

What to do if you have PFAS at your Brownfield Site?

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Does the presence of PFAS (or perfluoroalkyl and polyfluoroalkyl substances) at a Brownfield site mean the site cannot be successfully investigated and redeveloped under the Pennsylvania Act 2 Program?

Thankfully, the answer is no but due to the rapidly evolving world of PFAS there are many items to consider at the beginning of the project. These considerations include:

- Does the site history indicate that PFAS is likely to be present?
- What PFAS compounds (if any) should be sampled?
- Are there potential background or offsite PFAS contributors?
- Which PFAS compounds (if any) should be included in the release of liability?
- Will disposal of soils or obtaining a NPDES permit trigger additional PFAS sampling and costs?



Figure 1- Typical Brownfield Site

Another consideration for potential PFAS impacts at the start of a Brownfield project is how likely can remediation be completed since current

PFAS technologies are generally focused on point source treatment of water. PFAS soil remediation technologies are not widely deployed, and while there are some exciting developments in this area, integration of a pathway elimination approach may be important to the planned redevelopment from the start.

PFAS Overview

PFAS have been manufactured on a commercial scale since the 1950s.¹ Longer chain PFAS, or PFAS with more carbon atoms, were replaced by shorter chain and partially degradable “precursor” PFAS in the U.S. due to potential concerns of health and environmental impacts of the longer chain PFAS. U.S. manufacturers specifically phased out PFOA and PFOS production between 2000 and 2015, but these compounds are still produced world-wide and can still be found in many products, leading some states to commercially ban intentionally added PFAS.² The unique properties of PFAS resulted in oil, water, stain, and soil repellency, chemical and temperature resistance, friction reduction, and surfactant properties that cannot be matched by other chemicals which is why PFAS remain in a wide range of products and industries.³ The stable C-F bond found in these substances also make PFAS difficult to degrade and mobile in the environment. PFAS are found at elevated levels in wastewater treatment plants and landfills that receive PFAS-containing effluents and wastes, and hence are commonly detected in surface water.⁴ Decades of releases to the environment have also led to detectable “background” levels of PFAS in surface soils.

People often think PFAS means PFOS and PFOA since they were the first PFAS compounds to be regulated by many states and come to the attention of the public. However, PFAS are actually a class of almost 15,000 compounds which have been identified as PFAS in the EPA’s CompTox Chemicals Dashboard.⁵ While hundreds to thousands of these PFAS compounds are being studied by academia and the EPA, limited PFAS compounds have an EPA approved analytical method to be used in site characterization at Brownfield sites. The current approved EPA analytical methods for PFAS in soil and groundwater are shown in Table 1. The list of PFAS with targeted analyses is expanding; however, and the addition of more PFAS compounds in targeted analysis is expected over the next few years. Additional target analytes may influence how many PFAS compounds are analyzed for at Brownfield sites. The Total Oxidizable Precursor (TOP) Assay is an analysis that oxidizes all PFAS compounds in a sample to targeted PFAS compounds to help identify the total amount of PFAS present at the Site, most of which may not be detected by current analytical methods. The TOP assay has been used at Superfund sites and maybe be a tool for certain Brownfield sites.

Lab Method	Status	Media
Method 553	Final	25 PFAS in drinking water
Method 537.1	Final	18 PFAS in drinking water (UCMR 5 requirements)
Method 8327	Final	24 PFAS in non-drinking water
Method 1633	Final	40 PFAS (wastewater, SW, GW, soil, biosolids sediment, leachate, fish tissue)

Table 1- Current EPA Analytical Methods for Soil and Groundwater

PFAS can exist as acids, anions, cations, and zwitterions and the ionic state of the PFAS can influence its fate and transport, along with conditions in the subsurface such as interfacial air/water tension in unsaturated soils.⁶ During fate and transport, some PFAS can undergo environmental transformation, such that the precursor in the original product will transform into intermediate products and then finally to terminal end

products such as PFOS and PFOA.³ Research is ongoing to quantify the environmental transformation rates, but they are dependent on-site specific conditions which can vary for different PFAS compounds. Due to these environmental transformations, even though production of PFOA and PFOS have been phased out, there is the potential at some sites for concentrations of PFOS and PFOA in soils and or groundwater to increase due to the transformation of the precursor and intermediate products. Due to the technical complexities of PFAS, designing a site investigation for PFAS can be quite challenging, but it can be successfully accomplished, as is discussed further below.

The technical challenges related to PFAS are further complicated by the rapidly evolving regulatory landscape for PFAS, summarized below:

- Initially in 2009, the EPA issued Drinking Water Health Advisories (HAs) for PFOA and PFOS, were reduced to a single 70 parts per trillion (ppt) sum for the two compounds in 2016.
- In accordance with PADEP regulations, the PADEP developed soil and groundwater MSCs for PFOA and PFOS based on the 70 ppt HA.
- In January 2024, Pennsylvania issued its first state maximum contaminant levels (MCLs) for PFOA (14 ppt) and PFOS (18 ppt), which then became the Groundwater Medium-Specific Concentrations (MSCs) for these PFAS compounds. The soil MSCs remained unchanged from the 2016 MSCs since they are calculated and need to go through the regulatory approval process.
- In June 2024, the EPA established federal MCLs for PFOA (4ppt), PFOS (4 ppt), PFHxS (10 ppt), PFNA (10 ppt), Gen X (10 ppt) and the novel Hazard Index approach where the mixture of two or more PFHxS, PFNA, Gen-X, and PFBS cannot exceed a Hazard Index of 1. Due to Pennsylvania regulations, the federal PFAS MCLs became the PADEP Act 2 MSCs but the soil PFAS MSCs still remain unchanged and based on the HA of 70 ppt. The expectation is that when the new Act 2 soil MSCs for PFAS are promulgated, they will be significantly lower than the current soil MSCs.
- Since the soil MSCs are used as the Clean Fill criteria in PA, the new soil MSCs may be important for Brownfield sites not only for cleanup levels but also for Clean Fill requirements, which could be an especially important consideration if MSCs are lowered to below “background” levels, such as have been evaluated in other states such as Maine, Vermont and New Hampshire.⁸
- Finally, the EPA’s draft PFAS disposal guidance document⁹ issued in 2024 does not provide for cost effective options for PFAS impacted materials, rather recommending deep well injection, incineration and disposal in hazardous waste landfills. If soils at a Brownfield site cannot be used due to structural reasons and need to be sent offsite for disposal, and PFAS is present in the soils that may significantly impact disposal costs and options.

Another regulatory consideration for Brownfield sites is the EPA’s final rule designating PFOA and PFOS (including their salts and isomers) as CERCLA hazardous substances on July 8, 2024. This designation requires that PFAS be considered as in scope items under ASTM’s Phase 1 Standard. Brownfield relying on Phase 1’s complete before July 2024, may not be reliable to use if PFAS are present at the site.

PFAS Investigations at Brownfield Sites

Due to the widespread detections of at least one PFAS in streams and groundwater in Pennsylvania¹⁰ and potential aerial deposition of PFAS especially in industrialized areas, as assessment of potential background or offsite sources of PFAS should be considered for a Site. A review of former site operations to identify key areas such as fire training areas or metal plating can assist in identification of potential PFAS sources which will inform the sampling grid and depths. A discussion of which PFAS compounds should be analyzed is a critical consideration at the start of a Brownfields site assessment based on both the technical and regulatory challenges for PFAS. Depending on site assessment objectives and potential on-site and off-site PFAS sources, the list of PFAS analyzed is of strategic importance. For example, in some instances only those with Act 2 MSCs might be of interest, whereas the 40 PFAS that can be detected by Method 1633 may be important to support a forensic evaluation or establish a site specific standard under Act 2 for a broader release of liability. Several states such as New Hampshire, Maine and Vermont have assessed and/or established background levels for PFAS in soil¹¹, but since the Act 2 Program already includes a background standard option for individual sites, an effort to establish statewide background levels is not currently being pursued for Pennsylvania.

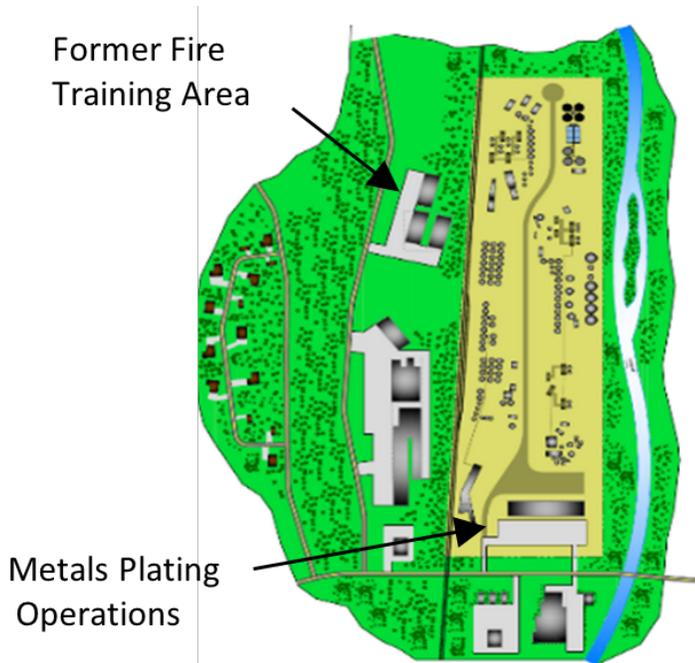


Figure 2- Hypothetical Brownfield Site

There are several PFAS sampling best practices that can be followed to avoid cross-contamination of PFAS during sampling.¹² Cross contamination occurs due to a combination of extremely low regulatory limits for PFAS, that PFAS can be found in sampling equipment, sampler's clothing and personal care products (e.g. sunscreen and insect repellent) and materials used for decontamination may contain PFAS. Routine sampling and analysis plans typically used at Brownfields sites may be revised to include Standard Operation Procedures (SOPs) that consider the particular challenges of PFAS sampling. In addition, collection of additional quality assurance and quality control (QA/QC) samples should be considered for the PFAS sampling plan. Finally, enhanced communication with the laboratory to cover items such as the use of PFAS free water and if heavily impacted PFAS samples are expected to minimize cross contamination in laboratory causing delays and impacting the quality of the PFAS analytical data.



Figure 3- Soil sampling for PFAS

PFAS Investigations at Brownfield Sites

Most efforts at PFAS treatment to date have focused on drinking water using proven technologies such as adsorption onto granular activated carbon, reverse osmosis, and ion-exchange (IX) resins. These technologies have also been used at a limited number of sites for ex situ groundwater treatment using groundwater pump and treat systems. These methods are more effective for longer chain PFAS, and each produces a PFAS-concentrated waste stream that must be managed according to EPA's currently recommended disposal options.¹³ Additional destructive technologies for treating high concentration are also being researched/pilot tested, including plasma and supercritical water oxidation. (SCWO). Foam fractionation is another method for treating higher concentration aqueous PFAS streams and is capable of producing a very high PFAS concentrate to minimize residual waste. Efforts at in situ treatment of groundwater are focusing on injection of granular activated carbon to sorb/arrest plume migration, and researchers are looking at different amendments such as XAD resins and more advanced absorbents that can improve shorter chain PFAS treatment. Soil treatment methods are beginning to emerge, but they are mostly still at the research/demonstration stage, and include thermal desorption and smoldering followed treatment of the airborne PFAS effluent in a destructive incineration technology such as a thermal oxidizer. Hydrothermal alkaline treatment (HALT) is another research method that offers promise for treating soils and takes advantage of the ability of alkaline amendments to lower the activation energy for treating PFAS.

Due to the current state of PFAS remediation, especially for Brownfield sites the approach being selected by most remediators is to identify PFAS source areas and mitigate PFAS movement from these areas. Since PFAS is commonly found around the groundwater interface in unsaturated soils, the use of caps (i.e. buildings and roads) to eliminate the soil to groundwater pathway should be considered in the initial planning phases of the project. Remediators are also trying to minimize offsite soil movement and to reuse onsite soils following Soil Management Plans. Point source treatment for groundwater being used as drinking water or discharged to surface water are being incorporated into onsite waste water treatment designs, where possible, along with other pathway mitigation measures such as lining of stormwater ponds. The use of monitored natural attenuation for low levels of PFAS in groundwater, combined with mitigation of the soil to groundwater pathway and point source treatment, when necessary, can be accommodated within the PADEP's Act 2 program allowing Brownfield sites with PFAS impacts to successfully move forward despite all the complexities surrounding PFAS.

1. ITRC, History and Use of Per- and Polyfluoroalkyl Substances found in the Environment, September 2023.
2. For example, see the details of [Maine's PFAS ban](#)

3. ITRC, PFAS Technical and Regulatory Guidance Document, May 2024
4. At least one PFAS was detected in 76% of the sampling locations in a [USGS-led surface water survey in PA](#)
5. (<https://www.epa.gov/comptox-tools/comptox-chemicals-dashboard>).
6. ITRC, Fate and Transport of Per- and Polyfluorinated Substances (PFAS), September, 2023.
7. ITRC, PFAS Technical and Regulatory Guidance Document, May 2024
8. Wenyu Zhu, A. R. Badireddy, H. Roakes, and S. Zemba. "PFAS Background in Vermont Shallow Soils", study report completed by Sanborn Head and the University of Vermont in partnership with the Vermont Department of Environmental Conservation. March 24, 2019. | Sanborn Head and Maine Department of Environmental Services. "Background Levels of PFAS and PAHs In Maine Shallow Soils". July 19, 2022. | New Hampshire Department of Environmental Services. "Proposed Soil Remediation Standards (SRS) for Perfluorooctanoic Acid (PFOA), Perfluorooctane Sulfonic Acid (PFOS), Perfluorohexane Sulfonic Acid (PFHxS), and Perfluorononanoic Acid (PFNA)". October 6, 2023.
9. EPA, Interim Guidance on the Destruction and Disposal of PFAS and Materials Containing PFAS, 2024
10. At least one PFAS was detected in 76% of the sampling locations in a [USGS-led surface water survey in PA](#)
11. Wenyu Zhu, A. R. Badireddy, H. Roakes, and S. Zemba. "PFAS Background in Vermont Shallow Soils", study report completed by Sanborn Head and the University of Vermont in partnership with the Vermont Department of Environmental Conservation. March 24, 2019. | Sanborn Head and Maine Department of Environmental Services. "Background Levels of PFAS and PAHs In Maine Shallow Soils". July 19, 2022. | New Hampshire Department of Environmental Services. "Proposed Soil Remediation Standards (SRS) for Perfluorooctanoic Acid (PFOA), Perfluorooctane Sulfonic Acid (PFOS), Perfluorohexane Sulfonic Acid (PFHxS), and Perfluorononanoic Acid (PFNA)". October 6, 2023.
12. ITRC, Sampling Precautions and Analytical Methods, September 2023.
13. EPA, Interim Guidance on the Destruction and Disposal of PFAS and Materials Containing PFAS, 2024