expected Spring 2023*

EPA will publish a list of PFAS for state and Tribal fish advisory programs that are either known or thought to be in samples of edible freshwater fish in high occurrence nationwide. This list will serve as guidance to state and Tribal fish tissue monitoring and advisory programs so that they know which PFAS to monitor and how to set fish advisories for PFAS that have human health impacts via fish consumption. This information will encourage more robust data collection from fish advisory programs and promote consistency of fish tissue PFAS monitoring results in EPA's publicly accessible Water Quality Portal. By issuing advisories for PFAS, state and Tribal programs can provide high-risk populations, including communities and individuals who depend on subsistence fishing, with more information about how to protect their health.

### **Finalize risk assessment for PFOA and PFOS in biosolids**

*Expected Winter 2024*

Biosolids, or sewage sludge, from wastewater treatment facilities can sometimes contain PFAS. When spread on agricultural fields, the PFAS can contaminate crops and livestock. The CWA authorizes EPA to set pollutant limits and monitoring and reporting requirements for contaminants in biosolids if sufficient scientific evidence shows that there is potential harm to human health or the environment. A risk assessment is key to determining the potential harm associated with human exposure to chemicals. EPA will complete the risk assessment for PFOA and PFOS in biosolids by Winter 2024. The risk assessment will serve as the basis for determining whether regulation of PFOA and PFOS in biosolids is appropriate. If EPA determines that a regulation is appropriate, biosolids standards would improve the protection of public health and wildlife health from health effects resulting from exposure to biosolids containing PFOA and PFOS.

## Office of Land and Emergency Management

---

### **Propose to designate certain PFAS as CERCLA hazardous substances**

*Proposed rule expected Spring 2022; Final rule expected Summer 2023*

EPA is developing a Notice of Proposed Rulemaking to designate PFOA and PFOS as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances. Such designations would require facilities across the country to report on PFOA and PFOS releases that meet or exceed the reportable quantity assigned to these substances. The hazardous substance designations would also enhance the ability of federal, Tribal, state, and local authorities to obtain information regarding the location and extent of releases. EPA or other agencies could also seek cost recovery or contributions for costs incurred for the cleanup. The proposed rulemaking will be available for public comment in Spring 2022. The Agency commits to conducting robust stakeholder engagement with communities near PFAS-contaminated sites.

### **Issue advance notice of proposed rulemaking on various PFAS under CERCLA**

*Expected Spring 2022*

In addition to developing a Notice of Proposed Rulemaking designating PFOA and PFOS as hazardous substances under CERCLA, EPA is developing an Advance Notice of Proposed Rulemaking to seek public input on whether to similarly designate other PFAS. The Agency may request input regarding the potential hazardous substance designation for precursors to PFAS, additional PFAS, and groups or subgroups of PFAS. The Agency will engage robustly with communities near PFAS-contaminated sites to seek their input

and learn about their lived experiences. Going forward, EPA will consider designating additional PFAS as hazardous substances under CERCLA as more specific information related to the health effects of those PFAS and methods to measure them in groundwater are developed.

### **Issue updated guidance on destroying and disposing of certain PFAS and PFAS-containing materials**

*Expected by Fall 2023*

The 2020 NDAA requires that EPA publish interim guidance on destroying and disposing of PFAS and certain identified non-consumer PFAS-containing materials. It also requires that EPA revise that guidance at least every three years, as appropriate. EPA published the first interim guidance in December 2020 for public comment. It identifies three technologies that are commercially available to either destroy or dispose of PFAS and PFAS-containing materials and outlines the significant uncertainties and information gaps that exist concerning the technologies' ability to destroy or dispose of PFAS while minimizing the migration of PFAS to the environment. The guidance also highlights research that is underway and planned to address some of these information gaps. Furthermore, the interim guidance identifies existing EPA tools, methods, and approaches to characterize and assess the risks to disproportionately impacted people of color and low-income communities living near likely PFAS destruction or disposal sites. EPA's updated guidance will address the public comments and reflect newly published research results. Since the publication of the interim guidance, EPA and other agencies have been conducting relevant research on destruction and disposal technologies. EPA anticipates that additional research data will become available starting in 2022. EPA will update the guidance when sufficient useful information is available and no later than the statutory deadline of December 2023.

## Office of Air and Radiation

---

### Build the technical foundation to address PFAS air emissions

#### *Expected Fall 2022 and Ongoing*

The Clean Air Act requires EPA to regulate emissions of hazardous air pollutants (HAPs), which are pollutants that are known or suspected to cause cancer or other serious health effects. At present, EPA actively works with Tribal, state, and local governments to reduce air emissions of 187 HAPs to the environment. While PFAS are not currently listed as HAPs under the Clean Air Act, EPA is building the technical foundation on PFAS air emissions to inform future decisions. EPA is conducting ongoing work to:

- Identify sources of PFAS air emissions;
- Develop and finalize monitoring approaches for measuring stack emissions and ambient concentrations of PFAS;
- Develop information on cost-effective mitigation technologies; and
- Increase understanding of the fate and transport of PFAS air emissions to assess their potential for impacting human health via contaminated groundwater and other media pathways.

EPA will use a range of tools, such as EJSCREEN, to determine if PFAS air pollution disproportionately affects communities with environmental justice concerns. Data from other ongoing EPA activities, such as field tests, TRI submissions, and new TSCA reporting and recordkeeping requirements, will help EPA collect additional information on sources and releases. By Fall 2022, EPA will evaluate mitigation options, including listing certain PFAS as hazardous air pollutants and/or pursuing other regulatory and non-regulatory approaches. The Agency will continue to collect necessary supporting technical information on an ongoing basis.

## Office of Research and Development

---

### Develop and validate methods to detect and measure PFAS in the environment

#### *Ongoing Actions*

Robust, accurate methods for detecting and measuring PFAS in air, land, and water are essential for understanding which PFAS are in the environment and how much are present. These methods are also essential for evaluating the effectiveness of different technologies for removing PFAS from air, land, and water and for implementing future regulations. To date, EPA has developed validated methods to measure 29 PFAS in drinking water and 24 PFAS in groundwater, surface water, and wastewater. EPA has also developed a method for measuring selected PFAS in air emissions. EPA will build on this work by developing additional targeted methods for detecting and measuring specific PFAS and non-targeted methods for identifying unknown PFAS in the environment. EPA also recognizes the need for “total PFAS” methods that can measure the amount of PFAS in environmental samples without identifying specific PFAS. EPA will increase its efforts to develop and, if appropriate, validate “total PFAS” methods, focusing on air emissions, wastewater, and drinking water. Near-term deliverables include:

- Draft total adsorbable fluorine method for wastewater for potential laboratory validation (Fall 2021);
- Draft method for measuring additional PFAS in air emissions (Fall 2022); and
- Draft methods and approaches for evaluating PFAS leaching from solid materials (Fall 2022).

### Advance the science to assess human health and environmental risks from PFAS

#### *Ongoing Actions*

EPA will expand understanding of the toxicity of PFAS through several ongoing research activities. First, EPA will continue to develop human health toxicity assessments for individual PFAS under EPA’s Integrated Risk Information System (IRIS) Program,

and if needed, other fit-for-purpose toxicity values. When combined with exposure information and other important considerations, EPA can use these toxicity assessments to assess potential human health risks to determine if, and when, it is appropriate to address these chemicals. Most PFAS, however, have limited or no toxicity data to inform human health or ecological toxicity assessments. To better understand human health and ecological toxicity across a wider variety of PFAS, EPA will continue to compile and summarize available and relevant scientific information on PFAS and conduct toxicity testing on individual PFAS and PFAS mixtures. This will inform the development and refinement of PFAS categories for hazard assessment. EPA will also conduct research to identify PFAS sources in the outdoor and indoor environment, to characterize PFAS movement through the environment, and to identify the relative importance of different human exposure pathways to PFAS (e.g., ingestion of contaminated food or water, interaction with household articles or consumer products, and inhalation of indoor or outdoor air containing PFAS). EPA also will work to characterize how exposure to PFAS may contribute to cumulative impacts on communities, particularly communities with environmental justice concerns. Near-term deliverables include:

- Identify initial PFAS categories to inform TSCA test orders as part of the PFAS National Testing Strategy (Fall 2021)
- Consolidate and update data on chemical/physical properties, human health toxicity and toxicokinetics, and ecotoxicity (Spring 2022 – Fall 2024)
- Complete draft PFHxS, PFHxA, PFNA, and PFDA IRIS assessments for public comment and peer review (Spring – Fall 2022)
- Complete and publish the final PFBA IRIS assessment (Fall 2022)

## Evaluate and develop technologies for reducing PFAS in the environment

### *Ongoing Actions*

EPA needs new data and information on the effectiveness of different technologies and approaches for removing PFAS from the environment and

managing PFAS and PFAS-containing materials to inform decisions on drinking water and wastewater treatment, contaminated site cleanup and remediation, air emission controls, and end-of-life materials management. This information is also needed to better ensure that particular treatment and waste management technologies and approaches do not themselves lead to additional PFAS exposures, particularly in overburdened communities where treatment and waste management facilities are often located. Toward that end, EPA will continue efforts to develop approaches for characterizing PFAS in source waters, at contaminated sites, and near PFAS production and treatment/disposal facilities. EPA will also continue to evaluate and develop technologies for drinking water and wastewater treatment, contaminated site remediation, air emission controls, and destruction and disposal of PFAS-containing materials and waste streams. These efforts include conducting laboratory- and pilot-scale studies, which will inform the design of full-scale field studies done in partnership with facilities and states to evaluate real-world applications of different PFAS removal technologies and management approaches.

EPA will prioritize efforts to evaluate conventional thermal treatment of PFAS-containing wastes and air emissions and assess the effectiveness of conventional drinking water and wastewater treatment processes. EPA will also continue to evaluate and advance the application of innovative, non-thermal technologies to treat PFAS waste and PFAS-contaminated materials. Building upon these evaluations, EPA will document the performance of PFAS removal technologies and establish technology-based PFAS categories that identify the list of PFAS that are effectively removed through the application of the associated technology. Near-term deliverables include:

- Collect data to inform the 2023 guidance on destroying and disposing of certain PFAS and PFAS-containing materials (Spring 2022 – Fall 2023);
- Identify initial PFAS categories for removal technologies (Summer 2022); and
- Develop effective PFAS treatment technologies for drinking water systems (Fall 2022).

## Cross-Program

---

### **Engage directly with affected communities in every EPA Region** *Expected Fall 2021 and Ongoing*

EPA must fully understand the challenges facing individuals and communities grappling with PFAS contamination to understand their lived experiences and determine the most effective interventions. As recommended by the National Environmental Justice Advisory Council (NEJAC), EPA will meet with affected communities in each EPA Region to hear how PFAS contamination impacts their lives and livelihoods. EPA will use the knowledge from these engagements to inform the implementation of the actions described in this roadmap. EPA will also use the input to develop and share information to reduce potential health risks in the near term and help communities on the path to remediation and recovery from PFAS contamination.

### **Use enforcement tools to better identify and address PFAS releases at facilities** *Ongoing Actions*

EPA is initiating actions under multiple environmental authorities—RCRA, TSCA, CWA, SDWA and CERCLA—to identify past and ongoing releases of PFAS into the environment at facilities where PFAS has been used, manufactured, discharged, disposed of, released, and/or spilled. EPA is conducting inspections, issuing information requests, and collecting data to understand the level of contamination and current risks posed by PFAS to surrounding communities and will seek to address threats to human health with all its available tools. For example, EPA's enforcement authorities allow the Agency, under certain circumstances, to require parties responsible for PFAS contamination to characterize the nature and extent of PFAS contamination, to put controls in place to expeditiously limit future releases, and to address contaminated drinking water, soils, and other contaminated media.

When EPA becomes aware of a potential imminent and substantial endangerment situation where PFAS poses a threat to human health, the Agency will swiftly employ its expertise to assess the situation and take appropriate action, including using statutorily authorized powers.

### **Accelerate public health protections by identifying PFAS categories** *Expected Winter 2021 and Ongoing*

To accelerate EPA's ability to address PFAS and deliver public health protections sooner, EPA is working to break the large, diverse class of PFAS into smaller categories based on similarities across defined parameters (such as chemical structure, physical and chemical properties, and toxicological properties). EPA plans to initially categorize PFAS using two approaches. In the first approach, EPA plans to use toxicity and toxicokinetic data to develop PFAS categories for further hazard assessment and to inform hazard- or risk-based decisions. In the second approach, EPA plans to develop PFAS categories based on removal technologies using existing understanding of treatment, remediation, destruction, disposal, control, and mitigation principles.

EPA plans to use the PFAS categories developed from these two approaches to identify gaps in coverage from either a hazard assessment or removal technology perspective, which will help EPA prioritize future actions to research, restrict, and remediate PFAS. For example, EPA may choose to prioritize research to characterize the toxicity of PFAS that are not being addressed by regulations that require the implementation of removal technologies. Conversely, EPA may prioritize research to evaluate the efficacy of technologies designed to remove PFAS that are included in a hazard-based category with relatively higher toxicities. To support coordination and integration of information across PFAS categories, EPA plans to develop a PFAS categorization database that will capture key characteristics of individual PFAS, including category assignments.

## **Establish a PFAS Voluntary Stewardship Program**

*Expected Spring 2022*

Reduction of PFAS exposure through regulatory means can take time to develop, finalize, and implement. Moreover, current PFAS regulatory efforts do not extend to all of the approximately 600 PFAS currently in commerce. As a companion to other efforts described in this roadmap, EPA will establish a voluntary stewardship program challenging industry to reduce overall releases of PFAS into the environment. The program, which will not supplant industry's regulatory or compliance requirements, will call on industry to go beyond those requirements by reporting all PFAS releases in order to establish a baseline and then continuing to report to measure progress in reducing releases over time. EPA will validate industry efforts to meet reduction targets and timelines.

## **Educate the public about the risks of PFAS**

*Expected Fall 2021 and Ongoing*

Addressing PFAS contamination is a critical part of EPA's mission to protect human health and the environment. This important mission cannot be achieved without effectively communicating with communities, individuals, businesses, the media, and Tribal, state, and local partners about the known and potential health risks associated with these chemicals. When EPA communicates risk, it is the Agency's goal to provide meaningful, understandable, and actionable information to many audiences. To accomplish this goal, EPA will make available key explainers that help the public understand what PFAS are, how they are used, and how PFAS can impact their health and their lives. These explainers and other educational materials will be published in multiple languages, and the Agency will work to ensure information reaches targeted communities (including those with limited access to technology and resources).

## **Issue an annual public report on progress towards PFAS commitments**

*Winter 2022 and Ongoing*

EPA is committed to acting on PFAS with transparency and accountability. On an annual basis, EPA will report to the public on the status of the actions outlined in this roadmap, as well as future actions the Agency may take. EPA will also engage regularly with communities experiencing PFAS contamination, co-regulators, industry, environmental groups, community leaders, and other stakeholders to clearly communicate its actions and to stay abreast of evolving needs.

# Conclusion

Every level of government—federal, Tribal, state, and local—needs to exercise increased and sustained leadership to accelerate progress to clean up PFAS contamination, prevent new contamination, and make game-changing breakthroughs in the scientific understanding of PFAS. This strategic roadmap represents the Agency’s commitment to the American people on what EPA seeks to deliver from 2021 to 2024.

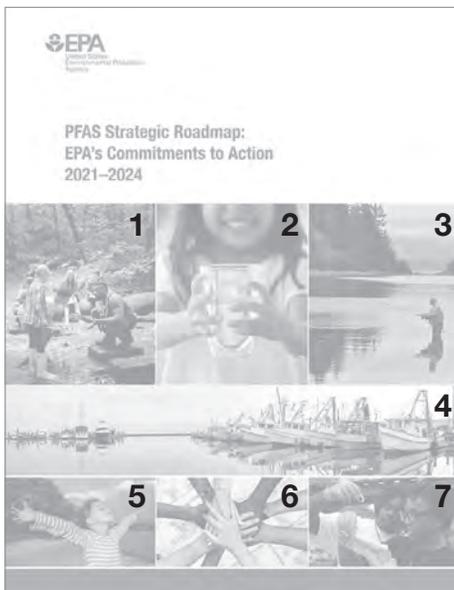
The risks posed by PFAS demand that the Agency take a whole-of-agency approach to attack the problem from multiple directions. Focusing only

on remediating legacy contamination, for example, does nothing to prevent new contamination from occurring. Focusing only on preventing future contamination fails to minimize risks to human health that exist today. To build more enduring, comprehensive, and protective solutions, EPA seeks to leverage its full range of statutory authorities and work with its partners—including other federal agencies, state and Tribal regulators, scientists, industry, public health officials, and communities living with PFAS contamination—to implement this multi-media approach and achieve tangible benefits for human health and the environment.<sup>vi</sup>

# Endnotes

- <sup>i</sup> Approximately 650 PFAS are currently in commerce under TSCA, roughly half of which were grandfathered into the TSCA inventory.
- <sup>ii</sup> EPA has identified 6-8 facilities that produce PFAS feedstock.
- <sup>iii</sup> Key industries with significant documented discharges include PFAS production and processing, metal finishing, airports, pulp and paper, landfills, and textile and carpet manufacturing.
- <sup>iv</sup> Examples include de minimis exemption, supplier notification requirements, and applicability of those requirements to wastes.
- <sup>v</sup> Federally-issued permits are those that EPA issues in MA, NH, NM, DC, territories, federal waters, and Indian Country (and federal facilities in DE, CO, VT, WA).
- <sup>vi</sup> This document provides information to the public on how EPA intends to exercise its discretion in implementing statutory and regulatory provisions that apply to PFAS. Those provisions contain legally binding requirements, and this document does not substitute for those statutory and regulatory provisions or regulations, nor is it a regulation itself.

## Photo Credits



### On the cover:

1. © istock.com
2. <https://photostockeditor.com/free-images/girl-glass/page/2>
3. Fly fishing, <https://www.flickr.com/photos/umnak/>, Joseph CC BY-SA 2.0
4. © istock.com
5. © istock.com
6. © Adobestock.com
7. High school students help with water monitoring and river cleanup, <https://www.flickr.com/photos/usepagov/6237611883>

page 4: Chesapeake Bay, Maryland,  
<https://www.maxpixel.net/Sky-Maryland-Reflection-Chesapeake-Bay-Water-1310538>



EPA-100-K-21-002  
October 2021