HSST Committee Hearing
December 7, 2021
"Forever Chemicals: Research and Development for Addressing the PFAS Program"
Written Testimony of Amy Dindal, Battelle Memorial Institute

Chairwoman Sherrill and Chairwoman Stevens, Ranking Member Bice and Ranking Member Waltz, thank you for the opportunity to testify before the Subcommittee on Environment and the Subcommittee on Research and Technology. My name is Amy Dindal, and I am the Director of Environmental Research and Development at Battelle. Battelle is a non-profit 501(c)3 organization that was established more than 90 years ago through an Ohio charitable trust. The Battelle Memorial Institute was the vision of a metallurgist, Gordon Battelle, who had a passion for both science and philanthropy. We are the world's largest, independent, nonprofit research and development organization and deliver innovative science, technology and engineering outcomes to help solve our nation's most difficult challenges. Our mission is to translate scientific discovery and technology advances into societal benefits. Our primary customer is the federal government, supporting basic research and applied science and technology. We have supported EPA as a contractor to the Office of Research and Development for more than 40 years. Our charitable mission is extremely important to Battelle. As a non-profit, we invest significant resources into STEM education through our national STEMx network across nineteen states and the Army Educational Outreach Program. Our goal is to reach one million students by 2025, and we are well on our way to reaching that goal. We also invest heavily in internal research to address tomorrow's threats. Tackling the current and future technology and research challenges of PFAS is true to our mission and the DNA of Battelle. We are also closely aligned with the EPA's directive in its PFAS Strategic Roadmap to 'invest in research, development, and innovation that incorporate the best available science', and I am proud to share with you today the advancementswe have made.

Our awareness of PFAS began more than a decade ago when we were supporting a site investigation at a Navy site in Pennsylvania. There was a mysterious foam coming out of an air stripper at the site. We sent the foam to our laboratory in Massachusetts, where it was identified as containing PFOA and PFOS. It was then that we began tracking this suite of chemicals as an emerging contaminant. We first invested in analytical techniques so that we could detect and measure the compounds, and in 2018 became the first laboratory to gain accreditation under the DoD Environmental Laboratory Accreditation Program for measuring PFAS in drinking water using the newly revised EPA Method 537.1. In 2019 we made a corporate commitment through a multi-year, multi-million dollar investment to develop new technology and capabilities around PFAS. We looked to the US Department of Defense's (DoD's) current and future needs to frame where we would invest in new technology for PFAS. In September 2017, DoD published a summary of the "SERDP and ESTCP Workshop on Research and Demonstration Needs for Management of AFFF-Impacted Sites." The critical priority needs described in that document informed the framework for our investments in PFAS, which continue today. Below I have provided a summary of the technologies we have developed to measure, sample, model, track, and treat PFAS. Each technology has a role in supporting current and future site investigation and remediation needs at both government and commercial sites. The technologies and methodologies include:

- Three offerings in advanced analytical techniques. These technological advances are critical to accurately identifying and/or quantifying PFAS in a variety of matrices.
    - Our DoD and state-accredited laboratory in Massachusetts has analyzed more than 42,000 samples for PFAS. In addition to traditional water and soil matrices, we work with complex matrices such as landfill leachate, environmental tissues, and vegetation.
    - We developed a totalorganofluorine method to assess total PFAS. Since only a limited number of PFAS analytes can be quantified using known analytical standards, there is a growing need for a holistic approach to quantify the total fluorine present in

environmental samples. Total PFAS measurements delineate the full inventory of PFAS at a site (e.g., perfluoroalkyl acids [PFAA] precursors, novel or unknown PFAS).

- Our most sophisticated analytical technique is a technology called PFAS Signature®, which combines high-resolution mass spectrometry with machine learning. PFAS Signature™ can determine if the site has been contaminated from Aqueous Film Forming Foam (AFFF) sources and non-AFFF sources such as landfills, wastewater effluent, and chemical manufacturing. The technology does this by looking for nearly 500 different PFAS through non-targeted suspect screening. Our innovation is in the data filtering and interpretation through advanced statistical techniques, which allow us to isolate the chemicals of interest from the tens of thousands of data points produced by the high-powered instrumentation. Application of this tool will better define and characterize source areas to improve the conceptual site model (CSM), fill data gaps, and provide a more robust picture of PFAS distribution beyond the targeted list of analytes and fate and transport of PFOA and PFOS.

- Because of the unique properties of PFAS chemicals, we also have developed sampling technologies to provide tools to characterize PFAS in a variety of matrices, including:
  - A passive sampler for surface and groundwater. As more detailed remedial investigations proceed, a significant amount of investigation-derived waste will be created. Passive samplers could help avoid this cost as waste is not generated. What makes passive sampling particularly beneficial in these applications is improved detection limits when compared to grab sampling, time-integrated results, and easy separation of only the most bioavailable, freely dissolved fraction of the contaminants. All these benefits translate into more reliable sampling at a reduced cost.

    - We also developed a sampler for ambient air to understand potential exposures and inform possible human and environmental health risks.
- Understanding the behavior of PFAS in groundwater has been identified as a key challenge in developing better knowledge about these chemicals of concern. Battelle created a tool called PFAS Predict™ that aims to help with that understanding. It is a tool that tracks and simulates PFAS transport in groundwater. It is capable of forward or backward tracking of the PFAS plume, and it can be used to predict future migration patterns over a span of time.
- Battelle has also pioneered a method of reactivating granular activated carbon (GAC) on-site. This innovative approach to GAC regeneration reduces operating costs and lengthens the life of a traditional GAC filtration system for drinking water treatment by allowing the GAC to be reused multiple times.

One of Battelle's most significant investments over the past two years is the development of a PFAS destruction technology. Our transformational innovation is powered by supercritical water oxidation (SCWO), which breaks the strong carbon-fluorine bonds within PFAS molecules and decomposes the material into a non-hazardous waste stream. SCWO is not a new technology, as it has been used since the 1980s to address difficult to treat compounds. What is new is the application and optimization of the technology for PFAS. In December 2020, the EPA issued interim guidance on suggested technologies for PFAS management. In addition to supercritical water oxidation, mechanochemical degradation, electrochemical oxidation and pyrolysis and gasification were highlighted as promising destruction solutions that merit further research and analysis. Others, like Allonnia, are attracting investment capital to innovate with synthetic biology. SCWO offers significant benefits for the environmental remediation and waste management industries. We call the technology “PFAS Annihilator” as it destroys PFAS in contaminated water to non-detect levels in seconds, leaving inert salts and PFAS-free water behind. Once the treated water has been tested to confirm that the PFAS have been destroyed, it can be safely discharged back into the environment. In addition to reducing liability, destroying PFAS to the lowest levels of detection ensures compliance, regardless of regulatory limits. Battelle's PFAS Annihilator system is housed in either fixed or mobile units that can be deployed to address on-site destruction needs. We have been testing the technology in the laboratory for more than two years. Battelle is preparing for field-testing a mobile SCWO system in January capable of treating up to 500 gallons per day of PFAS-contaminated liquids. We are also constructing a second mobile unit that will be able to treat up to 5,000 gallons per day. Because we are a non-profit, Battelle is able to collaboratively work with EPA on this important research. We have proposed demonstration projects to DoD's SERDP and ESTCP programs jointly with the U.S. EPA Office of Research and Development as a co-Principal Investigator. This enables EPA to actively contribute to the research and demonstrations needs, and stay current on technology improvements and progress.

DoD and EPA should be commended for their close collaboration on PFAS research. Considerable progress has been made through this collaboration. We would like to propose three additional opportunities to support the development of detection, monitoring, treatment, and destruction methods and technologies for PFAS.

1) Increasing the number of opportunities for field demonstrations of innovative technologies. Two weeks ago, EPA published a paper in the Journal of Environmental Engineering (Supercritical Water Oxidation as an Innovative Technology for PFAS Destruction | Journal of Environmental Engineering | Vol 148, No 2 (ascelibrary.org)) describing the efficacy of SCWO systems, including Battelle's Annihilator, to reduce PFAS concentrations in AFFF. The findings showed "a greater than 99% reduction of the total PFAS identified", demonstrating the promise of this technology for PFAS destruction. The federal government can further support the development of detection, monitoring, treatment, and destruction methods and technologies for PFAS by increasing the number of on-site demonstrations for technologies that are showing promising results. Technologies that are proven in the laboratory may not be equally successful in the field, so it is imperative that field demonstrations are executed as early in the technology development lifecycle as possible. Taking an aggressive approach to field promising technologies will prove out those technologies which are fieldable solutions. Those that do not succeed in early attempts will 'fail fast' and have an opportunity to address shortcomings. It is important to test technologies under multiple site conditions as there can be significant variations in geology and contaminant composition from site to site, which can impact technology performance. More technology performance data will increase confidence in these new approaches and ultimately accelerate cleanup timelines . One of EPA's recommendations in its December 2020 guidance on Destruction and Disposal of waste materials was interim storage if immediate disposal was not imperative. Stored waste creates an opportunity for promising technologies to be tested for various volumes and a variety of waste streams.

2) **Utilize available advanced analytical techniques to increase known information early in the investigation process, which will ultimately reduce time and cost.** Battelle also supports the need for the objective described in EPA's PFAS Roadmap to develop and validate additional methods to detect and measure PFAS in the environment. By following the structure of the CERCLA/Superfund process for site clean-up, the federal government has made considerable progress using targeted PFAS methods to understand which federal sites have PFAS impacts to address. Unlike historical contaminants like chlorinated solvents, the level of PFAS characterization needed is greater than we have seen for past environmental contaminants because PFAS are a more complex class of chemicals. Enhanced site investigation will increase the understanding of background levels of PFAS, provide information on potential sources, and further define the plume of contamination. This includes the use of high-

resolution mass spectrometry, which can provide information on non-target PFAS, and "total PFAS" methods that can measure the sum without identifying specific PFAS through the measurement of total organic fluorine. Considering all of the CERCLA stages to achieve site closure, it is estimated that there will be a reduction in sampling and analytical costs by deploying more informative advanced analytical technologies earlier in the investigation process. In addition to cost savings, the application of such an integrated set of methods allows site owners to make better informed decisions and provide greater flexibility in determining the extent of PFAS contamination at the site.

3) Leverage federal and private-sector partnerships and collaboration to drive forward solutions. More formal and deliberate federal government partnering with non-profit organizations (like Battelle) will be beneficial to achieve scale and accelerated action. For example, Battelle has demonstrated the ability to quickly test, finalize design and scale technology early in the pandemic when Battelle brought forward a technology that could decontaminate N-95 masks when these critical personal protective equipment were not available for front-line healthcare workers (Reference: Battelle CCDS Critical Care Decontamination System™ Services now Available at No Charge| Battelle Press Release). As a result, millions of masks were cleaned and reused at a time when N95 masks would otherwise not have been available. A similar model can be applied to PFAS for promising destruction technologies that are ready for scaling.

Battelle's development of technologies to monitor, sample, and destroy PFAS is indicative of the progress that can be made with focused commitment. Battelle and others are working relentlessly to bring these types of permanent solutions to life. Addressing these resilient and pervasive substances in our environment is not easy, but with more opportunities to test promising technologies in a real-world environment, an openness to utilizing new approaches, and enhancing collaboration opportunities, it can and will be done.