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US EPA

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Re: Request for Public Comment, Federal Register, April 16, 2024 (89 FR 26879)

We the undersigned 29 environmental, health, and community-based organizations are writing to comment on EPA's 2024 Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS).

Many of the undersigned groups also commented on the first guidance on PFAS disposal, issued in 2020. We noted that the rules and guidance on PFAS disposal are largely the same, and the core components of our comments are also unchanged.[1,2] In summary, ***EPA's non-binding guidance document is not adequate protection from improper or reckless disposal of PFAS waste***.

PFAS are a class of thousands of manmade chemicals that have become a global environmental and public health threat because they share several harmful properties.[3] PFAS are defined by the presence of one or more fully fluorinated carbon atoms.[4] These extremely strong carbon-fluorine bonds give PFAS their extreme persistence. Because PFAS do not break down easily in the environment and some PFAS can persist for thousands of years, they are commonly referred to as "forever chemicals."[5] PFAS are also highly mobile in the environment and can spread quickly in air and water from their point of release. Once PFAS enter the environment, they are very difficult to remove and/or destroy. Due to their widespread use, extreme persistence, and high mobility, PFAS now contaminate the globe, including polar regions which are far from

[1] Sierra Club et al. 2021. Public Comments on EPA's 2020 PFAS Disposal Guidance, Docket: No EPA-HQ-OLEM-2020-0527.

[2] Letter from 65 advocacy leaders to White House Council on Environmental Quality, regarding PFAS clean up and disposal. December 6, 2022.

[3] Ian T. Cousins et al., "Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS)," *Environmental Science & Technology* 56, no. 16 (2022): 11172–11179, https://doi.org/10.1021/acs.est.2c02765.

[4] Green Science Policy Institute, "Scientists' Statement on Defining PFAS," March 12, 2024,https://drive.google.com/file/d/1YLB2zvWG5Ez6VeMqqbw77LpVEj0JTj1H/view.

[5] D.J. Ivy et al., "Global Emission Estimates and Radiative Impact of C4F10, C5F12, C6F14, C7F16 and C8F18," *Atmospheric Chemistry and Physics* 12, no. 16 (August 22, 2012): 7635–7645, https://doi.org/10.5194/acp-12-7635-2012; Joseph G. Allen, "These Toxic Chemicals Are Everywhere — Even in Your Body. And They Won't Ever Go Away.," *Washington Post*, January 2, 2018, https://www.washingtonpost.com/opinions/these-toxic-chemicals-are-everywhere-and-they-wont-ever-go-away/2018/01/02/82e7e48a-e4ee-11e7-a65d-1ac0fd7f097e_story.html.

production and use sites.[6] Virtually all Americans have PFAS in their bodies, which is concerning given the toxicity associated with many PFAS.[7]

The need for safe destruction of PFAS chemicals is hitting a new level of urgency. In April 2024 the EPA issued strong, health-protective federal drinking water standards for six PFAS which will lead to cleaner, safer drinking water for over 100 million people.[8] Water districts around the country who enact treatment methods will need to decide what to do with used treatment residuals. The listing of PFOS and PFOA in Superfund is expected to prompt the cleanup of legacy pollution at military and industrial sites. And the Department of Defense is collecting and disposing of more than 2 million gallons of unusable PFAS-based firefighting foams, as are many companies, fire departments, or state agencies in many states pursuant to state restrictions on PFAS-based firefighting foams.

EPA has failed, over many years, to issue regulations governing PFAS disposal, or to curb production or emissions of the chemicals. Meanwhile, the Agency lacks robust tracking data to quantify the volume of waste generated, the locations it was sent, or the long-term impacts of disposal choices. The current Guidance documents will do relatively little to change this trend.

In every state in the country PFAS chemicals are dumped down wastewater drains, where they accumulate in wastewater effluent and solids. Millions of metric tons of PFAS-containing sewage sludge (also known as "biosolids") are spread on agricultural lands. Other PFAS wastes volatilize from landfills and are emitted from the stacks of municipal and hazardous waste incinerators back into global air circulation. As the EPA begins to compel widespread treatment of drinking water and cleanup of legacy industrial sites, it must ensure that the massive investment in safe drinking water and site remediation don't just result in the spread of PFAS pollution to new places by different means.

When it comes to PFAS disposal, several facts cannot be ignored:

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[6] Elsie M. Sunderland et al., "A Review of the Pathways of Human Exposure to Poly- and Perfluoroalkyl Substances (PFASs) and Present Understanding of Health Effects," *Journal of Exposure Science & Environmental Epidemiology* 29, no. 2 (March 2019): 131–147, https://doi.org/10.1038/s41370-018-0094-1.

[7] Antonia M. Calafat et al., "Legacy and Alternative Per- and Polyfluoroalkyl Substances in the U.S. General Population: Paired Serum-Urine Data from the 2013–2014 National Health and Nutrition Examination Survey," *Environment International* 131 (October 2019): 105048, https://doi.org/10.1016/j.envint.2019.105048; Guomao Zheng et al., "Elevated Levels of Ultrashort- and Short-Chain Perfluoroalkyl Acids in US Homes and People," *Environmental Science & Technology* 57, no. 42 (October 2023): 15782–15793, https://doi.org/10.1021/acs.est.2c06715; Agency for Toxic Substances and Disease Registry (ATSDR), *Toxicological Profile for Perfluoroalkyls*, U.S. Department of Health and Human Services, 2021, ch. 2, https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf; Shelia Zahm et al., "Carcinogenicity of Perfluorooctanoic Acid and Perfluorooctanesulfonic Acid," *Lancet Oncology* 25, no. 1 (November 2023), https://doi.org/10.1016/S1470-2045(23)00622-8.

[8] EPA, "PFAS National Primary Drinking Water Regulation," 89 *Federal Register* 32532 (April 26, 2024), https://www.federalregister.gov/documents/2024/04/26/2024-07773/pfas-national-primary-drinking-water-regulation

1. Environmental justice communities are most harmed by PFAS disposal options. The EPA clearly identifies the potential for unregulated waste disposal to spread pollution to new places. The reality is that landfills, incinerators, and deep injection wells are disproportionally located in so-called "environmental justice" (EJ) communities and on Tribal lands.[9]

As with many toxic pollutants, lower income communities and communities of color suffer from greater proximity to contaminated sites. Low income households are 15 percent more likely to live around PFAS-contaminated sites than would be expected based on their share of the population, and African American households are 48 percent more likely to live around PFAS-contaminated sites than would be expected.[10] Another study found that "watersheds serving higher proportions of Hispanic/Latino and non-Hispanic Black populations had significantly greater odds of containing PFAS sources."[11] Tribal communities and other racial and ethnic groups that consume more locally caught freshwater fish and wildlife will have greater exposure to PFAS and other persistent and bioaccumulative contaminants.

The EPA guidance offers standard screening tools to consider the potential impacts of PFAS waste disposal on heavily burdened communities, but no binding requirements that waste managers do so. The Department of Defense (DOD) determined that waste disposal could harm overburdened communities near long-term disposal sites, but concluded that the benefit of PFAS disposal outweighed additional harms to EJ communities.[12] As advocates, we reject the toxic tradeoff between the speed and safety of cleanup for PFAS-contaminated sites, especially since the cleanup is likely to be illusory for all of the currently used methods for PFAS disposal.

2. There are major safety concerns related to the fate of PFAS incineration, pyrolysis, landfilling and deep well injection. Since the initial draft Guidance was published in 2020, the EPA has made available several new analytical methods to more comprehensively evaluate the PFAS in air and wastewater and sewage sludges. It

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[9] Tishman Center, *US Municipal Solid Waste Incinerators: An Industry in Decline,* (May 2019) https://static1.squarespace.com/static/5d14dab43967cc000179f3d2/t/5d5c4bea0d59ad00012d220e/1566329840732/CR_GaiaReportFinal_05.21.pdf
LW Cole & S.R. Foster, *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement*. New York University Press, (2000).

[10] Genna Reed, Union of Concerned Scientists, "PFAS Contamination Is an Equity Issue, and President Trump's EPA Is Failing to Fix It" (Oct. 30, 2019), https://blog.ucsusa.org/genna-reed/pfas-contamination-is-an-equity-issue-president-trumps-epa-is-failing-to-fix-it/.

[11] Jahred M. Liddie et al., "Sociodemographic Factors Are Associated with the Abundance of PFAS Sources and Detection in U.S. Community Water Systems," *Environmental Science & Technology*. 57:7902-7912 (2023), https://pubs.acs.org/doi/pdf/10.1021/acs.est.2c07255.

[12] Department of Defense. *Interim Guidance on Destruction or Disposal of Materials Containing Per- and Polyfluoroalkyl Substances in the United States*. July 2023.

studied the fate of PFAS in hazardous waste incinerators and pyrolysis facilities. This research has not lessened our concerns about current disposal practices, rather identified the need for more analysis of the products of incomplete combustion. The EPA also reviewed existing data on landfills and estimated significant amounts of PFAS releases due to evaporation and leaching.

We share additional comments and recommendations in Appendix A.

3. Safe storage continues to be the best option for concentrated PFAS waste. As with the 2020 disposal guidance, the EPA suggests that safe storage may be the best option for certain waste streams. The EPA should make this advice stronger and more prominent. It should also clarify best practices for safe storage with appropriate monitoring for concentrated wastes, which will allow waste managers to best follow this recommendation.

4. Alternative technologies hold promise, but need to be carefully validated and evaluated. EPA, DOD, and private industry have been scrambling to identify alternative destruction technologies that can safely destroy PFAS. DOD recently announced that it is testing more than 70 non-incineration destruction technologies to handle PFAS waste.[13]

EPA's 2024 guidance provides a "PFAS Destruction and Disposal Technology Evaluation Framework" that is meant to be more comprehensive than existing metrics in guiding decisions on when and where to use proposed destruction or disposal technologies.

We agree with the framework that EPA provided for evaluating the relative success of these technologies, with several modifications. It is not clear to us why the EPA discussed the framework only in the context of discussing emerging destruction and disposal technologies. Rather, this framework should be used to guide discussion of all technologies discussed in the Guidance.

The Framework considers: technology readiness, what types of materials the technology is appropriate for handling, the extent to which various analytical methods have been employed to evaluate the efficacy of the technology, community considerations, and existing regulatory requirements. We recommend that the EPA incorporate additional key questions related to worker and community safety, energy requirements, the need for other non-PFAS hazardous chemicals to be used in order for the technology to operate effectively, and whether or not the technology has been independently validated to meet manufacturers' claims of performance and safety metrics.

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[13] Department of Defense, *Per- and Poly-fluoroalkyl Substances Non-Incineration Destruction Technologies - Report to Congress*, Sept. 3, 2024.

In 2017 the CEASE FIRE Campaign set forth criteria for the safest destruction of chemical munitions.[14] Applying these criteria to PFAS, we conclude that the safest and most equitable destruction technologies will achieve the highest levels of PFAS destruction, not emit fluorochemicals to air or water, and operate in contained systems to add an additional level of protection for when a destruction technology doesn't work as expected. Small systems that are optimized to work in the field can minimize the risks associated with long distance shipping. Treating waste on- site can be a more equitable solution to the current practice of sending the nation's most harmful waste to a small number of communities.

Additional recommendations for strengthening the framework are provided in Appendix A.

5. In the face of a chaotic landscape, we urge the EPA and the federal agencies to enact several urgent actions to minimize the most egregious harms of the PFAS waste cycle:

- Finalize EPA's proposed rule to add 9 PFAS to the list of RCRA hazardous constituents and initiate rulemaking to list PFAS, as a class, as RCRA hazardous wastes.

- EPA should name and discourage the worst disposal options for concentrated wastes, namely incinerators, including pyrolysis facilities; municipal waste landfills; and deep injection wells – systems that are not sufficient to contain these highly persistent, mobile and toxic chemicals. This is especially important since the current DOD 2023 Disposal Guidance memo suggests that these methods can be used in some instances.[15]

- Require collection and safe handling of landfill leachate. Studies show that landfill liquid waste contains PFAS and a host of other persistent and mobile synthetic chemicals. Current landfill practices allow leachate to be sent to wastewater treatment facilities that do not contain or detoxify these wastes. Rather chemicals are released back into global circulation through wastewater effluent or the land application of biosolids.

- Develop guidelines for a standardized leaching test (TCLP) that can be used to determine if waste contains harmful amounts of PFAS and divert this material from municipal solid waste landfills.

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[14] CEASE FIRE Campaign, *Criteria for Evaluation of Technology Alternatives to OB/OB of Conventional Munitions*, 2017, https://cswab.org/wp-content/uploads/2017/03/Cease-Fire-Campaign-Alternative-Technology-Criteria-FINAL.pdf

[15] Department of Defense, *Interim Guidance on Destruction or Disposal of Materials Containing Per- and Polyfluoroalkyl Substances in the United States*, (July 2023).

- Evaluate all destruction and disposal technologies under CERCLA, as outlined by the state of New Mexico and North Carolina in their comments.[16]

- Actively oversee the collection, storage and ultimately the safe destruction of AFFF stockpiles, including 2 million gallons of concentrated AFFF held by the Department of Defense, and the stockpiles held at airports, transportation departments and by municipal fire services.

Ultimately, all PFAS that are produced will remain a costly threat throughout their lifecycle, including the disposal phase. As the Guidance document points out, there are limitations in all currently available disposal and destruction methods. Those under development will still be costly and energy intensive. We must significantly reduce the production and use of all PFAS chemicals in order to lessen the burden on our planet, people, and wildlife. In the meantime, disposal and destruction technologies should be carefully evaluated to ensure the harms of PFAS are not spread to new communities and environments.

More details are in the technical comments attached. Thank you for your consideration of our comments.

Sincerely,

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[16] State of New Mexico and North Carolina, *Comments on EPA's Interim PFAS Destruction and Disposal Guidance; Docket ID EPA-HQ-OLEM-2020-0527* (2024)

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Appendix A - Detailed comments on PFAS disposal and destruction guidance

+ Landfills

In the 2024 guidance the EPA expresses new concern about landfilling as a solution for PFAS disposal. This is based on the volatility and mobility of PFAS compounds. EPA scientists recently reviewed existing data on leaching and volatilization and calculated significant loss of PFAS from landfills.[17] While it is impossible to estimate the amount of the chemicals that have been landfilled over past decades, they calculate that more than 7.5 metric tonnes of target PFAS are sent to municipal waste landfills each year. Of these, 14,500 pounds are generic mixed municipal waste, and more than 1,800 pounds of PFAS come from landfilled wastewater biosolids. This amount of PFAS entering landfills could increase in coming years with more cleanup of legacy contamination sites, if water treatment wastes are sent to landfills for disposal, and if more PFAS contaminated biosolids are sent to landfills instead of being land applied.

The review estimates that as much as 15 percent of the volume of PFAS entering US landfills each year could volatilize into air or wash out into landfill leachate. Of this more than 1,000 pounds are released in landfill gas, and more than 1,680 pounds in liquid leachate.

While these calculations are helpful to raise alarms about current landfilling practices, it is important to note that the data on the fate of PFAS in landfills are relatively scarce. This analysis doesn't account for abandoned landfills. Loss rates are influenced by landfill design, the specific practices of leachate and gas collection, and the presence of organic material and moisture content. The presence and effectiveness of landfill liners depends on the waste category and the age of the landfill. All landfill flares operate at temperatures that would not be expected to destroy PFAS (650-800 degrees C), thereby leading to the generation of products of incomplete combustion, which are challenging to measure. The EPA notes that GAC treatment could potentially remove PFAS from landfill gas, however, this is not a common practice and is not likely to efficiently capture short chain PFAS which are the most likely to volatilize. Hazardous waste landfills typically do not have any gas collection. However, they are the only type of landfills that currently handle leachate in ways that would limit re-circulation into the environment.

The EPA recommends that concentrated, soluble or volatile PFAS wastes are not sent to municipal solid waste landfills or construction & demolition (C&D) landfills, however the current DOD guidance suggests municipal waste landfills be used in some circumstances. We support EPA's conclusion that RCRA Subpart C landfills are more secure than MSWs and C&D landfills.

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[17] *Thabet Tolaymat et al.,* "A Critical Review of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Landfill Disposal in the United States"*, Science of the Total Environment, (905)167185* (2023).

EPA should:

- Finish revising its Landfills Point Source Category Effluent Limit Guidelines (ELGs) for PFAS in landfill leachate.[18]
- Directly refute bad guidance from DOD, which suggests PFAS waste could be sent to permitted municipal waste landfills.
- Revisit any financial assurance requirements for hazardous waste landfills and encourage states to revisit any financial assurance requirements for municipal solid waste and construction and demolition debris landfills, to ensure that the potential bankruptcy or closure of those facilities will not result in unfunded PFAS remedial obligations.
- Study the amount of PFAS leaching from abandoned landfills and help allocate money to remediate those posing the greatest threat to public health and water quality.

+Incineration and other thermal treatments

In both 2020 and 2024, the EPA raised concerns about the fate of PFAS wastes sent to municipal and hazardous waste incinerators. This is a critical question, as incineration has historically been the selected method of disposal for contaminated soil, sediment and waste AFFF. Unknowable quantities of PFAS have also been burned in the 193 municipal waste incinerators, 170 sewage sludge incinerators, and 17 RCRA-permitted carbon reactivation furnaces. The US military and several states incinerated millions of gallons of toxic PFOS-based foams in 3 commercial incinerators. Now the Department of Defense must decide how to dispose of a similar quantity of C6 PFAS fluorotelomer foams and rinsate water.

To fill the gaps in scientific knowledge related to the fate of thermally-treated PFAS wastes, the EPA has developed test methods for PFAS in air. Released in 2024, Other Test Method-45 (OTM-45) measures 50 targeted PFAS analytes and OTM-50 targets 31 volatile fluorinated compounds that are products of incomplete combustion (PICs) and/or products of incomplete destruction (PIDs).[19] These methods are not representative of all thermal breakdown products. EPA is developing a total organic fluorine test which would be used as a companion to these targeted methods to ensure

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[18] EPA, *Landfills Effluent Guidelines*, (Jan 2024) https://www.epa.gov/eg/landfills-effluent-guidelines#new-rulemaking

[19] EPA, *Other Test Method 45 (OTM-45) Measurement of Selected Per- and Polyfluorinated Alkyl Substances from Stationary Sources,* July 1, 2024. https://www.epa.gov/system/files/documents/2024-07/other-test-method-45-rev1-final-_1.pdf; EPA, *Other Test Method 50 (OTM-50) Sampling and Analysis of Volatile Fluorinated Compounds from Stationary Sources Using Passivated Stainless-Steel Canisters,* 2024, https://www.epa.gov/system/files/documents/2024-01/otm-50-release-1_0.pdf.

there are no additional PICs or PIDs released from incineration or other destruction technologies.

The EPA also performed and published an experimental study conducted at EPA's Rainbow research combustor.[20] This study also used EPA method OTM-45 to measure the destruction of PFAS from AFFF compounds, while using non-target analysis of OTM-45 canisters to identify about 10 fluorochemicals as breakdown products. These include fluoroform, pentafluoroethane, 1Hhepafluoropropane, and 1H perflouroheptane, which are greenhouse gasses with long atmospheric lifetimes in the atmosphere. Of particular importance was the observation that PFAS breakdown and byproduct formation is highly temperature dependent, with performance declining when temperatures dropped below 1,000° C. At 970° C less than 99.99% of two shorter chain PFAS chemicals (PFBA and PFPeA) were destroyed. At 870° C at least 15 measurable breakdown products were detected at concentrations ranging from 0.4 to 903 mg/m^3. The authors conclude: "These results suggest that [destruction efficiency] alone may not be the best indication of total PFAS destruction, and additional PIC characterization may be warranted." Additional research will be necessary with non-target or "total organic fluorine" to understand the fate of PFAS in incinerators and types and quantities of products of incomplete destruction.

The study also focused on steady-state combustor operations, noting that the real-world operating conditions of a hazardous waste incinerator will inevitably include temporary disruptions to oxygen flow and temperature depressions. The authors state the "time dependent behavior of PFAS in [hazardous waste incinerators] and other batch fed systems will depend on the system's ability to smooth these transients and maintain high temperatures," concluding, "[m]ore research into rotary kiln systems and full-scale incinerators is needed." It is common for commercial hazardous waste incinerators and aggregator kilns to operate outside of ideal temperature ranges and have a variety of citations for violations of air and waste permits. Multiple studies have detected elevated PFAS concentrations in the vicinity of operating incinerators or thermal oxidizers designed to destroy gaseous PFAS waste,[21] or leaching from incinerator ash[22], raising further concerns about the impacts of PFAS incineration.

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[20] Erin P Shields et al., "Pilot-Scale Thermal Destruction of Per-and Polyfluoroalkyl Substances in a Legacy Aqueous Film Forming Foam", Environmental Science & Technology Engineering, 3:1308-1317 (2023), https://pubs.acs.org/doi/abs/10.1021/acsestengg.3c00098

[21] Kaitlin V. Martin et al., "PFAS Soil Concentrations Surrounding a Hazardous Waste Incinerator in East Liverpool, Ohio, An Environmental Justice Community", *Environmental Science Pollution Research International*, 30:80643-80654 (June 10, 2023), DOI: 10.1007/s11356-023-27880-8; Bennington College, "First in the Nation Testing Reveals Toxic Contamination in Soil and Water Near Norlite Incinerator" (Apr. 2020), https://www.bennington.edu/sites/default/files/sources/docs/Norlite%20News%20Release%20%5Bdb%20final%20updated%5D.pdf; Jiaqi Zhou et al. "Legacy and Emerging Airborne PFAS Collected on PM2.5 Filters in Close Proximity to a Fluoropolymer Manufacturing Facility" *Environmental Science: Processes & Impacts*, 12:2272-2283 (2022), https://pubs.rsc.org/en/content/articlelanding/2022/em/d2em00358a/

[22] Tolyamat citing, S Liu et al, "Perfluoroalkyl Substances (PFASs) in Leachate, Fly Ash, and Bottom Ash from Waste Incineration Plants: Implications for the Environmental Release of PFAS", *Science of the Total Environment* 795:148468 (2020).

The Guidance document also briefly described two testing campaigns to evaluate the effectiveness of a thermal oxidizer installed at the Chemours Facility in Fayetteville, NC. As noted in the Guidance, the company was only required to monitor the destruction of 5 long-chain PFAS, including HFPO-DA (also known as GenX). While the reported destruction of the 5 targeted PFAS seemed very efficient (99.99% emission reduction), the EPA rightly acknowledged that the “removal processes for products of incomplete combustion or of destruction of potential compounds not studied but potentially found in the facility waste streams are still unclear.” Unfortunately, the current consent order that requires the use of the thermal oxidizer only specifies reductions in the 5 targeted PFAS. Independent analyses of rainwater collected adjacent to the Chemours Fayetteville facility indicate that other PFAS may be being emitted as well.[23] This testing, which focuses on measuring the presence of known PFAS structures and does not include PFAS that are products of incomplete combustion, is likely to underestimate the total emissions from the thermal oxidizer. Additional testing campaigns using the newly developed OTM-45 and OTM-50 and methods to measure Total Organic Fluorine are needed in order to more fully characterize the efficiency of the thermal oxidizer to reduce emissions of “all PFAS” coming from the facility.

EPA classifies pyrolysis and gasification units as incinerators under the Clean Air Act. These technologies pose similar concerns for incomplete destruction. Pyrolysis is currently used as a disposal technology for sewage biosolids, which are commonly contaminated with PFAS and other persistent contaminants, albeit at lower concentrations than unused AFFF. EPA’s sponsored study of a biosolids pyrolysis facility measured 21 “target” PFAS, destruction efficiency of >81.3 to >99.9% of these specific compounds.[24] The study faced similar limitations to the studies of commercial incinerator technology, including the inability to fully assess the mass balance of organic fluorine or determine the products of incomplete combustion.

EPA should:

- Refute DOD recommendation that could route some highly concentrated PFAS waste to commercial hazardous waste incinerators.
- Take immediate action to end incineration of concentrated PFAS waste in commercial and municipal incinerators. Inform federal agencies, state regulators, commercial industries and the fire service of these recommendations.
- Given the ubiquitous nature of PFAS-treated items in municipal waste, EPA should work to phase out municipal waste combustion.

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[23] Tom Perkins, “A North Carolina PFAS Factory Claims Its Emissions Fell by 99.99%. A Guardian Test Reveals Otherwise,” *The Guardian*, January 28, 2024, sec. US news, https://www.theguardian.com/us-news/2024/jan/28/north-carolina-pfas-forever-chemicals-testing.

[24] Eben Thoma et al., “Pyrolysis processing of PFAS-impacted biosolids, a pilot study”. *Journal of the Air & Waste Management Association,* 72(4), 309-318. https://doi.org/10.1080/10962247.2021.2009935

+ Deep Well Injection

EPA's draft guidance determines that deep wells are "feasible and effective disposal options that normally should minimize migration of PFAS into the environment." We have concerns about the capacity of deep wells to accommodate the volume of waste, the robustness of permitting programs and need for long-term monitoring to ensure that hazardous waste does not migrate out of the intended injection zone. EPA identifies research needs into "the long-term fate and transport of PFAS (including precursors) to predict migration potential in the injection zone could support future permits." But in fact significant quantities of PFAS containing and other hazardous waste have been injected into deep wells over prior decades, including industrial wastewater from fluorochemical production facilities,[25] resulting in an urgent need for stronger oversight.

Texas Molecular claims to have received and to be "safely managing" more than 140 million gallons of PFAS-containing waters since 2017. Facilities such as these are Class 1 hazardous waste disposal wells, and require the owner to verify that the waste will remain in place for as long as the materials will remain hazardous, yet there are examples of well failure. Failures happen when wells are improperly designed or when waste materials are added too quickly. The GAO and others have raised concerns that monitoring is inadequate to gauge the true performance or failure of deep well injection.

In 2014 the GAO reviewed the EPA's class II injection wells and concluded that the agency is "not consistently conducting two key oversight and enforcement activities for class II programs." The same is true today. There have been dozens of cases of water contamination related to deep well injection to date, particularly in the Oil and Gas industry where it is a common disposal strategy for liquid wastes.[26] An investigation by ProPublica of 220,000 well inspections from 2007 to 2010 found that well integrity violations were issued for 1 in 6 deep injection wells examined, and more than 7,000 of the wells inspected showed signs of leakage. "Regulators say redundant layers of protection usually prevent waste from getting that far, but EPA data shows that in the three years analyzed by ProPublica, more than 7,500 well test failures involved what federal water protection regulations describe as 'fluid migration' and 'significant leaks.'"[27] More research and transparency are needed to understand the impacts of deep well injection for disposing of PFAS and other hazardous wastes.

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[25] Michigan Waste & Recycling Association, *Statewide Study on Landfill Leachate: PFOA and PFOS Impact on Water Resource Recovery Facility Influent*, (2019) https://www.bridgemi.com/sites/default/files/mwra-technical-report.pdf; VLS Environmental Solutions, *VLS Texas Molecular Solution for PFAS: Meeting Future Regulations Today* https://www.vlses.com/2024/10/03/vls-texas-molecular-solution-for-pfas-meeting-future-regulations-today/

[26] Government Accountability Office, *EPA Program to Protect Underground Sources from Injection of Fluids Associated with Oil and Gas Production Needs Improvement*, GAO-14-555, (2014) https://www.gao.gov/products/GAO-14-555

[27] ProPublica, *Injection Wells: The Poison Beneath Us,* (2012) *https://www.propublica.org/article/injection-wells-the-poison-beneath-us*

+ Advanced, contained destruction methods

In contrast to other waste containment or thermal destruction methods, there are several types of advanced destruction methods for PFAS that show promise in destroying the chemicals. EPA published a review of 3 commercial systems[28] using Super Critical Water Oxidation (SCWO), and one system working at an industrial scale.[29] Both tests showed a >99% destruction of concentrated PFAS (AFFF) waste. Another new technology, Hydrothermal Alkaline Treatment or HALT, uses contained destruction techniques to destroy PFAS.[30] Further research is needed to ensure these types of advanced tools fully mineralize PFAS and do not form harmful byproducts.

In contrast to other technologies mentioned, the destruction byproducts of SCWO and HALT can be captured and subject to additional concentration or filtration steps. The use of technologies with closed systems is key to ensuring safe operation and containing the final byproducts of destruction technologies. The fact that SWCO and other advanced technologies could be optimized to run at small scales and on-site, holds promise for upending the dynamic of sending waste long distances and to historically burdened communities.

EPA should:

- Continue studying SCWO, HALT and other contained system technologies to understand the mass balance of fluorine in waste treatment scenarios and ensure the final outputs can be safely managed.

- DOD's August 2024 report to Congress highlights the fact that the department is widely investigating non-thermal destruction technologies. We urge EPA to exert oversight into the research and evaluation of these technologies.

- Ultimately, the federal government should prioritize using validated, contained, destruction technologies wherever possible to destroy concentrated PFAS wastes.

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[28] Max Krause et al., "Supercritical water oxidation as an innovative technology for PFAS destruction" *Journal of Environmental Engineering,* 148(2), 05021006. (2023) *https://doi.org/10.1061/(ASCE)EE.1943-7870.0001957*.

[29] Endalkac Sahle-Demessie et al., *Industrial SCWO for the treatment of PFAS/AFFF within a water matrix* (EPA/600/R-ww/257). U.S. Environmental Protection Agency. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=357639&Lab=CESER.

[30] Shilai Hao et al, "Hydrothermal Alkaline Treatment (HALT) of Foam Fractionation Concentrate Derived from PFAS-Contaminated Groundwater" Environmental Science & Technology, 57:44 (2023) https://pubs.acs.org/doi/10.1021/acs.est.3c05140

+ PFAS Destruction and Disposal Technology Evaluation Framework

In this Guidance document the EPA provided a framework to evaluate PFAS destruction and disposal technologies. It is not clear why this framework was presented at the end of the Guidance document rather than being used as a guiding framework to evaluate all of the technologies presented throughout the document. The primary audience of the Guidance document is "decision-makers who need to identify the most effective means for destroying or disposing of PFAS-containing materials and wastes." As the Guidance points out, there are limitations in all currently available disposal and destruction methods. Therefore, this framework should have been used to transparently inform the target audience about the available technologies, including their readiness, their effectiveness, and their potential for downstream and unanticipated impacts. Importantly, this framework is responsive to and inclusive of the considerations and inclusions outlined in FY 2020 NDAA Section 7361.

There are several good aspects of the Framework, a few of which we outline here:

- What is the technology readiness? We agree that this is important to consider as some destruction methods have only been evaluated at the bench scale and it is unclear if the technology is ready and able to be implemented at the larger field scale. Further, it is important to ask if the performance and life cycle effects will differ for any methods when moving from bench scale to field scale.

- What PFAS-containing materials were used to test the method? This is a really important question because it is a very different task to remove PFAS from a dilute source versus a concentrated source like AFFF or a liquid vs a solid.

- Which analytical methods were used to test the effectiveness of the method? This is a very important question. If a method claims to remove 99% of PFAS, one needs to know how PFAS were measured - whether individually for a select list of specific PFAS or more broadly with methods to detect total organofluorine. Targeted analyses for specific PFAS will not allow for a full mass balance analysis (i.e. how much PFAS went in and how much was actually destroyed versus being converted to other PFAS).[31] We are particularly interested in the potential for ultra-short chain and volatile PFAS to be generated, so methods are needed to evaluate their presence.

- Are there non-PFAS constituents released into the environment? In other words, this question asks what other byproducts might be released during operation of this method.

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[31] Sanne J. Smith et al., "The Need to Include a Fluorine Mass Balance in the Development of Effective Technologies for PFAS Destruction," *Environmental Science & Technology*, February 5, 2024, https://doi.org/10.1021/acs.est.3c10617.

- Community considerations are acknowledged, including concerns for siting of facilities and the potential for vulnerable populations and/or environmental justice communities to face further harm. The need for community engagement is also noted. However, there are no requirements for community engagement to actually occur, which should be addressed.

Importantly, we also note several elements that are currently missing from the framework. These should be added in future iterations in order to strengthen the framework and improve its comprehensiveness:

- Considerations for worker safety. Disposal and destruction technicians are a vulnerable population, given their potential for chronic exposures to highly concentrated PFAS wastes. Some disposal and destruction methods likely pose a greater risk of exposure to workers.

- Considerations of the energy intensiveness of the method. As the EPA pointed out in the Guidance document, "Breaking the carbon fluorine bond requires 1.5 times more energy [than breaking the carbon chlorine bond] and therefore higher temperatures and reaction times." Thus, destruction methods capable of fully mineralizing PFAS wastes are expected to be extremely energy intensive. The energy intensiveness of a technology is likely to drive its cost and feasibility and will impact its overall environmental profile.

- Consideration of the need to use other harmful chemicals in the method. Some destruction methods require the use of other harmful chemicals. For example, one destruction method recently discussed in the scientific literature would require the use of large amounts of industrial solvents.[32] Green chemist Terry Collins noted, "Even then the base/DMSO process is not a nice one, and I wouldn't want to live anywhere near it."[33] Disposal and destruction technologies for PFAS must also consider the other chemical inputs that could be required for them to work efficiently.

- Additional considerations for community impacts, including whether or not the method will require transportation to a facility. Currently, PFAS wastes are sometimes transported long distances by train for deep well injection in another state. This creates a situation where many communities along the train route could face exposure to concentrated PFAS waste in the event of an accident like the one that occurred in East Palestine.

- Whether the analytical tests demonstrating destruction or mineralization have been validated. In the Framework, the EPA asks "Are there any concerns about the quality of the data generated during testing?" This is an important question,

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[32] Brittany Trang et al., "Low-Temperature Mineralization of Perfluorocarboxylic Acids," *Science* 377, no. 6608 (August 2022): 839–45, https://www.science.org/doi/10.1126/science.abm8868.

[33] Terry Collins, "PFAS Removal Discovery Not yet a 'powerful Solution," August 25, 2022, https://www.ehn.org/terry-collins-pfas-removal-discovery-not-yet-a-powerful-solution-2657897799.html.

but could have been strengthened by asking the further question “Has a third party validated the technology’s performance and safety?” Independent validation is needed to ensure that claims from companies, which stand to make a large profit from newly developed technology, are accurate and not overstated.