TECHNOLOGY ASSESSMENT

Persistent Chemicals

Technologies for PFAS Assessment, Detection, and Treatment

Highlights of GAO-22-105088, a report to congressional requesters

July 2022

Why GAO did this study

PFAS are a large group of heat and stain resistant chemicals, first developed in the 1940s. PFAS are used in a wide range of products, including carpet, nonstick cookware, waterproof clothing, and firefighting foam used at airports and military bases. PFAS can persist in the environment, including in water, soil, and air, for decades or longer. The Centers for Disease Control and Prevention has found that most people in the U.S. have been exposed to two of the most widely studied PFAS, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Both have been linked to human health problems.

GAO was asked to conduct a technology assessment on PFAS assessment, detection, and treatment. This report examines (1) technologies for more efficient assessments of the adverse health effects of PFAS and alternative substances; (2) the benefits and challenges of current and emerging technologies for PFAS detection and treatment; and (3) policy options that could help enhance benefits and mitigate challenges associated with these technologies.

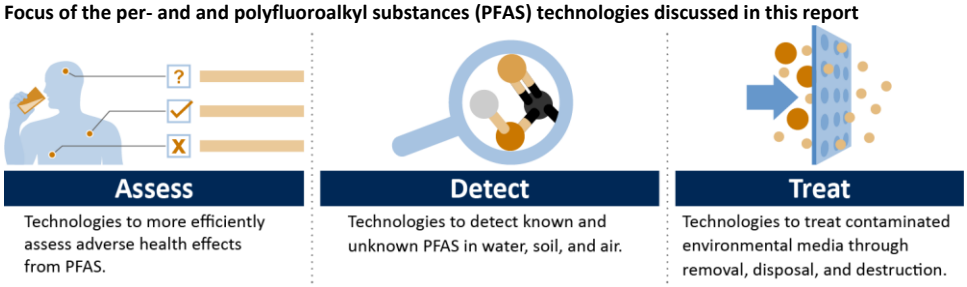
GAO assessed relevant technologies; surveyed PFAS subject matter experts; interviewed stakeholder groups including government, non-governmental organizations, industry, and academia; and reviewed key reports. GAO is identifying policy options in this report.

View GAO-22-105088. For more information, contact Karen L. Howard at (202) 512-6888 or howardk@gao.gov or J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

What GAO found

Current and promising technologies and methods could accelerate assessment of human health effects caused by per- and polyfluoroalkyl substances (PFAS) and improve the detection and treatment of PFAS in the environment. However, these technologies and methods face key challenges that hinder effective management of PFAS.

Focus of the per- and and polyfluoroalkyl substances (PFAS) technologies discussed in this report



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Assessment. Technologies that may accelerate assessment of PFAS health effects include high-throughput assays—automated testing methods that rapidly evaluate a large number of chemicals—and machine learning, which may help improve on technologies that predict health effects based on the effects of similar molecules.

Detection. Current technologies for detecting PFAS can reliably quantify about 50 specific PFAS, but these technologies are unable to detect or quantify the thousands of other PFAS known to exist. EPA requires reliable samples, known as analytical standards, to develop PFAS detection methods. However, researchers and agencies are developing new detection methods that do not need analytical standards and can screen for or quantify unknown PFAS. These methods include high-resolution mass spectrometry and total fluorine analysis.

Treatment. PFAS treatment can involve removal of PFAS from contaminated media, followed either by disposal in landfills or destruction by incineration. There are full-scale, proven treatment technologies that can remove PFAS from drinking water. But these technologies also leave behind PFAS-contaminated residual materials that must be disposed of or destroyed. Emerging technologies may be more effective, but none have been demonstrated at full scale, and most are still being researched.

GAO developed three policy options (see next page) to address the following challenges with PFAS-related technologies:

- PFAS chemical structures are diverse and difficult to analyze for health risks, and machine learning requires extensive training data that may not be available.
- Researchers lack analytical standards for many PFAS, limiting the development of effective detection methods.
- The effectiveness and availability of disposal and destruction options for PFAS are uncertain because of a lack of data, monitoring, and guidance.

GAO developed the following three policy options that could help mitigate challenges associated with PFAS assessment, detection, and treatment technologies. These policy options involve possible actions by policymakers, which may include Congress, federal agencies, state and local governments, academia, and industry. See below for details on some of the policy options and relevant opportunities and considerations.

Policy Options That Could Help Enhance Benefits or Mitigate Challenges of PFAS Assessment, Detection, and Treatment Technologies

Policy Option	Opportunities	Considerations
Promote research (report p. 35) Policymakers could support development of technologies and methods to more efficiently research PFAS health risks. *This policy option could help address the challenge of limited information on the large number and diversity of PFAS, as well as a lack of standardized data sets for machine learning.*	• Promoting research on predictive methods could allow researchers to more efficiently assess PFAS classes rather than individually. • Integrating existing PFAS health information from multiple studies could result in more efficient health assessments of the wide range of PFAS. • Supporting technologies for more efficient research could also improve the assessment of alternatives to PFAS.	• Computer models for more efficiently researching PFAS may not be sufficient on their own to accurately assess health effects, because of a lack of scientific knowledge on the behavior of PFAS in the human body. • Researchers lack complete data sets to train and validate machine learning models, which are needed before such models can be used for PFAS assessment.
Expand method development (report p. 36) Policymakers could collaborate to improve access to standard reference samples of PFAS, known as analytical standards and increase the pace of method and reference sample development for PFAS detection. *This policy option could help address the challenges of a lack of validated methods in media other than water, lack of analytical standards, and cost, which all affect researchers' ability to develop new detection technologies.*	• Supporting efforts by federal and independent laboratories to develop reference samples for known PFAS could increase access to available and affordable analytical standards for researchers. • Enabling researchers to accelerate development of new detection methods for media other than water could enable researchers to discover and reliably characterize more PFAS. • Enabling development and finalization of a standard method for high resolution mass spectrometry could enable better screening and identification of PFAS in the environment.	• Private industry has been reluctant to provide analytical standards, many of which are considered proprietary, hindering the development of detection methods. • High costs for PFAS testing may deter private well owners and smaller water utilities from testing.
Support full-scale treatment (report p. 37) Policymakers could encourage the development and evaluation of full-scale technologies and methods to dispose of or destroy PFAS. *This policy option could help address the challenges of cost and efficiency of disposal and destruction technologies and a lack of guidance from regulators.*	• Supporting optimization of full-scale disposal and destruction technologies for PFAS by encouraging finalization of EPA methods could improve PFAS monitoring during incineration. • Encouraging the development of guidance to improve monitoring at landfills could help prevent future contamination. • Accelerating the development and sharing of performance and cost models for disposal and destruction of PFAS and promoting treatment could help stakeholders plan for future costs.	• Technologies for destroying PFAS could be difficult to implement at scale, due to the lack of guidance from regulators. • In the absence of effective controls, landfills may release PFAS into the environment over time. • Guidelines currently vary by a considerable amount across the U.S. and may drive up the cost of PFAS disposal and destruction.

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