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US EPA

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Re: Request for Public Comment, Federal Register, December 22, 2020 (85 FR 83554)

This letter presents comments on the *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances*, released by the US Environmental Protection Agency (US EPA) in December 2020 for public comment. We thank you for the opportunity to comment.

These comments are submitted on behalf of 30 organizations, who collectively represent millions of U.S. residents as our members and supporters. We share a commitment to protection of the environment and the health of the people and to environmental justice for all, particularly the most vulnerable.

We welcome the Biden administration to this work. We appreciate the commitment of the President to restoring truth, considering science as a basis for its actions, and pursuing justice.

We live and work in communities across the US that are struggling with the burden of drinking water that is contaminated with PFAS chemicals. We represent the people and communities who are being contaminated by PFAS when it is released back into the environment by ineffective disposal and destruction technologies. EPA urgently needs to redress these problems.

We appreciate that the agency's Interim Guidance provides a credible review of commercially available destruction and disposal technologies that are currently being used for PFAS chemicals. It identifies many of the limitations of these technologies, though the discussion is opaque or overly positive in several instances.

EPA has made two very important findings in the Interim Guidance that deserve emphasis. One is that technologies and practices in use are not effective in destroying PFAS chemicals or containing them from re-release. The other is that

safe storage may be the best option at present. We urge EPA to take action necessary to address these findings, discussed in more detail below.

1. EPA finds that the available technologies cannot be viewed as capable of safely destroying or disposing of PFAS compounds.

The Interim Guidance reviewed “destruction” and “disposal” technologies. The discussion of destruction technology focused on thermal destruction including incineration. The review concluded that thermal technologies cannot be shown to safely destroy PFAS at this time with the data now available.

What this means is that existing widely-used practices including shipping unused PFAS-based fire fighting foams to incinerators and cement kilns cannot be seen to be successful destruction methods. Rather they are likely distributing PFAS chemicals, possibly in altered forms, back into the environment. This is not a surprising finding. PFAS chemicals may be the most persistent chemicals ever made and do not break down in the natural environment, because of the strength of the bond between carbon and fluorine atoms. Existing thermal treatment technologies were not designed or verified to break down such bonds. EPA correctly identifies technical issues and concerns about generation of toxic compounds during thermal processes. They are also not designed in many or most cases to retain emissions for testing and verification after the thermal process. This is an essential step for problematic compounds such as PFAS.

Similarly, the technologies intended to permanently confine PFAS chemicals from release back into the environment, referred to as “disposal” technologies, cannot be viewed as capable of doing so based on the information available now. Again, this is not a surprising finding. Unlike many highly persistent compounds, PFAS chemicals are also highly mobile as well as persistent. Methods of landfilling and deep well injection do not have systems that can be shown capable to stand for the centuries that the chemicals will persist. The extraordinary mobility of PFAS compounds require unprecedented measures to ensure that the chemicals “stay put” once they are disposed. Deep wells and landfills were not developed and verified for such compounds and can be expected to pose a continuing public health threat and clean up burden.

2. EPA concluded that it may be best, for some interim period, to gather and store PFAS materials using secure methods and active surveillance.

The Interim Guidance suggests that it is not advisable to continue to use unproven destruction technologies and inadequate disposal facilities at this time. Rather, it

suggests use of interim storage designed to ensure that releases do not occur. This would provide assurance that these compounds would not be further spread into the environment. EPA suggests a period of 2 to 5 years are needed to allow for research to continue to develop technologies capable of successfully destroying the compounds. This is an important finding that also needs to be clearly communicated to chemical waste managers, and elaborated in the inclusion of “best management practices” for stockpiled PFAS-waste.

The Agency is actively researching advanced technologies that destroy PFAS in contained systems, so effectiveness can be verified before the wastes are released into the environment. We support efforts to safely store wastes until such systems are validated.

While EPA’s Interim Guidance presents important findings and data gaps, it fails to consider the implications of these findings and identify urgent actions. Stronger action is urgently needed to address PFAS disposal.

The Interim Guidance fails to address the urgency of the PFAS waste problem. Specific guidance is needed to change course away from continued use of uncontained and unverified destruction or disposal technologies and toward interim monitored safe storage.

New guidance is needed immediately for all parties involved with management of unwanted PFAS materials. This is an urgent priority and cannot wait for a future revision of this document proposed to occur three years from now.

We ask the Agency to provide urgent guidance to the hundreds of managers who are actively considering how to handle waste chemicals and materials and to industries, local, state and federal governments, and communities facing decisions about their response to PFAS materials. EPA should act to ensure these efforts do not contaminate new sites or cause future contamination problems.

It will be important for EPA to address continuing practices by the Department of Defense (DOD). The Interim Guidance document was mandated by the US Congress in the National Defense Authorization Act of 2020. Congress created this mandate because the DOD has procured and used an enormous quantity of materials containing PFAS chemicals in fire fighting foam. These have contaminated water bodies and drinking water sources in communities all over the US. Incineration of unwanted PFOS-based foams poses hazards to people living near incinerator communities and adds to the global atmospheric burden of PFAS and fluorine-based greenhouse gases. The

DOD is under increasing pressure to clean up contaminated soils and groundwater near bases, and will ultimately need to replace millions of gallons of PFAS-based foams acquired to replace materials using PFOS chemistry.

*** EPA Should Address Impacts of PFAS Chemicals on Environmental Justice Communities and Vulnerable Populations**

PFAS disposal is indisputably an issue of environmental injustice as landfills and incinerators are often located near low-income communities and where people of color reside, as well as on or near Tribal lands and resources.

Releases of persistent and mobile compounds like PFAS contaminate medicinal and food plants, fish, shellfish, marine mammals and other traditional food sources that are vital for the physical, spiritual, and cultural sustenance of Indigenous peoples and other cultural and ethnic groups.

*** It is essential to reduce the threat of PFAS chemicals to human health and the environment, before they reach the point of requiring destruction or disposal**

It is time for EPA to recognize the need for a fundamentally different approach. EPA must treat PFAS as the dangerous substances that they are. PFAS need to be managed and regulated as persistent, toxic, often bioaccumulative and highly mobile chemicals. This means regulating them under major environmental statutes governing discharges to land, air and water.

In its guidance, it is important to acknowledge the direct connection between upstream regulation and downstream demand for disposal of PFAS-containing waste. For the most part, “upstream” releases of PFAS chemicals are still unregulated by EPA. This is profoundly inappropriate and negligent, given the adverse properties of these chemicals. Better management can minimize the amount of PFAS released into the environment and that ultimately require disposal. Only by controlling the manufacturing, use, release and disposal of PFAS chemicals can EPA meaningfully address the PFAS contamination.

EPA needs to take actions to better control their uses and to obtain information needed for detection, assessment, and characterization of PFAS. Below are examples of actions that are warranted by the dangerous traits of these chemicals:

- Halt PFAS incineration;
- Halt the approval of new PFAS chemicals and new uses of current PFAS chemical;

- Grant the pending petitions to list PFAS compounds as hazardous waste under RCRA;
- List PFAS as hazardous substances under CERCLA;
- Add PFAS chemicals to the list of Hazardous Air Pollutants and identify and regulate sources;
- Work with states to systematically identify existing sources of PFAS emissions and provide assistance to recover materials before they enter water bodies;
- Initiate a ban on using PFAS-based fire fighting foams where not required by federal law, and a require a take back program that safely contains these wastes until effective destruction technologies can be deployed locally;
- Engage with Congress to eliminate any provisions of federal law that require use of PFAS chemicals;
- Establish effluent limitation guidelines and pre-treatment standards under the Clean Water Act to control the discharge of PFAS chemicals into surface water and treatment works;
- Prohibit the land application of sewage sludge containing elevated PFAS chemicals;
- Stop allowing the transfer of landfill leachate to waste water treatment systems which are incapable of removing these and other persistent chemicals and which disperse this otherwise contained waste stream back into the environment when biosolids or sewage effluent are spread on agricultural or other lands;
- Ban the import and export of PFAS materials into and out of the US for disposal;
- Invest in destruction technologies that handle the waste in contained systems and can be deployed at the sites with contamination to minimize the injustices related to historic disposal siting.

*** Adverse Practices for Unwanted PFAS Are Widespread**

In the absence of action by EPA, current disposal and destruction techniques are spreading the harm of PFAS rather than reducing it. Adverse practices are happening every day and spreading the indestructible and long-lasting chemicals into the air water, wild lands and agricultural fields. In many cases, these chemicals are released in or near communities of color and lower income, adding to a legacy of environmental injustice. For example:

- The US Department of Defense contracted to [incinerate millions of gallons of unused PFOS-based fire fighting foams](#), despite the fact that it had no proof that incineration was effective or safe. Incineration locations were not publicly announced. Through FOIA requests, we learned that the DOD waste was largely sent to historically burdened incinerator communities in New York, Arkansas and Ohio.

- [Rhode Island and Massachusetts](#) collected about 20,000 gallons of PFAS-based AFFF, and sent the foam to a commercial fuel-blending facility in Ohio where it was blended into fuel. The products were ultimately incinerated in Covanta Waste-to-Energy facilities in Indianapolis, Indiana or Niagara, New York.
- After a recent [tank fire in the San Francisco Bay Area](#) wastewater containing PFAS-based fire fighting foams were collected and sent to Nevada, mixed with clay and deposited into a Class 1 landfill (solid, non-hazardous waste).
- In 2019, Chemours [imported an estimated 90 million gallons](#) of industrial waste containing PFOS-replacement GenX from the Netherlands. Much of the liquid waste was sent to Texas for deep well injection. Chemours has [spilled PFAS-containing liquid wastes](#) en route from North Carolina to Texas for injection.
- [Equova's carbon-filter reactivation facility](#) on the Colorado River Indian Tribes Reservation in Parker Arizona heats spent carbon filters in a high-temperature "carbon regeneration" furnace. The facility does not have to test air emissions for PFAS, claiming there are no standards for this and that PFAS are not RCRA-listed chemicals. Equova process wastewater is sent to the Parker treatment plant, which drains into the Colorado River.

PFAS are commonly detected in groundwater near municipal landfills, in landfill leachate, and in the biosolids produced from wastewater treatment, suggesting a broader intervention is needed to contain or collect PFAS from municipal waste to minimize threats to ground and surface water and agricultural lands.

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

Sincerely,

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DETAILED COMMENTS ABOUT EPA'S 2020 INTERIM GUIDANCE ON PFAS DISPOSAL

Section 1- Introduction

Section 1 of the draft interim guidance includes two important elements. It is the only place that EPA highlights its preference for “interim storage” in the 2-to-5 year timeframe for PFAS waste, which our organizations support as the safest and most rational option for highly concentrated waste until advanced destruction technologies are developed and validated. EPA should make this advice stronger and more prominent. It should also clarify best practices for monitored, safe storage that will allow managers to comply with this recommendation to safely hold stockpiles of unused firefighting foams or similarly concentrated wastes.

The section uses weak and passive language which obscures the agency's intent, suggesting managers “*could consider*” the destruction and disposal options in the order of lower uncertainty to higher uncertainty, placing deep well injection, hazardous waste landfills (RCRA Subtitle C) and solid waste landfills (RCRA Subtitle D) in the “*less uncertain*” category with hazardous waste and classifying thermal treatments as having “*higher levels of uncertainties.*”

EPA must rewrite Section 1 to clarify its findings and conclusions regarding the safety of current disposal practices, so that waste managers have a clear analysis of existing and future options for PFAS disposal. Specifically, EPA should clarify that “less uncertain” does not equate to “less dangerous,” in light of the known risks associated with PFAS injection and landfilling.

We request EPA immediately halt incineration and other thermal treatments until methods are developed to determine its safety (discussed in detail in Section 3a). At a bare minimum the agency must clarify language such as “PFAS-containing waste can potentially be treated in several types of thermal treatment devices, including HWCs, MWCs and SSIs, and carbon reactivation furnaces, but further research is planned to gain a better understanding of what may be possible in practice” (Interim Guidance, Page 58 – emphasis added).

Consistent with the findings in EPA's Interim Guidance, that introduction should be revised to state that:

“Scientists and regulators do not have the methods to gauge whether PFAS chemicals break down in HWCs, MWCs and SSIs, and carbon reactivation furnaces, or to determine the type of breakdown products that are formed under various heat, holding and pollution control practices. It will take several years for these analytical methods to be validated. In the meantime these technologies

should not be used because incomplete breakdown could release a complex mixture of highly problematic compounds into the environment.”

Section 2. Description of PFAS-containing materials

Section 2 makes clear that a vast amount of PFAS is produced, held and used in the United States.

EPA is not able to track with any certainty the identities and releases of these chemicals, nor the stocks of highly toxic materials like Class B AFFF foams that should be recalled and held to prevent contamination.

Even the most regulated long-chain PFAAs, a group of 172 chemicals largely phased out of production in the US and subject to TRI reporting, may still be “produced as unintentional byproducts and may persist in facility emissions as product impurities.” (Interim Guidance, page 19)

A larger number of virtually unregulated PFAS are manufactured or imported into the US. EPA’s estimate of 25,600 metric tons of production and import annually comes from self-reported data from 2015. The Agency’s estimate of holdings of PFOS-based AFFF of 4.6 million gallons is from 2004. EPA does not mention that the largest industrial holder, the US DOD, contracted to incinerate several million gallons of this foam in recent years. State-based surveys of fire stations make it clear that significant quantities of “legacy” PFOS-based foams are found in small and large municipal fire stations across the country. EPA must improve its tracking of these materials.

One challenge EPA should recognize in the Interim Guidance is the burden that secrecy protections and confidential business information claims pose to waste managers, as well as scientists. EPA has granted protection for industry claims that PFAS chemical identities should be kept confidential. As a result, chemical industry employees and downstream users lack information about the chemical identity and quantities of PFAS chemicals in products they purchase and handle. This secrecy may make it impossible for waste managers to make informed decisions to minimize use of dangerous chemicals or to Kallus employ proper disposal practices.

Scientists and regulators commonly have to go through complex analyses to determine the type and quantity of PFAS chemicals emitted by industrial facilities. A recent report involving complex chemical detective work by the state of New Jersey and EPA scientists identified new PFAS chemicals in soil near the Solvay Specialty Polymers facility in West Deptford New Jersey (Washington 2020). The chemicals were evidently used as replacements for PFNA as processing aids in fluoropolymer production.

Section 3. Technologies for the Destruction and Disposal of PFAS and PFAS-Containing Materials

3a. Thermal treatment

Even after sending millions of gallons of PFOS-based AFFF to hazardous waste incineration facilities, the federal government lacks data to determine whether PFAS chemicals are completely destroyed, whether harmful fluorinated byproducts are formed, and whether pollution control measures are adequate for capturing harmful products of incomplete combustion (PICs). The EPA summarized scientific uncertainties surrounding the thermal destruction of PFAS and determined that “information on the efficacy of PFAS destruction in these facilities is currently lacking.” We support this conclusion but believe it should be made more prominent in the draft guidance.

Below we share peer-reviewed studies that shed light on the risks posed by incomplete destruction in thermal systems. They include findings that PFAS could pass unchanged through incinerators, and that partial destruction of PFAS creates a multitude of harmful compounds that are acutely toxic to human health and/or potent greenhouse gases.

Ensuring the safety of thermal destruction methods is challenging for many reasons, but an important one is analytical limitations. We do not have methods to measure most of the potential byproducts and don't know what their chemical identities are. As many scientists state, “There are no proven analytical technologies which have been demonstrated to detect all potential fluoro-organic by-products,” (Horst 2020). Of particular concern are PFAS that get volatilized or transformed into volatile organofluorine compounds and escaped detection (Watanabe 2018). EPA is working to develop measurement methodologies to conclude whether potential PICs are adequately controlled, but the unregulated use of thermal methods has far outpaced this effort. EPA is woefully behind.

EPA itself acknowledges that breakdown products produced through the use of thermal methods for fluorinated compounds have different and more challenging and toxic qualities than those created when burning chlorinated compounds. While the agency just released a test method for PFAS in air from stationary sources (EPA 2021) it covers less than 30 discrete chemicals with in-stack detection limits (QRLs) ranging from 0.05 to 5.5 ng/m³. It is essential to measure the total amount of organic fluorine for gauging the uncaptured elements as well as potential for reformation of hazardous compounds after release from the stack. EPA states that this work is in its early stages of development. Managers will ultimately need analytical methods for the wide variety of harmful shorter-chain organic fluorine compounds.

This is not an abstract concern. Dozens of studies document a wide range of harmful chemicals post PFAS combustion. Testing in 2020 from Bennington College suggests that the Norlite incinerator facility, contracted by the Department of Defense to burn concentrated AFFF, was not fully destroying PFAS, but transforming and redistributing the compounds to the soils and water surrounding the community (Hogue, 2020).

Both academic studies and government agency reports have raised concerns that PFAS incineration can also release ozone-depleting chlorofluorocarbons, fluorinated greenhouse gases such as tetrafluoromethane, hexafluoroethane, fluoro-dioxins, fluoro-benzofurans, fluorinated aromatic compounds and perfluorinated carboxylic acids (California Department of Toxic Substances Control 2019; Ellis 2001; Feng 2015; Huber 2009; Merino 2016). In 2003, a study from Canada noted that incineration of fluoropolymers can release a “plethora of unidentified and previously unreported materials, thermolysis products that await characterization” (Ellis 2003). A Japanese research team investigated the fate of PFAS during thermal reactivation of granular activated carbon with absorbed PFOA, PFOS and 6-carbon perfluorohexanoic acid. The team reported that after treatment at 700 C, a significant portion of the original compounds was converted to volatile species that escaped the final analysis (Watanabe 2018). The specific profiles of fluorinated organic compounds released depend on incineration temperatures and operating conditions (García 2007; Wang 2013).

As noted in the Interim Guidance, laboratory experiments suggested a minimum temperature of 1000°C and a residence time of 2 seconds for destroying PFOS and PFOA in pilot scale laboratory conditions. We agree with EPA’s statement that studies that measure the destruction of certain PFAS compounds do “. . . not provide certainty that all carbon-fluorine bonds were severed.” In fact, the few industry-generated studies commonly cited as proof of PFAS breakdown also measured fluorobenzene, one- and two-carbon fluoroalkanes and fluoroalkenes as byproducts (Taylor 2003; Yamada 2005).

EPA’s guidance document acknowledges that highly stable compounds like CF4 require temperatures exceeding 1400°C, which is not typically achieved in a rotary kiln afterburner, GAC reactivation, or thermal oxidizer (Interim Guidance, Pages 35, 37, 38-39).

The draft guidance document should elaborate that the global warming potential of carbon tetrafluoride and other short chain byproducts are thousands of times more potent than carbon dioxide, which has a Global Warming Potential of 1 on this unitless scale (GGP 2016).

Fluorochemical	Global Warming Potential over 100-year time horizon*
Carbon tetrafluoride (CF4)	6,630
Fluoroform (CHF3)	12,400
Hexafluoroethane (C2F6)	11,100

Perfluoropropane (C3F8)	8,900
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* the Global Warming Potential of carbon dioxide is 1.

In considering any thermal treatment, EPA must account potential harms of emissions and discharges of products of incomplete combustion during non-normal operating conditions (upset conditions) including start up, shut down, malfunction or during equipment failure (NRC 2000). One study reviewed facility-specific data on pollutants emitted during startup and shutdown conditions. There was wide variability but 88 percent of facilities studied had vastly increased emissions of dioxins and furans, dioxin/furan precursors, and carbon monoxide during start up or shut down monitoring compared to normal operating conditions, likely due to incomplete combustion (Obaid 2017).

PFAS wastes are often poorly characterized mixtures of many PFAS chemicals. Concentrations can range from parts per billion to parts per hundred, in aqueous or solid form. These inconsistent feedstocks will further complicate thermal protocols.

In addition to the uncertainties surrounding PFAS destruction during thermal treatment, incineration also results in other wastes that require long-term containment. The portion of incineration byproducts stripped by emission control systems will end up in scrubber water and fly ash and bottom ash requiring perpetual storage in a secure location. Several studies find incineration reduces but does not eliminate the PFAS in fly ash residues, and the chemicals are found in leachate from landfills accepting incinerator ash (Solo-Gabriele 2020). Therefore, incineration does not terminate the management responsibilities for entities disposing of PFAS wastes.

While it may be appropriate to focus on the destruction of PFAS in concentrated forms, PFAS are known to be present in general waste and wastewater residues, which are often sent to municipal waste incinerators (193 facilities in the U.S.), sewage sludge incinerators (170 facilities), and carbon reactivation furnaces (17 facilities) where operating temperatures are not sufficient for PFAS destruction. This underscores the need for widespread testing and monitoring for PFAS in waste that is sent to all types of facilities, prior to incineration.

In light of this uncertainty, EPA must immediately work within its existing powers to halt PFAS incineration until methods are developed to gauge the effectiveness of thermal breakdown and the full range of potential products of incomplete combustion. It should adjust language in the Interim Guidance document to clearly discourage PFAS destruction by thermal treatment methods and name potential harms posed by incomplete destruction of PFAS chemicals and wastes.

3b. Landfill disposal

The landfill section, like others, describes a mix of serious safety and management challenges of PFAS, interspersed with overly positive statements like, “It is currently unclear if all landfills used for PFAS disposal have controls that are effective for managing PFAS discharges and emissions from waste streams” (Interim Guidance, Page 71, emphasis added).

Careful review of the section makes it clear that nearly every landfill contains some PFAS containing items, and almost none were specifically designed for PFAS storage. Instead, PFAS will persist in the long-term, posing inevitable management challenges.

There are also concerns about future landfill stability, due to the potential for greater precipitation and heavier storms associated with global climate change. Landfills may serve as a source of leaching PFAS pollution for decades in the future, making the current practice of landfilling a poor disposal option for long-lived PFAS compounds..

EPA’s document focuses on the disposal of concentrated PFAS wastes. Yet, the extensive use of the wide-array of PFAS-based products and materials, of which many are non-essential, produces a large quantity of PFAS-laden waste that ends up in landfills. Therefore, the majority, if not all landfills, in the U.S. likely contain PFAS. Inevitably, PFAS will end up in landfill leachate and groundwater near the landfill, and these will likely be worse near older, inactive landfills.

States including Michigan, Minnesota, California, and Vermont have investigated and found groundwater contaminated with PFAS from nearly every older non-hazardous landfill. PFAS exceeded 70 ppt in groundwater near over 20 landfill and dump sites in Michigan (Michigan Department of Environment Great Lakes and Energy, 2020). Of the landfills investigated in Minnesota, unlined municipal landfills that received industrial waste had the highest levels of PFAS in groundwater (Minnesota Pollution Control Agency 2010; Oliaei 2006). Vermont and California have also reported that drinking water has been impacted from PFAS from landfills. (Vermont Department of Environmental Conservation 2018, 2019, and California State Water Resources Control Board 2019).

In the U.S., landfill leachate is commonly collected and transferred to wastewater treatment plants, whereby PFAS and other contaminants in the leachate end up in wastewater effluent and in treated sewage sludge, aka biosolids. In turn, sewage sludge from wastewater treatment, if not applied to the land, is either transferred to landfills or incinerated. PFAS contaminants thus cycle between landfills and wastewater treatment, causing food and water pollution in the process. Capturing and treating PFAS in leachate at the landfill site reduces the migration off-site provided treatment residues can be safely stored.

PFAS can also volatilize into the air above landfills and other waste processing and disposal facilities and sites. The detection of PFAS in air emissions indicate that landfills, especially currently operating landfills, act as a source of atmospheric PFAS pollution (Tian 2018). More research is needed to address PFAS air emissions from historical landfills that no longer operate, as well as from different landfills types. Although studies of PFAS in air above landfills have been conducted in other countries, this research still needs to be done in the U.S.

The Interim Guidance noted that there are no federal requirements for the monitoring of PFAS in landfill waste, leachate or off-gassing from landfills. Regulations requiring testing and monitoring landfill sites are urgently needed and the actual extent of contamination remains unknown until monitoring data is collected. A limitation in many earlier studies was analytical capabilities. Testing for total PFAS, precursor compounds and degradation products is needed to understand the true extent of contamination. Monitoring of landfill leachate and air above landfills is necessary to determine the amount of PFAS being discharged from individual landfills. EPA should also 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. Finally, the problems associated with landfill disposal of PFAS reinforce the need for EPA to more stringently regulate PFAS upstream and thus reduce the amount of PFAS-containing waste that ends up in landfills.

3c. Underground injection

EPA's draft guidance determines that deep wells are "feasible and effective, *to varying degrees*, disposal options that normally should minimize migration of PFAS into the environment" (Interim Guidance, Page 85 - emphasis added) It concludes, "Research on the long-term fate and transport of PFAS (including precursors) to predict migration potential in the injection zone *could support* future permits." (Interim Guidance, Page 91 - emphasis added)

However, despite uncertainties and a lack of regulation, deep well injection is already occurring. While EPA doesn't track the complete volume of PFAS injected into deep wells for disposal, it does note that more than 50 million gallons of PFAS-containing waste have been injected into Class I hazardous waste wells in Texas, and an example of landfill leachate injected in Michigan. We have also seen documentation of injection of landfill leachate and for industrial wastewater from fluorochemical production facilities (Markley, 2019; Michigan Waste & Recycling Association, 2019; Texas Molecular, 2020), resulting in an urgent need for oversight.

Class 1 hazardous waste disposal wells 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 1987 GAO concluded, "...although there are few confirmed cases of drinking-water contamination, because the contamination is hard to detect, there could be more." 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 (GAO 2014). But only time will tell how many more will be found in the coming decades.

For example, 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'" (ProPublica 2012).

More research and transparency are needed on injection of PFAS waste into deep wells before the agency formally recommends it for disposal of liquid waste.

Section 4. Considerations for Potentially Vulnerable Populations Living Near Likely Destruction or Disposal Sites

EPA identifies several types of vulnerabilities that might intensify risks of PFAS exposure. They are related to race, income, health status, age, occupation, consumption of subsistence foods, and other factors.

However, section 7361 of the FY 2020 National Defense Authorization Act said that the EPA must consider "potentially vulnerable populations *living near* likely destruction or disposal sites" when preparing the interim guidance document, which EPA has failed to do. The guidance document should go beyond the generalized statement. It should identify the locations of PFAS "disposal," including fixed sources like incinerators, other thermal technologies, deep well injection sites, or landfills. EPA should determine which of these are sited in lower income communities, communities of color and Tribal lands. Our review of both municipal and hazardous waste incinerators shows they are more likely to be located in these "overburdened" communities - where the toll of poverty and racism combine with a legacy of harmful pollution and a history of being a receiving ground for the nation's waste (Martuzzi 2010; Saha 2005). Incinerators that have received PFAS waste include the Hazardous Waste Corridor in Toole County of western Utah adjacent to the Skull Valley Indian reservation; the petrochemical complex

surrounding the overburdened community of Port Arthur Texas; and the East Liverpool incinerator on the Ohio River.

In addition to ensuring the nation's PFAS waste is not distributed to overburdened communities, EPA should also not use these communities as testing grounds for experimental studies on the success or failure of existing thermal technologies. Just last year, EPA attempted to test the incineration of PFAS analogues in the environmental justice community of Rahway, New Jersey. While that experiment was cancelled in response to local opposition, the use of overburdened communities as test subjects perpetuates environmental racism and undermines President Biden's commitment to "secure environmental justice ... for disadvantaged communities that have been historically marginalized and overburdened by pollution." EPA's Interim Guidance should clarify that any testing of incineration or other PFAS disposal technologies should be designed with environmental justice principles in mind, and should not add to the burdens facing communities of color and other environmental justice communities.

Section 5. Planned Research and Development on Destruction and Disposal Technologies for PFAS and PFAS-Containing Materials

Section 5 outlines an ambitious list of research gaps and needs, and the agencies' intentions to fill them. We fully support these efforts. EPA should also consider research and guidance about safe transportation and storage of PFAS-containing wastes.

Additional sections needed

EPA should develop another document section, (Section 6), which names the immediately actionable management practices that are necessary to contain PFAS, appropriately manage existing stocks and uses, and minimize the production of new PFAS chemicals until the research items in Section 5 are completed and the chemicals can be safely managed throughout their lifecycle. This section would ideally include items within the agency's purview and those that require action by other Federal agencies, States, chemical manufacturers, DOD, or Congress.

References:

California Department of Toxic Substances Control, 2019. Product - Chemical Profile for Carpets and Rugs Containing Perfluoroalkyl or Polyfluoroalkyl Substances.

https://dtsc.ca.gov/wp-content/uploads/sites/31/2020/02/Final_Product-Chemical_Profile_Carpets_Rugs_PFASs_a.pdf

Ellis, et al. 2001. Thermolysis of fluoropolymers as a potential source of halogenated organic acids in the environment. *Nature* 412 (6844), 321e324.
<https://doi.org/10.1038/35085548>

Ellis, et al. 2003. The use of ¹⁹F NMR and mass spectrometry for the elucidation of novel fluorinated acids and atmospheric fluoroacid precursors evolved in the thermolysis of fluoropolymers. *Analyst* 128 (6), 756e764.
<https://doi.org/10.1039/B212658C>

Environmental Protection Agency (EPA). 2021. Other Test Method 45 (OTM-45) Measurement of Selected Per- and Polyfluorinated Alkyl Substances from Stationary Sources. https://www.epa.gov/sites/production/files/2021-01/documents/otm_45_semivolatile_pfas_1-13-21.pdf

Feng M., et al. 2015. Characterization of the thermolysis products of Nafion membrane: a potential source of perfluorinated compounds in the environment. *Sci. Rep.* 5, 9859.
<https://doi.org/10.1038/Srep09859>

GAO. 2014. EPA Program to Protect Underground Sources from Injection of Fluids Associated with Oil and Gas Production Needs Improvement. GAO-14-555.
<https://www.gao.gov/products/GAO-14-555>

García, et al. 2007. Products obtained in the fuel-rich combustion of PTFE at high temperature. *J. Anal. Appl. Pyrol.* 80 (1), 85e91.
<https://doi.org/10.1016/j.jaap.2007.01.004>

Greenhouse Gas Protocol. 2016. Global Warming Potential Values.
https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

Hogue, C. 2020. Incineration may spread, not break down PFAS. *Chemical & Engineering News*. <https://cen.acs.org/environment/persistent-pollutants/Incinerators-spread-break-down-PFAS/98/web/2020/04>

Horst, et al. 2020. Understanding and Managing the Potential By-Products of PFAS Destruction. *Groundwater Monitoring & Remediation*.
<https://ngwa.onlinelibrary.wiley.com/doi/abs/10.1111/gwmr.12372>

Huber, S., et al. 2009. Emissions from Incineration of Fluoropolymer Materials - A Literature Survey. Norwegian Institute for Air Research Report # OR 12/2009.
https://www.researchgate.net/publication/267737177_Emissions_from_incineration_of_fluoropolymer_materials_-_A_literature_survey

Markley, M. 2019. The basics of deep well injection as a leachate disposal option - technical, economic and regulatory considerations 2019 World of Coal Ash, Covington,

Kentucky. <https://www.scsengineers.com/wp-content/uploads/2019/06/Deep-Disposal-Well-Considerations-for-Leachate-Management-Jun-2019.pdf>

Martuzzi M., et al. 2010. Inequalities, inequities, environmental justice in waste management and health. *European Journal of Public Health*, Vol 20:1, February 2010, <https://doi.org/10.1093/eurpub/ckp216>

Merino, et al. 2016. Degradation and removal methods for perfluoroalkyl and polyfluoroalkyl substances in water. *Environ. Eng. Sci.* 33 (9), 615e649. <https://doi.org/10.1089/ees.2016.0233>

Michigan Department of Environment Great Lakes and Energy. 2020. PFAS Sites. Retrieved April 20, 2020 from https://www.michigan.gov/pfasresponse/0,9038,7-365-86511_95645---,00.html

Michigan Waste & Recycling Association. 2019. Statewide Study on Landfill Leachate: PFOA and PFOS Impact on Water Resource Recovery Facility Influent. <https://www.bridgemi.com/sites/default/files/mwra-technical-report.pdf>

Minnesota Pollution Control Agency. 2010. 2005-2008 Perfluorochemical Evaluation at Solid Waste Facilities in Minnesota Technical Evaluation and Regulatory Management Approach. <https://www.pca.state.mn.us/sites/default/files/c-pfc4-01.pdf>

National Academy of Sciences (NAS). 2000. Waste Incineration and Public Health. National Research Council. <http://www.nap.edu/catalog/5803.html>

Obaid, et al. 2017. Comparing non-steady state emissions under start-up and shut-down operating conditions with steady state emissions for several industrial sectors: A literature review. *Energies*. 10(2):179. <https://www.mdpi.com/1996-1073/10/2/179>

Oliaei, F., et al. 2006. Investigation of Perfluorochemical (PFC) Contamination in Minnesota Phase One. <https://www.leg.state.mn.us/archive/leg/minutes/database/84-s-1261-0-20060227-a.pdf>

ProPublica. 2012. Injection Wells: The Poison Beneath Us. <https://www.propublica.org/article/injection-wells-the-poison-beneath-us>

Saha, R. Mohai, P. 2005. Historical Context and Hazardous Waste Facility Siting: Understanding Temporal Patterns in Michigan. *Social Problems*. 52:4 618-648. <https://doi.org/10.1525/sp.2005.52.4.618>

Solo-Gabriele, H. M., et al. 2020. Waste type, incineration, and aeration are associated with per- and polyfluoroalkyl levels in landfill leachates. *Waste Management*, 107, 191-200. <https://doi.org/10.1016/j.wasman.2020.03.034>

Stoiber, T., Evans, S., & Naidenko, O.V. (2020). Disposal of products and materials containing per- and polyfluoroalkyl substances (PFAS): A cyclical problem. *Chemosphere*, 260, 127659. <https://doi.org/10.1016/j.chemosphere.2020.127659>

Taylor, P and Yamada, T. 2003. Final Report - Laboratory Scale Thermal Degradation of Perfluoro-Octanyl Sulfonate and Related Precursors. University of Dayton Research Institute (UDRI) May 2003.

Taylor P, et al. 2014. Investigation of waste incineration of fluorotelomer-based polymers as a potential source of PFOA in the environment. *Chemosphere* 110, 17e22. <https://doi.org/10.1016/j.chemosphere.2014.02.037>

Texas Molecular. 2020. PFAS Disposal Solution for Wastewater, Leachate, Groundwater, and Fire Fighting Water. Texas Molecular. Retrieved April 20, 2020 from <http://texasmolecular.com/pfas/>

Tian, Y, et al. 2018. Occurrence and Phase Distribution of Neutral and Ionizable Per- and Polyfluoroalkyl Substances (PFASs) in the Atmosphere and Plant Leaves around Landfills: A Case Study in Tianjin, China. *Environmental Science & Technology*, 52(3), 1301-1310. <https://doi.org/10.1021/acs.est.7b05385>

Vermont Department of Environmental Conservation. 2018. Perfluoroalkyl Substances (PFAS) Contamination Status Report. <https://legislature.vermont.gov/Documents/2020/WorkGroups/House%20Natural/Reports%20and%20Resources/W~DEC,%20Agency%20of%20Natural%20Resources~PFAS%20Contamination%20Status%20Report~1-15-2019.pdf>

Vermont Department of Environmental Conservation. 2019. Per and Polyfluoroalkyl Substances (PFAS) Statewide Sampling Plan. <https://dec.vermont.gov/announcement/PFAS-sampling-plan>

Wang, et al. 2013. Mineralization behavior of fluorine in perfluorooctanesulfonate (PFOS) during thermal treatment of lime-conditioned sludge. *Environ. Sci. Technol.* 47 (6), 2621e2627. <https://doi.org/10.1021/es305352p>

Washington J W, et al., 2020. Nontargeted mass-spectral detection of chloroperfluoropolyether carboxylates in New Jersey soils. *Science*. 368:1103-07.

Watanabe, et al. 2018. Thermal mineralization behavior of PFOA, PFHxA, and PFOS during reactivation of granular activated carbon (GAC) in nitrogen atmosphere. *Environ. Sci. Pollut. Res. Int.* 25 (8), 7200e7205. <https://doi.org/10.1007/s11356-015-5353-2>

Yamada, T, et al. 2005. Thermal degradation of fluorotelomer treated articles and related materials. *Chemosphere* 61 (7), 974e984. <https://doi.org/10.1016/j.chemosphere.2005.03.025>

