



Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

100 Cambridge Street Suite 900 Boston, MA 02114 • 617-292-5500

Maura T. Healey
Governor

Kimberley Driscoll
Lieutenant Governor

Rebecca L. Tepper
Secretary

Bonnie Heiple
Commissioner

Sampling and Analysis Guidance for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan

November 13, 2023¹

Introduction

This Sampling and Analysis Guidance (“Guidance”), prepared by the Massachusetts Department of Environmental Protection (MassDEP) Bureau of Waste Site Cleanup (BWSC), provides guidance to Licensed Site Professionals and consultants regarding when and how to sample and analyze for Per- and Polyfluoroalkyl Substances (together, PFAS) at Disposal Sites regulated under the Massachusetts Contingency Plan (MCP). MassDEP recommends a specific list of target PFAS analytes and discusses appropriate quantitative and qualitative risk characterization approaches. This Guidance also summarizes physical and chemical properties, potential environmental health effects, and current state and federal standards and guidelines for PFAS compounds.

PFAS may be present at MCP sites as a result of current or past releases associated with the manufacturing, use, or disposal of products containing these chemicals. PFAS are considered hazardous materials under MGL Chapter 21E and potential Contaminants of Concern (COCs).

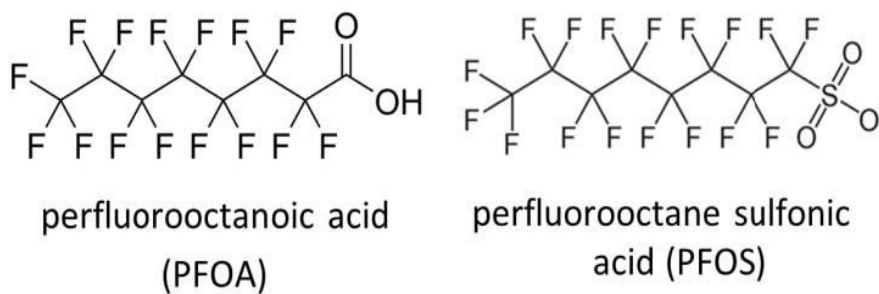
¹ Original publication date: June 19, 2018. Previously updated December 27, 2019, October 21, 2020 and June 16, 2022.

Background Information

What are PFAS?

PFAS are part of a large family of man-made fluorine-containing chemicals which have been used to impart unique properties when applied to materials, including resistance to water, grease and stains. They are also used for thermal stability, foaming control, flow control, leveling and wetting.

MassDEP currently regulates six long-chain PFAS compounds (PFOA, PFOS, perfluorononanoic acid or PFNA, perfluorodecanoic acid or PFDA, perfluorohexane sulfonic acid or PFHxS, and perfluoroheptanoic acid or PFHpA), collectively referred to as “PFAS6”.² MassDEP’s Technical Support Document describes how these compounds were chosen for regulation (see “Technical Support Document” in reference section).



As with any large family of structurally-similar compounds, PFAS can exhibit a wide range of physical, chemical and toxicological properties. This Guidance focuses on those compounds and characteristics of greatest environmental concern while acknowledging that unique properties of individual PFAS may be considered on a case-by-case basis.

Some PFAS (e.g., PFOA, PFOS) can be very resistant to breakdown, migrate easily, and concentrate in the food chain (i.e., bioaccumulate). As a result, they may be found throughout the environment in groundwater, surface water, soil, and air, as well as in food, breast milk, and human blood serum. PFAS have been used for decades in many common products. Research on PFAS compounds is evolving and expanding. As more research is completed, we will have a better understanding of how these compounds react in the environment. MassDEP directs you to the Interstate Technical and Regulatory Council (ITRC, <https://pfas-1.itrcweb.org/>) for additional information.

Human Exposure and Potential Health Effects

While our knowledge of the health risks posed by PFAS is still evolving, it is widely accepted that sufficient exposures to these compounds, particularly PFOA and PFOS, are associated with a wide range of adverse health effects in studies on laboratory animals and in people including adverse effects on fetal and neonatal development such as low birth weight, accelerated puberty, delayed mammary gland development and skeletal variations. Other adverse effects observed in adults include liver damage and

² The discussion in this Guidance applies to both the acid and anion forms of PFAS.

effects on the immune system, thyroid, and cholesterol levels. There is also inconclusive evidence that they might cause testicular and kidney cancer in animals and humans. Some studies suggest that these chemicals function as endocrine disruptors and mimic fatty acids in the body. The chemicals are not easily excreted and remain in the human body for years, which can cause them to build up in the body following continuing exposures.³

While humans may be exposed to PFAS through a variety of pathways, the most common and significant environmental exposure at Disposal Sites is through the consumption of drinking water from contaminated public or private water supplies.⁴ In Massachusetts these chemicals have been found in hundreds of drinking water systems due to localized contamination from nearby sources including manufacturing facilities that used PFAS and/or PFAS-containing products, or locations where the chemicals were used in firefighting foams. There is evidence to indicate that discharges from wastewater treatment plants, pesticide usage, and discharges from private septic systems, among others, may also contribute to the presence of PFAS in the environment. Some PFAS are capable of traveling long distances through air, surface water and groundwater, and may be found far from the locations where they were initially released into the environment.

Because these chemicals have been used in an array of consumer products, most people have been exposed to them. Since 1999, United States Centers for Disease Control and Prevention (US CDC) has measured several types of PFAS in the US population as part of the National Health and Nutrition Examination Survey (NHANES). In particular, the survey has measured PFOS and PFOA. With the decrease in production and use of some PFAS, the national PFAS levels have dropped over time. From 1999 to 2014, blood PFOA and PFOS levels declined by more than 60% and 80%, respectively.⁵

Sources of PFAS in the Environment

PFAS have been used since the 1940s as manufacturer-applied oil and water repellants on products such as clothing, upholstery, paper, and carpets. PFAS were also used in making fluoropolymers for non-stick cookware. Thus, these materials may be associated with many industries, including subsets of the aerospace, automotive, manufacturing, electronics, and textiles industries. In addition to any direct releases to the environment that may have occurred at manufacturing locations, PFAS-containing products and waste materials generated by these industries may also contribute to PFAS contamination elsewhere. PFAS surfactant qualities were also utilized in mist suppressants added to metal plating baths to prevent air releases, and in firefighting foams used to extinguish or prevent fires associated with flammable liquids. ITRC has compiled (and periodically updates) a table of potential sources of PFAS in the environment: *Table 2-5. Sample historic and current uses of PFAS* - <https://pfas-1.itrcweb.org/2-5-pfas-uses/>.

³ The half-life of a chemical is the amount of time it takes for 50% of it to be metabolized and/or eliminated from the body after the exposure has stopped. While the half-lives of PFAS compounds vary by chemical species, the US CDC's Agency for Toxic Substances and Disease Registry (ATSDR) estimates the half-lives may range from 3-5 years or more (<https://www.atsdr.cdc.gov/pfas/activities/assessments/online-session.html#effects>).

⁴ Depending upon the Disposal Site, other exposure pathways may be of concern, such as inhalation of contaminated air and contact with contaminated soil.

⁵ National Report on Human Exposure to Environmental Chemicals, <https://www.cdc.gov/exposurereport/>. For additional information regarding PFAS in human blood, please refer to the CDC: [Per- and Polyfluorinated Substances \(PFAS\) Factsheet | National Biomonitoring Program | CDC](#) and https://www.cdc.gov/exposurereport/data_tables.html and ITRC: [7 Human and Ecological Health Effects of select PFAS – PFAS — Per- and Polyfluoroalkyl Substances \(itrcweb.org\)](#).

PFOA and PFOS are no longer manufactured in the United States as a result of voluntary phase-outs, with a few exceptions for limited industrial uses. As part of the US Environmental Protection Agency's (USEPA) PFOA Stewardship Program, eight major chemical manufacturers committed to eliminate the use of PFOA and PFOA-related chemicals in their facilities' emissions and product content by 2015.⁶ However PFOA and PFOS continue to be produced in many countries and imported goods (such as carpets, leather, apparel, textiles, paper and packaging, coatings, rubber, and plastics) may contain these compounds.

PFOA and PFOS can also be created via biotransformation or abiotically from some fluorotelomers and other PFAS compounds (i.e., precursor compounds). Fluorotelomers are used in firefighting foams (as a replacement for PFOS) and as surface protection to provide soil, stain, grease, and water resistance in products such as tile, stone, textiles, and paper packaging. PFOA and PFOS should not be ruled out as COCs at Disposal Sites simply based on information that only fluorotelomer foams were used. Fluorotelomers can be precursors to PFOA, and PFOA (and other regulated PFAS compounds) can be manufacturing by-products of fluorotelomer production.

Aqueous Film-Forming Foams (AFFF) that contain PFAS, particularly PFOS, have been used since the 1960s to prevent or extinguish highly flammable or combustible liquid Class B fires, such as fires involving gasoline and jet fuel at tank farms, oil refineries, military bases, airports, and firefighting training facilities. The foam has also been used by local fire departments in training and to extinguish (or prevent) motor vehicle fires at crash sites. AFFF containing PFOS has not been manufactured in the US since 2002. Fluorotelomer AFFF consisted of long-chain polyfluorinated compounds that could break down into perfluorinated carboxylic acids such as PFOA. Fluorotelomer AFFF was produced in the United States from the 1970's until 2016. Stockpiles of these discontinued (legacy) foams may remain in use at Department of Defense (DoD) bases, airports, local fire departments and other facilities.

PFOA has been used primarily as an aqueous dispersion agent in the manufacturing of fluoropolymers, which are substances with special properties that have thousands of manufacturing and industrial applications. While manufacturers are phasing out the use of PFOA in these applications, site investigations should consider the past use and past formulations when investigating possible PFAS releases.

As a consequence of the widespread use of PFAS in consumer products, the effluent from residential septic systems, discharge from wastewater treatment plants and leachate from solid waste landfills can contribute to environmental contamination. The presence of such sources should be documented and considered as a component of the Conceptual Site Model.

Standards and Guidelines

Federal Criteria

In March 2023, US EPA proposed drinking water Maximum Contaminant Levels (MCLs) of 4 parts-per-trillion each for PFOA and PFOS.⁷ US EPA also proposed separate MCL for any mixture of PFNA, PFBS,

⁶ Fact Sheet: 2010/2015 PFOA Stewardship Program, <https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/201015-pfoa-stewardship-program-guidance-reporting>.

⁷ Parts-per-trillion (ppt) can also be expressed as nanograms per liter, or ng/L.

PFHxS and GenX compounds using case-specific risk assessment and a Hazard Index standard of 1.0.⁸

The final Federal drinking water MCLs are expected to be released by the end of December 2023 with an anticipated compliance date three years from the date the MCLs are published in the Federal Register.

Massachusetts Maximum Contaminant Level (MCL)

On October 2, 2020, MassDEP promulgated a drinking water standard of 20 ppt for the sum of six PFAS: PFDA, PFHpA, PFHxS, PFNA, PFOS and PFOA. The MassDEP Drinking Water Program has published information about the development and implementation of the PFAS MCL, including material specific to consumers and Public Water Suppliers.⁹ The Drinking Water Program works closely with public water suppliers if PFAS is detected in a system at concentrations exceeding or approaching the MCL. The DWP can assist with technical support, public notice templates, fact sheets and development of treatment options or alternative sources if necessary.

The Massachusetts Drinking Water Program implements the Federal and state drinking water MCLs. It is anticipated that the Massachusetts MCL will be revised in the near future, following a public review process and considering the proposed Federal standards. The state drinking water standards must be at least as stringent as the Federal values.

Massachusetts Reportable Concentrations and Cleanup Standards

In December 2019, MassDEP-BWSC promulgated MCP Reportable Concentrations and Cleanup Standards for six PFAS compounds (PFNA, PFDA, PFHxS, PFHpA, PFOA and PFOS), either individually or summed, depending upon the groundwater or soil category. The MCP GW-1 standard and the RCGW-1 Reportable Concentration are consistent with the Massachusetts MCL described above, and these values are also likely to be revisited when the Federal MCLs are finalized. Additional information on the MCP Reportable Concentrations and Cleanup Standards are included below.

PFAS CONSIDERATIONS AT MCP SITES

Hazardous Materials Regulated Under M.G.L. Chapter 21E

Hazardous Material is defined (310 CMR 40.0006) to be a “material, including, but not limited to, any material in whatever form which, because of its quantity, concentration, chemical, corrosive, flammable, reactive, toxic, infectious or radioactive characteristics, either separately or in combination with any substance or substances, constitutes a present or potential threat to human health, safety, welfare, or to the environment, when improperly stored, treated, transported, disposed of, used, or otherwise managed...” MassDEP has determined, pursuant to 310 CMR 40.0342, that the available toxicity information for PFOS, PFOA and related PFAS compounds indicates that these materials are “hazardous materials” subject to regulations under M.G.L. c.21E and the MCP.

⁸ While this approach to an MCL is novel under the Federal Safe Drinking Water Act, it is similar to the approach used under the MCP’s Method 3 Risk Characterization for evaluating Cumulative Receptor Non-cancer Risk (310 CMR 310 CMR 40.0993(10)).

⁹ <https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas>.

While the general class of PFAS compounds are considered hazardous materials based upon the statutory definition, six PFAS are specifically included on the Massachusetts Oil and Hazardous Material List (310 CMR 40.1600) with associated Reportable Quantities and Reportable Concentrations.

Reportable Conditions for PFAS Compounds

MassDEP has established Reportable Concentrations (RCs) and Reportable Quantities (RQs) under the MCP in 310 CMR 40.1600 – the Massachusetts Oil and Hazardous Material List (“MOHML”). The RQs and RCs for PFAS are listed in Table 1.

A release indicated by the measurement of PFAS in soil and/or groundwater at a concentration equal to or greater than the applicable RC requires notification to the Department under the provisions of 310 CMR 40.0315. A sudden, continuous or intermittent release to the environment equal to or greater than the RQ requires notification to the Department under the provisions of 310 CMR 40.0311.

Table 1 – Reportable Quantities and Reportable Concentrations for PFAS

	RQ (pounds)	RCGW-1 mg/L	RCGW-2 mg/L	RCS-1 mg/kg	RCS-2 mg/kg
∑ 6 PFAS (listed below)	-	2E-05 (20 ng/L or ppt)	-	-	-
PERFLUORODECANOIC ACID (PFDA)	1	See ∑6 PFAS	40	3E-04 (300 ng/kg)	0.4
PERFLUOROHEPTANOIC ACID (PFHpA)	1	See ∑6 PFAS	40	5E-04 (500 ng/kg)	0.4
PERFLUOROHEXANESULFONIC ACID (PFHxS)	1	See ∑6 PFAS	0.5	3E-04 (300 ng/kg)	0.4
PERFLUORONONANOIC ACID (PFNA)	1	See ∑6 PFAS	40	3.2E-04 (320 ng/kg)	0.4
PERFLUOROOCETANESULFONIC ACID (PFOS)	1	See ∑6 PFAS	0.5	2E-03 (2,000 ng/kg)	0.4
PERFLUOROOCETANOIC ACID (PFOA)	1	See ∑6 PFAS	40	7.2E-04 (720 ng/kg)	0.4

Other notification requirements applicable to any oil or hazardous material may also apply to PFAS, as described in 310 CMR 40.0300¹⁰.

PFAS Compounds as Contaminants of Concern

MassDEP recommends that the 40 analytes specified in draft EPA Method 1633 (the most current version) should be the focus of MCP site investigations. (See also the following discussion of analytical methods and reporting limits.) However, specific knowledge of site history/operations, the results of past analyses and other relevant information may be considered, consistent with MassDEP sampling and analysis guidance, to expand or narrow the list of target analytes. For example, if past industrial operations at the site indicate the likely presence of other PFAS compounds, then those compounds would also be included in the investigation.

¹⁰ For example, pursuant to 310 CMR 40.0311(7), “any release of any oil and/or hazardous material, in any quantity or concentration, that poses or could pose an Imminent Hazard, as described in 310 CMR 40.0321 and 40.0950” requires notification within two hours.

PFAS in MCP Risk Characterizations

The potential risks posed by PFAS contamination at a Disposal Site may be addressed using MCP Methods 1, 2 or 3 risk characterizations, as described in 310 CMR 40.0900.

Method 1 – MassDEP has published Method 1 groundwater and soil standards for PFAS. As part of a Method 1 Risk Characterization, Exposure Point Concentrations at a site may be compared to the applicable groundwater and soil standards listed in 310 CMR 40.0970.

Method 2 – As described in 310 CMR 40.0980, the Method 1 standards (not including the GW-1 standards) may be modified under Method 2 to reflect site-specific fate and transport conditions. These modifications may address soil leaching (310 CMR 40.0982(3)(b)), vapor intrusion (310 CMR 40.0982(3)(c)), and/or discharge to surface water (310 CMR 40.0982(3)(d)). For example, a site-specific evaluation of PFAS leaching potential may result in a target cleanup level (Method 2 Standard) that is different (higher or lower) than the published Method 1 Standard.

Method 3 – A site-specific risk characterization pursuant to 310 CMR 40.0990 may be used at any site to evaluate current and foreseeable future risk of harm to human health, safety, public welfare and the environment. When conducting a Method 3 human health risk characterization for PFAS, MassDEP requires the use of a specific chronic and subchronic reference dose (RfD) of 5E-06 mg/kg/day pursuant to 310 CMR 40.0993(6)(f).^{11, 12} The Massachusetts drinking water MCL for PFAS is considered an applicable or suitably analogous standard pursuant to 310 CMR 40.0993(3)(a).

Evaluation Other PFAS Compounds

For other PFAS compounds not listed in Table 2, MassDEP has not yet identified toxicity information for the purposes of an MCP risk characterization. Other sources of toxicity values may be used, pursuant to the hierarchy described at 310 CMR 40.0993(7) to quantitatively evaluate these PFAS compounds.

In the absence of an appropriate toxicity value, additional PFAS compounds identified at a Disposal Site should be discussed as part of the overall site assessment, but these PFAS need not be quantitatively included in the MCP risk characterization.

PFAS SAMPLING AND ANALYSIS CONSIDERATIONS

When/Where to Sample for PFAS

Under the MCP, many factors are considered by the Licensed Site Professional (LSP) to determine the sampling strategy – including likely COCs - at a Disposal Site. The need to sample for PFAS will depend on the Disposal Site Conceptual Site Model and case-specific information, including the specific nature of

¹¹ See “Technical Support Document - Per- and Polyfluoroalkyl Substances (PFAS): An Updated Subgroup Approach to Groundwater and Drinking Water Values” <https://www.mass.gov/doc/per-and-polyfluoroalkyl-substances-pfas-an-updated-subgroup-approach-to-groundwater-and/download>.

¹² As part of the proposed drinking water Maximum Contaminant Levels described above, the US EPA published draft revisions to several PFAS toxicity values, including the RfDs for PFOS and PFOA. When the US EPA finalizes this information, it is likely that the toxicity information published in the MCP will be revisited.

operations at a site, the time period (relative to PFAS availability) of operations and the proximity to current or future drinking water sources (GW-1 areas).

For example, sampling for PFAS is likely warranted at locations in or near GW-1 areas where the following activities may have occurred or where related wastes have come to be located, including:¹³

- **Facilities** where PFAS have been manufactured (i.e., chemical facilities) or applied and may have resulted in releases to the environment (including air emissions and subsequent air distribution).
- **Landfills**¹⁴ where uncontrolled leaching from disposal of PFAS-containing waste materials may have occurred.
- **Junkyards** and other locations where auto fluff may have been disposed.
- **Former or Current DoD sites** where there has been (or likely has been) historic use of AFFF.
- **Airport** hangars, rail yards and other facilities (e.g., petrochemical) where quantities of AFFF may have been applied or stored.
- **Firefighting training and equipment test areas** where AFFF has been (or likely has been) used.
- **Crash sites**, including aircraft, rail and motor vehicle sites where AFFF may have been used.
- **Metal coating and plating facilities**
- **Facilities using commercial septic systems**
- **Locations where drinking water or wastewater treatment plant residuals have been land applied**

The need for drinking water samples (i.e., from a public or private drinking water well or tap) would be indicated where plume delineation shows potential for contamination of a drinking water supply well.

How to Sample for PFAS

Because of the potential presence of PFAS in common consumer products and in equipment typically used to collect soil, groundwater, surface water, sediment, and drinking water samples as well as the need for very low reporting limits, special handling and care must be taken when collecting samples for PFAS analysis to avoid sample contamination. In general, items that are specifically identified as waterproof, water resistant or stain-resistant should be avoided or examined for the potential presence of PFAS. There is extensive guidance available online and it is not MassDEP's intent to require the use and avoidance of certain products, particularly as formulations may change over time.¹⁵

¹³ ITRC's PFAS Fact Sheet provides a comprehensive list of potential sources in Section 2.6: <https://pfas-1.itrcweb.org/2-6-pfas-releases-to-the-environment/>.

¹⁴ This guidance is applicable to landfills and other solid waste facilities for which assessments are conducted in whole or in part under the MCP. Facilities regulated under 310 CMR 16.00: Site Assessment for Solid Waste Facilities may also be required to sample for PFAS as a permit requirement.

¹⁵ Sources of sampling information include:

- USEPA's "Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS), Methods and guidance for sampling and analyzing water and other environmental media", <https://www.epa.gov/water-research/pfas-methods-and-guidance-sampling-and-analyzing-water-and-other-environmental-media>
- ITRC's "Sampling Precautions and Laboratory Analytical Methods for Per- and Polyfluoroalkyl Substances (PFAS)," https://pfas-dev.itrcweb.org/wp-content/uploads/2020/10/sampling_analytical_508_2020Aug_Final.pdf
- ITRC's "Site Characterization Considerations and Media-Specific Occurrence for Per- and Polyfluoroalkyl Substances (PFAS)," https://pfas-1.itrcweb.org/wp-content/uploads/2023/10/SiteChar_PFAS_FactSheet_Sept2023_final.pdf

Specific recommendations are less important than the LSP's awareness and consideration of how product formulation or analytical methodologies may affect the results at a site.

Sample Collection Method/Sequence

- Use new nitrile gloves, collect the sample for PFAS prior to collecting samples for any other analysis to avoid contact with other types of sample containers, bottles or packaging materials.
- As with all samples, do not place the sample bottle cap on any surface when collecting the sample, and avoid all contact with the inside of the sample bottle or its cap.
- When the sample is collected and capped, place the sample bottle(s) in an individual sealed plastic bag, separate from all other sample parameter bottles, and place in shipping container packed only with ice.
- Groundwater, surface water, or drinking water samples should not be field filtered as the glass fiber on the filter can potentially absorb PFAS, resulting in underestimates of PFAS concentration. No sub-sampling/sample transfer should occur in the field. Water samples should be placed in sealed plastic bags to avoid contamination during transport.
- There may be instances where groundwater, surface water, or wastewater samples contain elevated levels of suspended solids. Depending on the levels, the suspended solids can interfere with the laboratory extraction process and may also interfere with the detected PFAS (as PFAS, especially PFASs, tend to sorb to particulates). It is important to work with the laboratory to determine the appropriate procedure for such samples. Options may include (1) centrifuging the sample and decanting the aqueous phase for extraction, leaving the particulate phase out or (2) centrifuging the sample, decanting the aqueous phase for extraction, performing a separate extraction of the particulate phase and combining with the aqueous phase extract. The use of one method over the other will be dependent upon the project objectives and may be contingent upon whether the objective is related to risk assessment, transport, remedial design, or mass flux total measurements for discharge, for example. The preparation method used should be justified and documented in subsequent reports.

Field/Equipment Blanks

When sampling for PFAS, it is recommended that additional and/or more frequent field/equipment blanks be collected prior to and during sampling to check for residual PFAS on sampling equipment due to the potential for cross-contamination issues and the need for very low reporting limits. Source water for blank samples and decontamination rinses should be certified PFAS-free by the analytical laboratory.

Analytical Methods

Chemical and physical properties of PFAS prevent the use of conventional analysis (e.g., gas chromatography/mass spectrometry [GC/MS]) to measure them in the environment. US EPA has published a Technical Brief that describes methods for analyzing PFAS in various analytical media,

including methods specifically *required* for drinking water analyses (EPA Methods 537.1 and 533).¹⁶

The use of a method other than EPA Method 537, 537.1 or 533 may not be acceptable for the evaluation of Public Drinking Water Supplies regulated pursuant to 310 CMR 22.00.

Close coordination and advance planning with a qualified laboratory is strongly recommended, particularly if sampling matrices other than drinking water.

For sampling media *other than* drinking water, a “modified” Method 537.1, 533 or 1633 - *or other analytical method* - may also be considered for an MCP site investigation. Under the MCP, results from the use of an alternative method may be acceptable for site assessment and remedial decisions if the results meet data quality objectives and the supporting QA/QC information is provided. (Note for media other than drinking water, field duplicate samples are not generally required for each sample taken.) It is important to confirm the acceptability of using results from an alternative method before samples are analyzed.

MassDEP recommends the use of EPA Method 1633 (most current version) for the analysis of non-drinking water samples (i.e., groundwater, surface water, wastewater, soil, sediment, biota). As discussed previously, the 40 analytes specified in EPA Method 1633 (most current version) should be the focus of MCP site investigations at this time.

MassDEP intends to include a PFAS analysis in the Compendium of Analytical Methods (CAM). Readers should check the CAM online for the status of this work.¹⁷

Before September 2009, there were no validated test methods or standardized data quality criteria for PFAS analytes. As a result, most PFAS data generated and used in earlier publications and assessments have limitations and should be used with caution.

¹⁶ **Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)** - Methods and guidance for sampling and analyzing water and other environmental media https://www.epa.gov/sites/production/files/2019-12/documents/pfas_methods-sampling_tech_brief_23dec19_update.pdf. See also:

- www.epa.gov/water-research/epa-drinking-water-research-methods
- www.epa.gov/sites/production/files/2016-09/documents/pfoa-technical-advisory.pdf

¹⁷ www.mass.gov/guides/compendium-of-analytical-methods-cam

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