United States
Environmental Protection
Agency

EPA 600/R-23/294 I November 2023 I www.epa.gov/research

Subsurface Per- and Polyfluoroalkyl Substances (PFAS) Distribution at Two Contaminated Sites

Office of Research and Development
Center For Environmental Measurement and Modeling

EPA 600/R-23/294 I November 2023 I www.epa.gov/research

Subsurface Per- and Polyfluoroalkyl Substances (PFAS) Distribution at Two Contaminated Sites

Prepared for
Brian A. Schumacher, John H. Zimmerman, and Alan C. Williams
United States Environmental Protection Agency
Center for Environmental Measurement and Modeling
Athens, GA, and Research Triangle Park, NC

Prepared by

Katherine Bronstein and Rohit Warrier
RTI International
3040 E. Cornwallis Road
Research Triangle Park, NC 27709

and

Christopher C. Lutes
Jacobs Engineering
333 Fayetteville Street
Raleigh, NC 27601

EPA Contract EP-C-16-016

U.S. Environmental Protection Agency
Office of Research and Development
Washington, DC 20460

Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

ACM	Assessment of Corrective Measures
BGS	Below Ground Surface
CAP	Corrective Action Program
CCV	Continuing Calibration Verification
ESI	Electro-Spray Ionization
FTOH	Fluorotelomer Alcohol
GAEPD	Georgia Environmental Protection Division
GC	Gas Chromatography
HLC	Henry's Law Constant
HDPE	High Density Polyethylene
L	Liter
LC	Liquid Chromatography
LCS/LCSD	Laboratory Control Sample/Laboratory Control Sample Duplicate
mL	Milliliter
MNA	Monitored Natural Attenuation
MRM	Multiple Reaction Monitoring
MS	Mass Spectrometry
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSW	Municipal Solid Waste
MTBE	Methyl tert-Butyl Ether
NJ	New Jersey
ORD	Office of Research & Development
PFAA	Perfluoroalkyl Acid
PFAS	Per- and Polyfluoroalkyl Substances
PFBA	Perfluorobutanoic Acid
PFCA	Perfluoroalkyl Carboxylic Acids
PFHP	Perfluoro-1-Heptene
PFHpA	Perfluoroheptanoic Acid
PFHxA	Perfluorohexanoic Acid
PFOA	Perfluorooctanoic Acid
PFPeA	Perfluoropentanoic Acid
PID	Photoionization Detector
RLs	Reporting Limits
QA/QC	Quality Assurance/Quality Control
sFTOH	Secondary Fluorotelomer Alcohol
SPE	Solid Phase Extraction
SS	Subslab
TD	Thermal Desorption
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
VI	Vapor Intrusion

VOC	Volatile Organic Compound
VP	Vapor Pressure

1 Executive Summary

1.1 Background

Vapor intrusion (VI) is the migration of vapors from the subsurface to indoor air. The VI exposure pathway extends from the contaminant source — which can be free product, volatile organic compounds (VOCs) sorbed to vadose zone soil, or VOC-contaminated groundwater — to indoor air exposure points. Vapor intrusion occurs because there are pressure and concentration differentials between indoor air and soil gas. Indoor environments are often negatively pressurized with respect to outdoor air and soil gas. This pressure difference allows soil gas containing subsurface contaminant vapors to flow into indoor air through advection. In addition, concentration differentials cause VOCs to migrate from areas of higher to lower concentrations through diffusion from the soil gas into the home or building.

Per- and polyfluoroalkyl substances (PFAS) are a group of manufactured chemicals that have been used in industry and consumer products since the 1940s because of their useful properties. There are thousands of different PFAS, some of which have been more widely used and studied than others. In the environment, PFAS have been found in soil and water at or near waste sites such as at landfills; disposal and hazardous waste sites; where aqueous film-forming foams were used to extinguish flammable liquid-based fires; manufacturing or chemical production facilities that produce or use PFAS; food packaging; household products for their use in stain and water-repellents, cleaning products, non-stick cookware, paints, sealants, personal care products, and biosolids from wastewater treatment plants that are used as fertilizers on agricultural lands. One common concern with PFAS is that many break down very slowly and can bioaccumulate in people, animals, and the environment over time.

Numerous polyfluorinated organic substances (e.g., fluorotelomer alcohols (FTOHs)) have sufficient vapor pressure (>1 mm Hg) and Henry's Law constants (>1E-5 atm m^3/mol) to be designated as vapor-forming chemicals based on current federal and state VI guidance. According to the U.S. Environmental Protection Agency's (USEPA's) technical guide on assessing and mitigation the vapor intrusion pathway, vapor-forming chemicals warrant investigation for vapor intrusion when they occur as subsurface contaminants at sites subject to a federal statute for land cleanup (e.g., Comprehensive Environmental Response, Compensation, and Liability Act and Resource Conservation and Recovery Act corrective action).

1.2 Purpose

This initial study was designed to determine whether the VI exposure pathway is germane to PFAS with a focus on FTOHs. FTOHs are chemical intermediates and byproducts in some PFAS manufacturing operations and have been measured in municipal solid waste (MSW) landfill leachates. This research will provide regulators information that will help: (1) decide whether VI should be evaluated at the hundreds of sites where PFAS are reasonably expected to have been released to the subsurface, and (2) determine what additional research is needed to evaluate any such threat further before making policy determinations.

1.3 Methods

The study focused on two sites where volatile PFAS were likely present in the soil or uppermost groundwater bearing zone due to past industrial (e.g., manufacturing) or waste disposal activities. A PFAS manufacturing plant in New Jersey was selected as the first site due to historical and current production of fluoroelastomers. At the PFAS manufacturing plant, subslab soil gas was collected within the manufacturing building and at two locations outside and away from the building. Soil, soil gas, and groundwater samples were collected at four locations outside and away from the building. The second field site was a closed, unlined MSW landfill in Franklin County, Georgia, developed in the mid-1970s and operated until approximately 1995. At the Georgia MSW landfill site, groundwater and well head gas samples were collected at multiple locations.

Soil samples were analyzed for PFAS by solvent extraction (1:1 hexane:acetone) with microwave digestion prior to analysis. The soil samples were analyzed using gas chromatography (GC)/tandem mass spectrometry/mass spectrometry (MS/MS) by SW-846 Method 8270E modified to include FTOHs. Other PFAS were analyzed by solid phase extraction and liquid chromatography (LC) MS/MS following Method 537. A second set of soil samples were sent to the USEPA Office of Research and Development (ORD) laboratory in Athens, GA, where the soil samples were analyzed for FTOHs after extraction in methyl tert-butyl ether (MTBE) followed by GC/MS quantitation. Soil gas and subslab soil gas samples were analyzed by thermal desorption (TD)/GC/MS following modified Method TO-17 after collection on clean multibed perfluorochemical thermal sorbent tubes. Groundwater samples were analyzed for FTOHs using GC/MS/MS in electron impact ionization mode following a modified SW-846 Method 8270E adding the additional MS detector. Analysis for other PFAS in groundwater was performed by LC/MS/MS operated in negative electro-spray ionization (ESI) mode following a modified USEPA method 537.

1.4 Results

At the New Jersey site, FTOH concentrations in soil gas were generally greatest at the subslab locations beneath the presumed source building and decreased with distance away from the presumed source building. This general distribution pattern was also found for perfluoroalkyl carboxylic acids (PFCAs) in soil gas, and PFCAs in both soil and groundwater. FTOHs were not detected in the groundwater samples.

During a second sampling event at the New Jersey site, a quartz microfiber filter was placed between the sorbent tube and the sample probe to determine the distribution of PFAS between the vapor and any possible particulate or moisture-based transport phases. For 6:2 FTOH and longer chained FTOHs, most of the FTOH mass was reported on the filters. In contrast, the two smaller chain FTOHs, 4:2 and 5:2s FTOH, had discernable concentrations on both the filter and the sorbent tubes.

At the Georgia MSW landfill, PFAS concentrations were negligible or not detected in methane vent wellhead gas. Groundwater samples had very low concentrations (<0.004 µg/L) of perfluorobutanoic acid (PFBA), perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), and perfluorooctanoic acid (PFOA).

1.5 Discussion/Conclusions

Multiple PFAS were found in multiple matrices at the New Jersey site. PFAS concentrations in the soil gas phase were greatest (when detected) in the subslab soil gas underneath the presumed source building and tended to decrease with distance. Virtually no PFAS were present at the furthest locations from the presumed source building. This distributional pattern suggests that PFCAs and FTOHs could be migrating in either the vapor phase in the vadose zone (including the coarse subslab environment), PFCAs in groundwater, or both (i.e., PFCAs), away from the source area. Alternately, and to some extent, if there are cracks, openings in the concrete/asphalt covering the ground surface, or grass or gravel covered open areas between the presumed source building and the sampling locations, atmospheric deposition of PFAS may have occurred due to release from stacks followed by washing through the openings into the subsurface during rainfall or snowmelt events.

No FTOHs were found in groundwater. The lack of FTOHs in groundwater and their presence in the soil gas phase would indicate vapor phase transport. Supporting the vapor phase transport hypothesis, when examining the FTOH distribution within the soil column, the greatest concentrations were found in subslab soil gas followed by the deepest sampling depth for the nFTOHs. The driving force for this vapor phase transport can be attributed to diffusion and advection due to barometric pumping from surficial openings during weather events.

In contrast, the sFTOH and PFCA concentrations were greater at depth and decreased towards the surface. This distribution would indicate groundwater transport from the presumed source building to the sampling locations. However, while the PFCAs were found in groundwater, supporting a groundwater transport hypothesis, no sFTOHs were quantified in the groundwater. The presence of the sFTOHs in greater concentrations at depth could be the result of concomitant vertical diffusion/dispersion of the nFTOHs into the underlying soils going through cycles of reduction and oxidation to produce sFTOHs. Changing redox conditions in the subsurface were indicated by the presence of "redox features." If sFTOHs are generated in relatively high concentrations, they can diffuse or advect towards the surface into the oxidizing coarse sand and cobble layer found under the slab, degrade, and contribute to the vapor phase PFCA concentrations.

While the presence of PFAS at the New Jersey site was not unexpected, since the site has long been used to produce fluoroelastomers and fluorotelomers, the presence of PFBA, PFHxA, PFHpA, and PFOA in the soil gas phase was unexpected due their very low or non-volatility. PFCAs are generally considered to be predominantly partitioned to the particulate phase in the atmosphere; however, PFBA, PFHpA, PFHxA, PFOA, and PFPeA in the gas phase has been found at some ambient air sites. Gas phase PFHpA, PFHxA, and PFOA at concentrations below 2.5 ng/m^3 have also been reported in indoor air at background sites.

Although PFBA, PFHxA, and PFOA were detected during the first New Jersey field sampling, only PFHxA and PFHpA were found and only on the unfiltered thermal desorption tubes during the second sampling at the site. The short chain 4:2 and 5:2s FTOHs were quantified in unfiltered thermal desorption tubes, filters, and the post-filter thermal desorption tubes. In contrast, 6:2, 7:2s, 8:2, and 10:2 FTOHs were found in the unfiltered thermal desorption tube or on the filter with little to no concentrations on the subsequent post-filter thermal desorption tube. These results indicate that the 4:2 and 5:2s FTOHs may be moving in both the vapor and particulate phase while the other FTOHs may be moving in the particulate phase and were trapped on the quartz microfiber filter. Whether the particulate phase is a solid particle, in a liquid phase (mist), or the sorption of longer chain FTOHs to the quartz filter is a future research need.

In contrast to the New Jersey site, PFCA concentrations in the well head gas and groundwater samples were very low at the Georgia MSW landfill and consisted of PFBA, PFPeA, PFHxA, PFHpA, and PFOA. Only 8:2 FTOH was reliably detected in the well head space at one location. These results provided the landfill operators with information that PFAS are migrating towards the groundwater.

1.6 Implications

With the presence of PFAS in soil, soil gas (including subslab soil gas), and groundwater, the potential for vapor intrusion has been recognized; however, the final confirmatory analysis of indoor air to complete the exposure pathway is lacking. The vapor intrusion of volatile PFAS may pose health risks to building occupants and should, therefore, warrant consideration during vapor intrusion assessments at facilities where high concentrations are present in shallow soils and groundwater.

2 Introduction

2.1 Vapor Intrusion and PFAS Background

This investigation represents the U.S. Environmental Protection Agency's (USEPA's) initial research into whether the vapor intrusion (VI) pathway is germane to per- and polyfluoroalkyl substances (PFAS) exposure. Vapor-forming chemicals associated with contaminated soil and groundwater pose a risk of upward migration and intrusion into overlying buildings (ITRC, 2021). The USEPA defines volatile chemicals as compounds having a Henry's Law constant greater than 0.00001 atm m^3/mole or a vapor pressure (VP) greater than 1 mm mercury and a molecular weight less than 200 (USEPA, 2022). At least four fluorotelomer alcohols (FTOHs) including 4:2, 6:2, 8:2 and 10:2 FTOH, have sufficient VP to be designated as vapor-forming chemicals (ITRC, 2021).

In accordance with the *OSWER Technical Guide For Assessing And Mitigating The Vapor Intrusion Pathway From Subsurface Vapor Sources To Indoor Air* (USEPA, 2015), "Vapor-forming chemicals warrant investigation for vapor intrusion when they occur as subsurface contaminants at sites subject to a federal statute for land cleanup (e.g., Comprehensive Environmental Response, Compensation, and Liability Act and Resource Conservation and Recovery Act corrective action)." The report authors are not aware of any prior measurements of PFAS in soil gas that directly demonstrate the VI potential for these compounds. The selected compounds are common chemical intermediaries and byproducts in some PFAS manufacturing operations (Evich, 2022). FTOHs are also present in many consumer and building products and have been measured in ambient air and surface water (Yamazaki et al., 2021).

This research was performed under an approved quality assurance project plan with the identifier of J-EPD-0033018-QP-1-0. The field results presented in this report are anticipated to be of interest to regulators, the private sector and the scientific community, informing continued investigation regarding the VI contribution to PFAS exposure.

2.2 PFAS Fate and Transport

Our research concept was based on a conceptual site model of upward attenuation of vapor-phase PFAS in the vadose zone with increasing distance from a groundwater or soil source, and subsequent risk for intrusion into overlying buildings (i.e., the soil VI pathway; USEPA, 2015). Initial literature review and consultation with USEPA experts suggests that preferential concentration of PFAS at air/water interfaces is likely for volatile compounds (ITRC, 2020 and Evich, 2022 and references cited therein). This might include, for example, a concentration of FTOH compounds within the capillary fringe at the groundwater-vadose zone interface.

Published research further suggests that air emissions of volatile PFAS compounds at manufacturing and use sites results in local, regional, and global-scale distribution through atmospheric transport (Cai, 2012; Lai , 2016; Wang, 2015; ITRC, 2020; Evich, 2022). The volatile PFAS can then be deposited, via precipitation or via sorption to dust particles or aerosols, on the ground surface and washed into the vadose zone. Once in the vadose zone, PFAS compounds have been shown to accumulate at interfacial boundaries (e.g., the water table or capillary fringe; Brusseau, 2018). PFAS compounds have an affinity for organic matter in soil and sediment, as evidenced by relatively high soil/water partition coefficients and studies showing PFAS mass storage in high organic soil horizons (ITRC, 2020). Although less well studied, PFAS can also diffuse into and become entrained within clay particles in soil and sediment (Loganathan and Wilson, 2022).

These processes indicate that the observed vertical distribution of PFAS compounds in the vadose zone may be attributable to the upward migration from contaminated groundwater or soil in addition to downward migration due to atmospheric deposition. The accumulation of PFAS at a given point in the vadose zone can be further influenced by factors that include soil type, surface water infiltration rate, moisture content, preferential sorption to soil organic carbon or clay, accumulation at water-air interfaces, and both lateral and vertical conduit pathways (e.g., subsurface utilities corridors).

2.3 Evidence for FTOH in Landfill Emissions

Scientific literature provides evidence that municipal solid waste (MSW) landfills operating during recent timeframes are likely to have detectable FTOH in site media (Ahrens et al., 2011; Tian et al., 2018; Wang et al., 2020; Weinberg et al., 2011). In studies across Canada, Germany, and China, FTOHs were found to be the predominant class of PFAS reported in the ambient air above landfills, which is consistent with the greater volatility observed in FTOH chains. Specific to MSW test sites, 8:2 FTOH was the dominant compound detected (Ahrens et al., 2011; Tian et al., 2018; Wang et al., 2020; Weinberg et al., 2011).

At select sites in China, Wang et al., (2020) found that FTOHs in water leachate samples were the predominant detectable PFAS class, with 8:2 FTOH contributing most significantly to the overall concentrations observed. Other reported FTOH compounds included 6:2 FTOH and 10:2 FTOH.

When assessing the detections of FTOHs, 6:2 FTOH may release much faster than 8:2 and 10:2 FTOHs in consumer products due to its higher vapor pressure, yielding less residual 6:2 FTOH in products disposed of in MSW landfills. After release from the consumer products, 6:2 FTOH is more susceptible to biodegradation in landfill leachate or aerobic soils (Liu et al., 2010). After release, the biodegredation of 6:2 FTOH could lead to the production of fluorotelomer carboxylates (e.g., 5:3 fluorotelomer carboxylic acid) and related but non-volatile degradation compounds (Evich, 2022). In addition, it is only in recent years that the major fluorochemical manufacturers have been moving toward 6:2 FTOH as a principal raw material to manufacture FTOH-based products in an effort to eliminate the use of perfluorooctanoic acid and its precursors. Therefore, 6:2 FTOH may not be widespread in landfills (Tian et al., 2018).

In general, current studies tend to agree that more research is necessary to assess and address PFAS air emissions from closed landfills.

2.4 Study Objectives

The primary objectives of this investigation include:

- Investigate the presence or absence of vapor-phase PFAS compounds at previously identified, PFAS-contaminated study sites;
- Demonstrate the occurrence of PFAS VI with field measurements;
- Compare the measured versus predicted partitioning of PFAS compounds between dissolved, sorbed and vapor phases based on study site data for groundwater, soil and soil gas, respectively;
- Document and compare the relative composition of PFAS mixtures within dissolved, sorbed and vapor phases; and
- Evaluate the apparent attenuation of PFAS vapors with distance from source.

2.5 Target PFAS Compounds

Test sites for this study were selected places where the four FTOHs are present (or are likely to be present) because of past industrial (e.g., manufacturing) activities or waste disposal activities. The study focused on sites where volatile PFAS compounds were likely to be present in soil or in the uppermost groundwater. **Table 1** presents the target PFAS compounds for this investigation including their chemical properties. In addition to the FTOHs, the list in **Table 1** includes other potentially volatile PFAS compounds, as defined by their VP and Henry's Law Constant (HLC) or as FTOH parents or progeny.

2.6 Selected Field Sites

Study sites were selected based on past and ongoing manufacturing or waste disposal activities and the anticipated presence of the four targeted FTOHs in soil or groundwater. Two study sites were selected — an operating PFAS manufacturing facility in New Jersey and a MSW landfill in Georgia.

2.6.1 New Jersey Field Site

An aerial view of the New Jersey field site is provided **Figure 1**. The site was selected due to historical and current production of fluoroelastomers and fluorotelomers which began in the late 1960s. The site is located along the Delaware River.

The area is underlain by a sequence of alternating coarse and finer grained soils. The water table is situated approximately four feet below the natural ground surface. The primary hydrogeologic units are identified, from shallow to deep, by a series of letters from A to F (**Table 2**). The hydrologic units include a discontinuous A zone (shallowest) and deeper, water bearing units labeled B through F with intervening aquitards described by the letter designations of the bounding aquifers (e.g., the C/D aquitard lies between the C and D aquifers). Groundwater flows across the site with both horizontal and vertical components and is highly controlled by an interceptor well system to prevent offsite flow. Without the interceptor well system, the groundwater would flow to the west towards the river or south towards a bordering canal.

Figure 1. Aerial View of the New Jersey Field Site.

Groundwater in the A zone is not laterally extensive. The A zone groundwater either discharges to surface water where not controlled by passive flow barriers or recharges the underlying B aquifer. Groundwater flow in the B aquifer is downward to the deeper C and D aquifers where the B/C aquitard is thin or absent, or horizontally to the surface water. The collection of groundwater samples focused on the A zone, where present, and the B zone where the A zone was not present.

2.6.2 Georgia Field Site

An aerial view of the Georgia study site is provided **Figure 2**. The Georgia field site is a closed MSW landfill that was developed in two phases. The Phase I area of the landfill was developed in the mid-1970s and Phase II was developed in the late-1980s. The landfill continued to accept MSW from the entirety of the county through approximately 1995. The county was primarily residential and agricultural during that time-period, although some local industries did exist. According to the 2000 census, the county population was approximately 20,300 (USCB, 2021).

Table 1. Target PFAS Compounds with Physical Properties.

CASRN	Short Name	Compound Class[†]	Compound[*]	VP[‡] 20-25°C (Pa)	HLC[§] Minimum (unitless)	HLC Average (unitless)	HLC Maximum (unitless)	pKa Minimum (unitless)	pKa Maximum (unitless)
4151-50-2	n-EtFOSA	FOSA	N-Ethylperfluoro-1-octansulfonamide	1.2E-01	6.83E-09	3.56E+03	1.91E+04	--	--
31506-32-8	n-MeFOSA	FOSA	N-Methylperfluoro-1-octanesulfonamide	3.0E-01	7.77E-09	3.85E+03	2.34E+04	--	--
2043-47-2	4:2 FTOH	FTOH	2-Perfluorobutyl ethanol	2.1E+02	1.09E-07	2.56	18.2	--	--
--	5:2 sFTOH	sFTOH	1-Perfluoropentyl ethanol	--	--	--	--	--	--
647-42-7	6:2 FTOH	FTOH	2-Perfluorohexyl ethanol	1.8E+01	1.13E-08	18.8	251	--	--
24015-83-6	7:2 sFTOH	sFTOH	1-Perfluoroheptyl ethanol	--	--	--	--	--	--
678-39-7	8:2 FTOH	FTOH	2-Perfluorooctyl ethanol	4.0E+00	8.87E-09	2.57E+02	3.47E+03	14.19	14.19
--	9:2 sFTOH	sFTOH	1-Perfluorononyl ethanol		--	--	--	--	--
865-86-1	10:2 FTOH	FTOH	2-Perfluorodecyl ethanol	2.0E-01	1.61E-08	5.46E+03	4.68E+04	--	--
--	11:2 sFTOH	sFTOH	1-Perfluoroundecyl ethanol	--	--	--	--	--	--
39239-77-5	12:2 FTOH	FTOH	2-Perfluorododecyl ethanol	--	--	--	--	--	--
--	13:2 sFTOH	sFTOH	1-Perfluorotridecyl ethanol	--	--	--	--	--	--
375-22-4	PFBA	PFCA	Perfluorobutanoic acid	3.9E+03	5.00E-04	2.51E-01	2	0.08	0.4
375-85-9	PFHpA	PFCA	Perfluoroheptanoic acid	1.6E+02	9.07E-09	12.6	100	-0.19	-0.15
307-24-4	PFHxA	PFCA	Perfluorohexanoic acid	4.6E+02	1.03E-08	3.38	26.9	-0.16	0.7
335-67-1	PFOA	PFCA	Perfluorooctanoic acid	2.3E+00	8.26E-09	28.9	372	-0.5	3.8
2706-90-3	PFPeA	PFCA	Perfluoropentanoic acid	1.3E+03	1.32E-08	1.81	7.24	-0.1	0.4
375-73-5	PFBS	PFSA	Perfluorobutanesulfonic acid	6.3E+02	1.24E-08	2.62	10.5	0.14	0.3
355-46-4	PFHxS	PFSA	Perfluorohexanesulfonic acid	5.9E+01	8.01E-09	35.3	141	0.14	0.3
1763-23-1	PFOS	PFSA	Perfluorooctanesulfonic acid	6.8E+00	7.56E-10	150	1950	0.14	1

* Acid name of compound presented. Note that an anion form of the compound is more likely to be present in the environment. This can affect physiochemical properties and the predicted fate and transport of the compound in environmental media.

† FOSA = perfluorooctane sulfonamide, FTOH = fluorotelomer alcohol, sFTOH = secondary FTOH, PFCA = perfluoroalkyl carboxylic acid, PFSA = perfluorosulfonic acid.

‡ VP = Vapor pressure, HLC = Henry's Law Constant, °C = degrees Celsius, Pa = Pascals.

§ HLC = Henry's Law Constant is defined as the relative concentrations of a compound between an aqueous solution and gas phase at equilibrium and is reported in its dimensionless form or as a unitless fraction. pKa is the negative logarithm of the equilibrium acid dissociation constant, reported as a unitless fraction. Minimum, average and maximum values are summarized from values reported by ITRC (https://pfas-1.itrcweb.org/), last updated 2022. Average Henry's law constants, minimum and maximum pKa values were used in equilibrium partitioning calculation discussion. Among fluorotelomer alcohols, pKa values have been reported only for 8:2 FTOH (Gomis et al., 2015). pKa values for 4:2 FTOH, 6:2 FTOH and 10:2 FTOH were assumed to be similar to 8:2 FTOH in equilibrium partitioning calculations.

Table 2. Hydrostratigraphy Below New Jersey Field Site.

Hydrogeologic Unit	Geologic Age	Interpreted Depositional Environment	Geologic Description	Thickness (feet)	Hydrogeologic Description
A	Recent	Fill	Sand and gravel to clay and rubble	0-10 not including landfill areas	Generally, saturated groundwater has limited lateral extent. Saturated groundwater may be perched above A/B or part of Upper B where A/B not present.
A/B	Recent to Holocene	Marsh, Floodplain/Overbank	Organic silt, clay and peat	0-11	Aquitard. Not laterally continuous due to breaching by recent streams and on-site excavations.
Upper B	Pleistocene Cape May Formation 3 (potential Holocene component near western boundary of site)	Fluvial	Interbedded clays, silts and sands, typically with a basal sand and gravel	0-15+ in area of Salem Canal and eastern half of site	Unconfined to semi-confined aquifer
Middle B Silt	Pleistocene Cape May Formation 3	Marsh, Estuarine	Silt to clayey silt	≤5; multiple discontinuities; two larger discontinuities associated with the Pleistocene paleochannel and in the area of Bouttown Creek	
Lower B	Pleistocene Cape May Formation 3	Fluvial	Fine to medium-grained sand that often contains a gravel component near the base	<5 to 35+; thicker in area of the Pleistocene paleochannel	
B/C	Pleistocene - potentially associated with Sangamonian interglacial high stand	Marsh, Estuarine	Gray to black silt or clayey silt	0-20+ with large discontinuity present near eastern boundary just south of Henby Creek	Aquitard. Thin to absent or sandy in the eastern portion of the site and in the vicinity of the basins, but well developed along Delaware River.
C	Pleistocene Cape May Formation 2	Fluvial	Coarse sand with areas of gravel/cobbles near base	Approximately 20 or less except in the area of the Pleistocene paleochannel where thickness is 20-40	Semi-confined to confined aquifer
C/D	Pleistocene Cape May Formation 2	Marsh, Estuarine	Gray, grayish green, or black silty clay to clayey silt	5-20+ in southern half of site; 5-13 in northern half of site	Aquitard
D	Predominantly Pleistocene Cape May Formation 2 with portions consistent with Cretaceous Potomac Formation	Fluvial	Medium sand to poorly sorted coarse grained sand with some gravel	5-65; thicker in areas coinciding with the Pennsville paleovalley	Semi-confined to confined aquifer
D/E	Cretaceous Potomac Formation	Floodplain Paleosol	Dense red clay or variegated (red, white to tan, yellow and gray clay)	10-60	Aquitard (regional)
E through F	Cretaceous Potomac Formation	Fluvial	Several fining upward sequences of sand, silt and clay	300-400	PRM Aquifer System

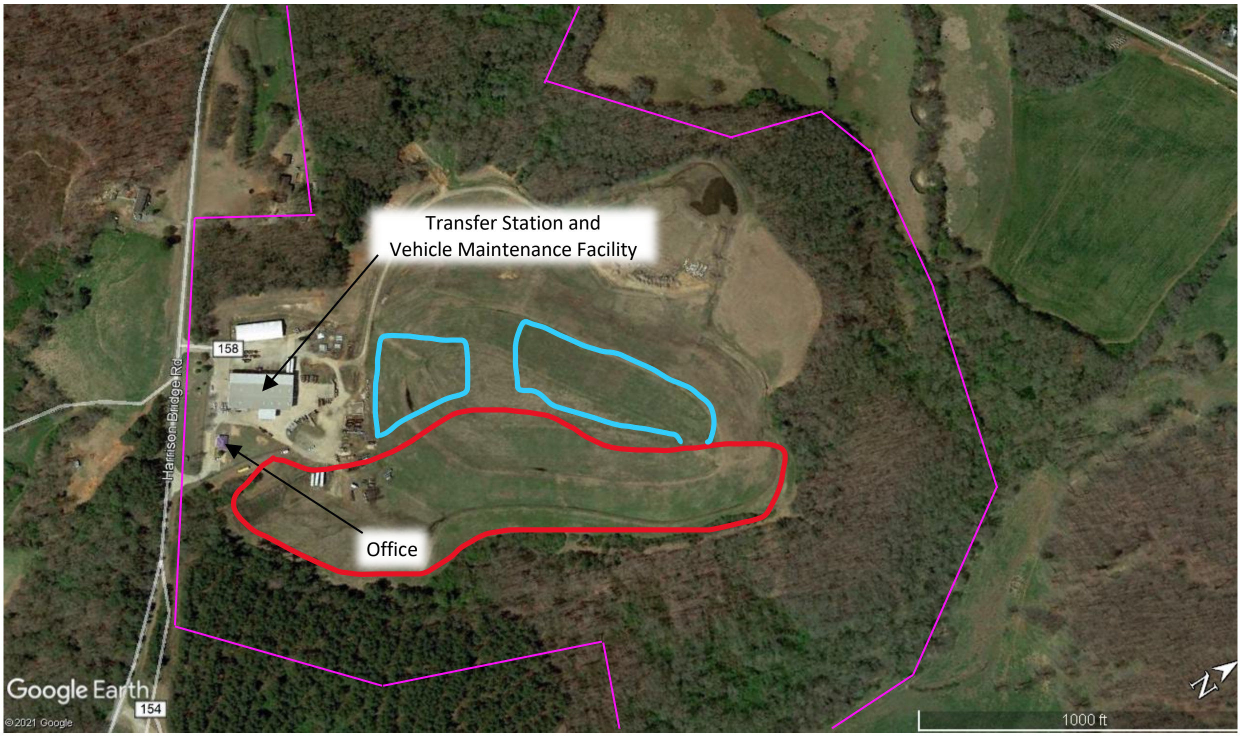


Figure 2. GA Aerial Landfill View.

Figure note: The pink outline indicates the approximate property boundary of the landfill. Reference: Google Earth. Red outline is Phase I. Teal outline is Phase 2.

The underlying geology consists mainly of interlayered biotite and amphibolite gneiss. The residual soils are typical of the Piedmont physiographic province, consisting of sandy clays with micaceous saprolite weathered from gneissic parent material (**Figure 3**). The site is gently sloping with the depth to groundwater varying from approximately 5 to 55 ft. The shallow groundwater is mostly situated in partially weathered rock. Monitoring wells, in some cases, are screened across interlayers of silty sand and sandy silt. The estimated groundwater velocity is 0.39 ft/year based on the hydraulic conductivity value from well B-2 (Jacobs, 2020).

Groundwater monitoring at the site began in 1993. The county operating the landfill submitted a minor modification in June 2000 to include the addition of approximately 13 acres along the eastern boundary of the landfill property. Methane concentrations at the site show considerable temporal variability, likely controlled by shallow soil moisture content, barometric pumping, and temperature differentials between the soil and open atmosphere. Elevated methane concentrations suggest that the waste matrix is in contact with the groundwater. A corrective action/remediation plan for methane gas migration was implemented at the site in March 2001. An Assessment of Corrective Measures (ACM) report for the landfill was submitted to the Georgia Environmental Protection Division (GAEPD). Site-related groundwater impacts were identified (Jacobs, 2020), and, after ACM approval, a public meeting was held where a Corrective Action Program (CAP) was developed (Jordan, Jones & Goulding, 2003).

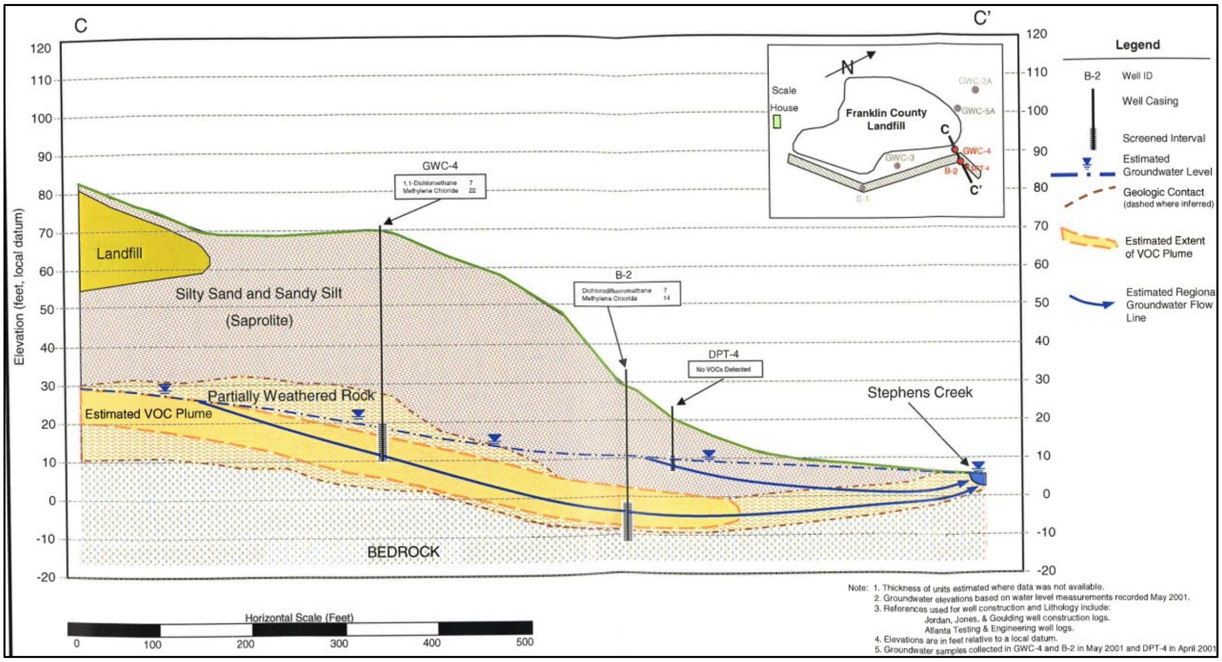


Figure 3. GA Landfill Geologic Cross-Section.

Figure note: The elevation at the site is variable, with depth to groundwater ranging from 10 to 50 feet below ground surface. Reference: reprinted from Jordan, Jones & Goulding, 2003.

The CAP consisted of three primary approaches to mitigate VOCs in groundwater: infiltration control by landfill capping, gas migration control (methane vents in cap), and monitored natural attenuation (MNA). The landfill was capped using 18 inches of clay and top-soil. Methane vents were installed in 2003. MNA monitoring began in 2004. To date, the GAEPD-approved corrective measures continue to be implemented at the facility.

Prior to this project, site-specific data were not available to indicate the presence or absence of vapor-phase PFAS at the GA site. Groundwater at the site is known to be impacted by methane and VOCs including, but not limited to, 1,1-dichloroethane, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene (Jacobs, 2020).

3 Methods

3.1 Study Design

Guiding aspects for the sampling process design (experimental design) are as follows:

- Collection of co-located groundwater, soil and soil gas samples to assess partitioning of PFAS in subsurface media.
- Use groundwater and/or soil samples to estimate the source strength concentrations of the target volatile PFAS compounds.
- Use multi-depth soil gas samples to assess attenuation of vapors away from source.
- Multiple sites were selected to represent different geologies, climates, and contaminant release histories.

Where possible, soil gas samples were collected from one foot above the water table and in subsequent one-foot increments upward to the ground surface. Subslab or subpavement samples were collected in areas where a building was located or the ground surface was capped with pavement.

Samples from each of the two sites were collected concurrently in order to provide a profile that reflects PFAS concentrations at the source and at multiple depths in the vadose zone above the source. Samples collected were analyzed for (at least) the target volatile PFAS compounds.

It was expected that the media PFAS concentrations were influenced by independent variables that have been shown to influence the VI process and VOC flux. These independent variables included barometric pressure, soil moisture, soil temperature, groundwater level, and air temperature, among others. While each of these independent variables has a potentially different site-specific time cycle, determining that cycle was not part of the scope with this exploratory research study. In general, grab samples were used with the assumption that soil gas, soil, and groundwater are in quasi-equilibrium with respect to the parameters and statistics of interest to this study.

3.2 Sample Representativeness

Sample representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring the approved plans were followed during sampling and analysis. A rigorous assessment of the representativeness of groundwater, soil and soil gas samples and subsequent data in terms of field sample collection error, laboratory processing and subsampling error and laboratory analytical error was beyond the scope of this research.

Groundwater field and laboratory data error is assumed to be minimal. Error in both cases is substantially reduced in the case of single-phase (e.g., dissolved) media. Wells accessed during the study were purged prior to sample collection only to the extent needed to stabilize field quality parameters. Groundwater within the well was then assumed to be in equilibrium with the soil immediately surrounding the borehole and reasonably representative of equilibrium conditions with the soil removed from the borehole for analysis. Confidence in the representativeness of the groundwater data is reasonably high. The data should not, however, be assumed to be reliably representative of mean PFAS impacts in groundwater outside of the immediate borehole area in the absence of data for larger-volume samples and/or additional monitoring wells.

Error associated with soil sample data could, in contrast, be relatively high. Soil sample data are particularly susceptible to field collection and laboratory subsampling error and misinterpretation of sample data (Brewer et al., 2017a,b). “Composite” sampling methods utilized and described in Section 3 were intended to reduce potential field error and increase sample representativeness. Field replicates were not collected to test the precision and reproducibility of the method used to collect a sample from an extracted core. Sample as well as subsample mass were unlikely to have met requirements under Gy’s theory of sampling for particulate matter (ITRC, 2021). This includes a minimum 1-2 kg mass for samples collected in the field and a minimum 10 gram mass for subsamples collected and tested at the laboratory. Relatively small, 200 to 300 gram samples of soil were, in contrast, collected in the field. Samples to be tested for volatile compounds should ideally be minimally disturbed and immediately placed in methanol or an alternative solvent and preservative after collection. Soil samples collected as part of this study were, however, inadvertently mixed in the field and placed in glass jars for shipment with no preservative. A half-gram subsample was subsequently collected and tested by the laboratory. Replicate laboratory subsample data were not collected to test the overall precision and reproducibility of the subsample collection method. Error in the soil data due to random, small-scale variability of PFAS concentrations in soil is, therefore, unknowable and confidence in the representativeness of the soil sample data is low.

Confidence in the representativeness of soil gas data collected as part of the study is assumed to be moderate. Concentrations of volatile chemicals in soil gas can vary dramatically over short distances due to random, small-scale changes in soil moisture or variability of organic carbon or clay. The use of single, small-volume samples of subslab soil gas to assess the intrusion and mixing of volatile chemicals in overlying structures is particularly prone to error (Brewer et al., 2014). For the purposes of this study, however, sample collection error associated with relatively small-volume (e.g., less than one liter) samples of soil gas can reasonably be assumed to be relatively low in terms of the representativeness of the initial vapors drawn into the sampling tube and the immediately surrounding soil gas. The entrainment of mists or particles into the sample collection tube may also bias the resulting laboratory data. Consideration of these factors are discussed in Section 7.

3.3 Groundwater Sampling and Analysis

3.3.1 Groundwater Sampling

Groundwater samples were collected from temporary wells installed at the New Jersey field site at depths of 137 to 152 cm (54 to 60 in) below ground surface (bgs) using a hand auger. Once the water table was reached, the probes were pushed approximately one foot deeper. The soil boring hole was filled with sand to cover the sampling tip plus 15 cm (6 inches), followed by 15 cm of dry granular bentonite, and then sealed to the surface with hydrated granular bentonite. At locations covered by pavement, a hammer drill was used to open a hole in the pavement and the probes were pushed to the desired depth using the AMS vapor probe kit. The groundwater probes consisted of a stainless-steel AMS probe with a dedicated tip and a stainless-steel screen #50 mesh. Groundwater samples were collected after an approximate 24 hour period to allow groundwater stabilization. Field measurements of pH, specific conductivity, dissolved oxygen, reduction-oxidation potential, and temperature were made using a YSI water quality parameter meter (YSI Inc., Yellow Springs, OH) with flow-through cell to ensure stabilized groundwater was collected. Samples were collected, using a low flow peristaltic pump, at a rate no greater than the recharge rate of each monitoring well (typically between 0.2 and 1 liter [L] per minute), into two 250 milliliter (mL) bottle preserved with Trizma® for non-FTOH PFAS analysis and into one 1 L unpreserved high density polyethylene (HDPE) bottle for FTOH analysis. All samples were shipped on ice to the analytical laboratories.

3.3.2 Groundwater Sample Analysis

Groundwater samples were analyzed at laboratory 1 for FTOH by gas chromatography tandem mass spectrometry (GC/MS/MS) in electron impact ionization mode following a modified USEPA Method 8270E adding the additional MS detector (USEPA, 2018). Analysis for other PFAS in groundwater was performed by liquid chromatography (LC)/MS/MS operated in negative electro-spray ionization (ESI) mode following a modified USEPA method 537 (USEPA, 2009). In brief, a 250 mL groundwater sample was fortified with isotopically-labeled extraction standards and passed through a solid phase extraction (SPE) cartridge to extract the analytes. The compounds are eluted from the solid phase with a combination of solvents. The extract is concentrated to approximately 200-300 µL with nitrogen in a heated water bath, and then reconstituted to 1 mL. All analytical instruments and sample handling instruments were free of Teflon™ and other PFAS.

3.3.3 Quality Assurance/Quality Control

One field duplicate groundwater sample was collected during the New Jersey (NJ) sampling event. The duplicate sample was analyzed to verify the reproducibility of the laboratory and field procedures based on the degree of variability among the reported concentrations. Additionally, one matrix spike and matrix spike duplicate (MS/MSD) sample was collected from one location to check accuracy and precision of the laboratory analysis. As part of the quality assurance and quality control (QA/QC) measures, one trip blank (PFAS-free deionized laboratory water) was included with the samples to check potential contamination of samples during handling, storage, and shipment from the field to the laboratory, as well as one equipment blank to check field decontamination procedures.

3.4 Soil Sampling and Analysis

Soil samples were only collected at the New Jersey field site.

3.4.1 Soil Sampling

Soil samples were a composite grab sample collected over the full length of the core (i.e., from surface to groundwater or refusal). Soil core lengths fluctuated from the surface to 107 cm (42 in), 91 cm (36 in), 91 cm (36 in), and 122 cm (48 in) bgs at locations A, B, C, and D, respectively. A 118 mL (4 oz) glass jar, two 250 mL (8 oz) HDPE bottle, and a 118 mL (4 oz) HDPE bottle (for moisture determination) were filled, after brief mixing, at each sampling location. Loss of volatile PFAS may have occurred during sample mixing leading to a potential low bias of the results. One field duplicate soil sample was collected. The 118 mL bottles were shipped to a commercial laboratory (Laboratory 1) while the 250 mL bottles were shipped to a USEPA research laboratory (Laboratory 2). All samples were shipped on ice to the analytical laboratories.

3.4.2 Soil Sample Analysis

Ten gram soil samples were analyzed at Laboratory 1 for PFAS by solvent extraction (1:1 hexane:acetone) in a CEM Corporation MARS™ Xpress microwave prior to analysis (USEPA, 2007). The soil samples were analyzed using GC/MS/MS by Method 8270E modified to include FTOHs on a Thermo Scientific 1310 GC and TSQ-8000 tandem mass spectrometer (USEPA, 2018). Other PFAS were analyzed by solid phase extraction and LC/MS/MS following Method 537 using an ExionLC system and AB Sciex Triple Quadrupole instrument (USEPA, 2009). In brief, a 250-mL water sample was fortified with surrogates and passed through a polystyrenedivinylbenzene SPE cartridge. The compounds are eluted from the solid phase and the extract concentrated to approximately 200-300 µL with nitrogen in a heated water bath. The extract was reconstituted to 1 mL with a 96:4% (vol/vol) methanol:water followed by the addition of the internal standards. Reporting limits (RLs) were 0.67 ng/g for the perfluoroalkyl carboxylic acids (PFCAs) and 20 ng/g for the FTOHs.

At Laboratory 2, soil samples were analyzed for FTOHs after the addition of surrogates and extraction in methyl tert-butyl ether (MTBE) followed by GC/MS quantitation (Ellington et al., 2009). In brief, samples were analyzed using an Agilent Technologies 6890N gas chromatograph equipped with a 5973N mass selective detector operated in the positive chemical ionization mode. The GC oven was equipped with a Restek (Bellefonte, PA) RTX-1701 (40 m×0.25 mm i.d., 0.25 µm film thickness) column. Sample volumes of 1 µL were injected in the pulse-splitless mode at 40 psi for 0.90 s into a 4-mm I.D. gooseneck inlet liner. The GC system inlet and MS interface temperatures were set at 140 and 290°C, respectively. The column temperature was programmed as follows: held at 60°C for 1 min, and then ramped up at 3°C/min to 75°C, then at 20°C/min to 185°C with ballistic heating to a final temperature of 260°C, which was held for 6 min. The carrier gas was helium at a constant flow of 1mL/min. Detection limits were defined as the concentration (ng/mL) equivalent to three times the standard deviation of replicate instrumental measurements of the low concentration standard of the target analyte in MTBE. Detection limits at laboratory 2 ranged from 0.13-0.26 ng/g with detection limits increasing as the number of carbons increased. Laboratory 2 analyzed only soil samples.

3.4.3 Soil Characterization

Field descriptive notes on the soil cores collected during New Jersey Field Event 1 at site locations A through D were recorded at the time of sampling (**Table 3**). The soil columns were segmented for visual characterization into layers based on texture, color, and redox features (i.e., mottling). Each soil core was analyzed for particle size distribution using the hydrometer method, pH in a 1:1 soil:0.01M $CaCl_2$ suspension, and total organic carbon by combustion at 1350°F and infrared detection (Kissel and Sonon, 2011).

3.4.4 Quality Assurance/Quality Control

One field duplicate soil sample was collected during the sampling event. The duplicate sample was analyzed to verify the reproducibility of the laboratory and field procedures based on the degree of variability among the reported concentrations. Additionally, one MS/MSD sample was collected from one location to check accuracy of the laboratory analysis.

3.5 Soil Gas Sampling and Analysis

3.5.1 Soil Gas Probe Installation

Two types of soil gas samples were collected at the NJ site: multilevel exterior soil gas samples and subslab soil gas samples. The multilevel exterior soil gas samples were collected east of the building where PFAS were and are being produced while subslab soil gas samples were collected inside the building or immediately under the pavement when present.

Only existing soil gas vents were sampled at the GA site.

3.5.1.1 Multilevel Exterior Soil Gas Probe Installation

Multilevel exterior soil gas probes were installed in the selected locations (**Figure 4, Table 4**) in clusters within a 30 cm (12 in) diameter. Exterior soil gas probes consisted of an AMS (AMS, Inc., American Falls, ID) stainless steel dedicated tip with a stainless steel #50 screen and silicone tubing to the surface. Locations at which the presence of cobbles or gravel stopped the AMS vapor probe from advancing, a hand auger was used to open a bore hole to the desired depth. The hole was filled with sand, dry granular bentonite, and the surface was sealed with hydrated bentonite in lifts.

The soil gas probes were installed at the desired depth using a slide hammer and 1.6 cm (0.625 in) outer diameter hollow drive rods. At locations A and B, sampling depths were 30 to 46 cm (12 to 18 in) and 61 to 76 cm (24 to 30 in) below ground surface (bgs). At location C, sample depths were 15 to 30 cm (6 to 12 in) and 46 to 61cm (18 to 24 in) bgs while at location D, samples were collected from 15 to 30 cm (6 to 12 in), 61 to 76 cm (24 to 30 in), and 91 to 107 cm (36 to 42 in) bgs. At locations B and C, the ground surface was covered by pavement and the last probe was installed at subslab level using a stainless steel Vapor Pin®.

3.5.1.2 Subslab Soil Gas Probe Installation

Two subslab soil gas probes were installed within a building at which PFAS were and are being produced. Subslab soil gas sampling ports were installed within the building by drilling a shallow 4 cm (1.5 in) hole followed by a 1.6 cm (5/8 in.) diameter hole through the remaining foundation. The subslab soil gas probes consisted of a stainless-steel Vapor Pin® with a silicone sleeve (Vapor Pin Enterprises, 2021a). Once the Vapor Pin® was secured, the top barb was covered with a silicone cap for a complete seal between the subsurface and indoor air environment and the boring holes were covered with a flush stainless steel cap. **Figure 4** shows the location at which the subslab soil gas probes were installed at the NJ site.

3.5.2 Media Preparation

Perfluorochemical analysis tubes from CAMSCO were selected, considering results from Thaxton et al. (2020), as a multibed tube suitable for analysis conducted on a thermal desorption (TD)-GC/MS/MS.

Thermal sorbent tubes are typically cleaned prior to field deployment by conditioning at approximately 300°C for a minimum of 1 hour under nitrogen flow rates of 50–100 mL/min. Tubes were certified as clean by analyzing all tubes individually for the compounds of concern before sampling. The associated batch of tubes was considered acceptable if there were no detections above the reporting limit for the target compounds.

After cleaning, each tube was sealed with Swagelok caps with inert ferrules and wrapped in aluminum foil to minimize ingress of trace levels of contaminants during storage and shipment. Wrapped tubes were shipped in sealable metal containers with packets of silica gel/charcoal. A clean refrigerator or cooler was used for the storage of clean tubes awaiting shipment to the field. Tubes were transported to the field packed in coolers with blue ice.

3.5.3 Preliminary Laboratory Method Development of Filtration

A very limited bench-scale method development effort was undertaken before the initial field test of filtration to distinguish between vapor-phase PFAS transport from particulate-phase PFAS transport . The filters were prepared by punching 6.3 mm (0.25 inch) diameter disks from a Whatman quartz microfiber filter QMA 101.6 mm circle (**Figure 5**). Filter disks were rinsed with methanol as part of the initial cleaning step. The rinsed disks were dried for several hours at ~80°C and stored covered with foil. These tests established the blank cleanliness and ability to recover spiked compounds (see **Appendix E**). Blank concentrations were not detectable at 0.1 ng per filter for most of the FTOH compounds. Recoveries after a 1 ng spike ranged from 50 to 127% for the various target compounds. Recoveries after a 10 ng spike ranged from 73 to 136% for the various target compounds.

.

Table 3. Soil Sample Log, July 2021, NJ Site.

Sample ID	Sample Depth (ft bgs)	Sample Date	Sample Time	Composite/ Grab	Contract Laboratory		USEPA		Soil Characteristics
					Container	Analysis	Container	Analysis	
CW-A-SO01-072821	0.0 – 3.5	7/28/2021	16:15	Composite	(1) Glass jar (1) HDPE jar	Moisture PFC_IDA	(2) 250 mL HDPE	PFAS	0 to 0.5 ft – coarse sand with cobbles 1.5 to 3.5 ft – coarse brown sand 3.5 ft – water table
CW-B-SO01-072921	0 – 3.0	7/29/2021	10:45	Composite	(1) Glass jar (1) HDPE jar	Moisture PFC_IDA	(2) 250 mL HDPE	PFAS	Not able to characterize. Paved area. Pavement was drilled through, and screen installed with AMS. Refusal found at 4 ft.
CW-B-SO01-072921-Dup	0 – 3.0	7/29/2021	10:46	Composite	(1) Glass jar (1) HDPE jar	Moisture PFC_IDA	(2) 250 mL HDPE	PFAS	
CW-C-SO01-072921	0.0 – 3.0	7/29/2021	9:00	Composite	(1) Glass jar (1) HDPE jar	Moisture PFC_IDA	(2) 250 mL HDPE	PFAS	0 to 1 ft – coarse sand with cobbles 1 to 1.5 ft – coarse dark sand 1.5 to 2.0 ft – pale light brown silt cohesive not plastic trace clay. Reddish/brown redox lamination features. 2 to 2.5 ft – redox features increase 3.0 ft – refusal
CW-D-SO01-072921	0.0 – 4.0	7/29/2021	12:30	Composite	(1) Glass jar (1) HDPE jar	Moisture PFC_IDA	(2) 250 mL HDPE	PFAS	0 to 2.5 ft – fine to medium sand 3.5 ft – white silt layer with redox features 4.0 ft – water table
CW-D-SO01-072921-MS	0.0 – 4.0	7/29/2021	12:30	Composite	(1) Glass jar (1) HDPE jar	Moisture PFC_IDA	(2) 250 mL HDPE	PFAS	
CW-D-SO01-072921-MSD	0.0 – 4.0	7/29/2021	12:30	Composite	(1) Glass jar (1) HDPE jar	Moisture PFC_IDA	(2) 250 mL HDPE	PFAS	

Table 4. Soil Gas Sampling Log, July 2021, NJ Site.

Sample ID	Sample Depth (ft bgs)	Tube ID	Sample Date	Start Time	End Time	Flow Rate (mL/min)	Volume Collected (mL)	Portable Chemical Detector Readings				
								VOCs (ppm)	Oxygen (% V/V)	LEL (%)	H2S (ppm)	CO (ppm)
Subslab Soil Gas Samples												
CW-1156-SG01-072821	Below building slab	1172721	7/28/2021	12:35	12:36	<100	100	1.3	20.9	0.0	0.0	0.0
CW-1156-SG01-072821		1172870		12:36	12:37	<100	100					
CW-1156-SG02-072821	Below building slab	1172867	7/28/2021	13:05	13:06	<100	100	3.6	19.5	0.0	0.0	0.0
CW-1156-SG02-072821		1172870		13:06	13:07	<100	100					
Exterior Soil Gas Samples												
CW-A-SV01-1.5-073021	1.0 – 1.5	1172594	7/30/2021	11:47	11:50	~50	100	0.4	19	2.0	0.0	0.0
CW-A-SV01-1.5-073021		1172504		11:51	11:54	~50	100					
CW-A-SV02-2.5-073021	2.0 – 2.5	1161969	7/30/2021	11:18	11:20	~50	100	0.5	19.9	0.0	0.0	0.0
CW-A-SV02-2.5-073021		1161953		11:22	11:25	~50	100					
CW-B-SV01-SS-073021	Below parking lot pavement	1172827	7/30/2021	14:00	14:02	~50	100	1.6	9.2	6.0	0.0	0.0
CW-B-SV01-SS-073021		1161736		14:03	14:05	~50	100					
CW-B-SV02-1.5-073021	1.0 – 1.5	1172823	7/30/2021	14:16	14:18	~50	100	1.2	8.5	7.0	0.0	0.0
CW-B-SV02-1.5-073021		1162005		14:18	14:21	~50	100					
CW-B-SV03-2.5-073021	2.0 – 2.5	1162485	7/30/2021	14:36	14:37	~50	100	1.0	8.4	7.0	0.0	0.0
CW-B-SV03-2.5-073021		1161824		14:39	14:41	~50	100					
CW-C-SV01-SS-073021	Below pavement	1172537	7/30/2021	9:14	9:19	200	1,000	0.0	19	0.0	0.0	0.0
CW-C-SV01-SS-073021		1161737		9:20	9:20	100	100					
CW-C-SV01-SS-073021	Below pavement	1172537	7/30/2021	9:14	9:19	200	1,000	0.0	19	0.0	0.0	0.0
CW-C-SV01-SS-073021		1161737		9:20	9:20	100	100					
CW-C-SV02-01-073021	0.5 – 1.0	1161802	7/30/2021	8:53	8:58	200	1,000	0.1	18.2	0.0	0.0	0.0
CW-C-SV02-01-073021		1162008		9:00	9:00	100	100					
CW-C-SV03-02-073021	1.5 – 2.0	1162393	7/30/2021	9:40	9:45	200	1,000	0.1	19	0.0	0.0	0.0
CW-C-SV03-02-073021		1172983		9:46	9:47	<100	100					
CW-D-SV01-01-073021	0.5 – 1.0	1162010	7/30/2021	12:49	12:53	~50	100	7.1	12	5.0	0.0	0.0

Sample ID	Sample Depth (ft bgs)	Tube ID	Sample Date	Start Time	End Time	Flow Rate (mL/min)	Volume Collected (mL)	Portable Chemical Detector Readings				
								VOCs (ppm)	Oxygen (% V/V)	LEL (%)	H2S (ppm)	CO (ppm)
CW-D-SV01-01-073021		1172862		12:54	12:57	~50	100					
CW-D-SV02-2.5-073021	2.0 – 2.5	1161685	7/30/2021	13:15	13:18	~50	100	12	12	6.0	0.0	0.0
CW-D-SV02-2.5-073021		1162013		13:19	13:21	~50	100					
CW-D-SV03-3.5-073021	3.0 – 3.5	1161750	7/30/2021	13:40	13:40	~50	10	25	12.5	5.0	0.0	0.0
CW-D-SV03-3.5-073021		1172663		13:42	13:43	~50	100					
CW-Blank-073021[2]	N/A[1]	1172950	7/30/2021	14:43	14:48	200	1,000	N/A[1]	N/A	N/A	N/A	N/A
Subslab Soil Gas Samples												
CW-SG01-120921-A1T	Below building slab	1172950	12/9/2021	8:55	8:57	<100	100	3.4	20	0.0	0.0	0.0
CW-SG01-120921-B1T	Below building slab	1172509	12/9/2021	9:05	9:07		100					
CW-SG01-120921-B1F	Below building slab	1172509	12/9/2021	9:05	9:07		100					
CW–SG01-120921-A2T	Below building slab	1162009	12/9/2021	9:15	9:17		100					
CW-SG01-120921-B2T	Below building slab	1172532	12/9/2021	9:25	9:27		100					
CW-SG01-120921-B2F	Below building slab	1172532	12/9/2021	9:25	9:27		100					
CW-SG01-120921-C1T	Below building slab	1162084	12/9/2021	9:37	9:37		25					
CW-SG01-120921-D1T	Below building slab	1172504	12/9/2021	9:45	9:45		25					
CW-SG01-120921-D1F	Below building slab	1172504	12/9/2021	9:45	9:45		25					
CW-SG01-120921-A3T[c]	Below building slab	1162008	12/9/2021	9:53	9:54		100					

[1] N/A = not applicable.

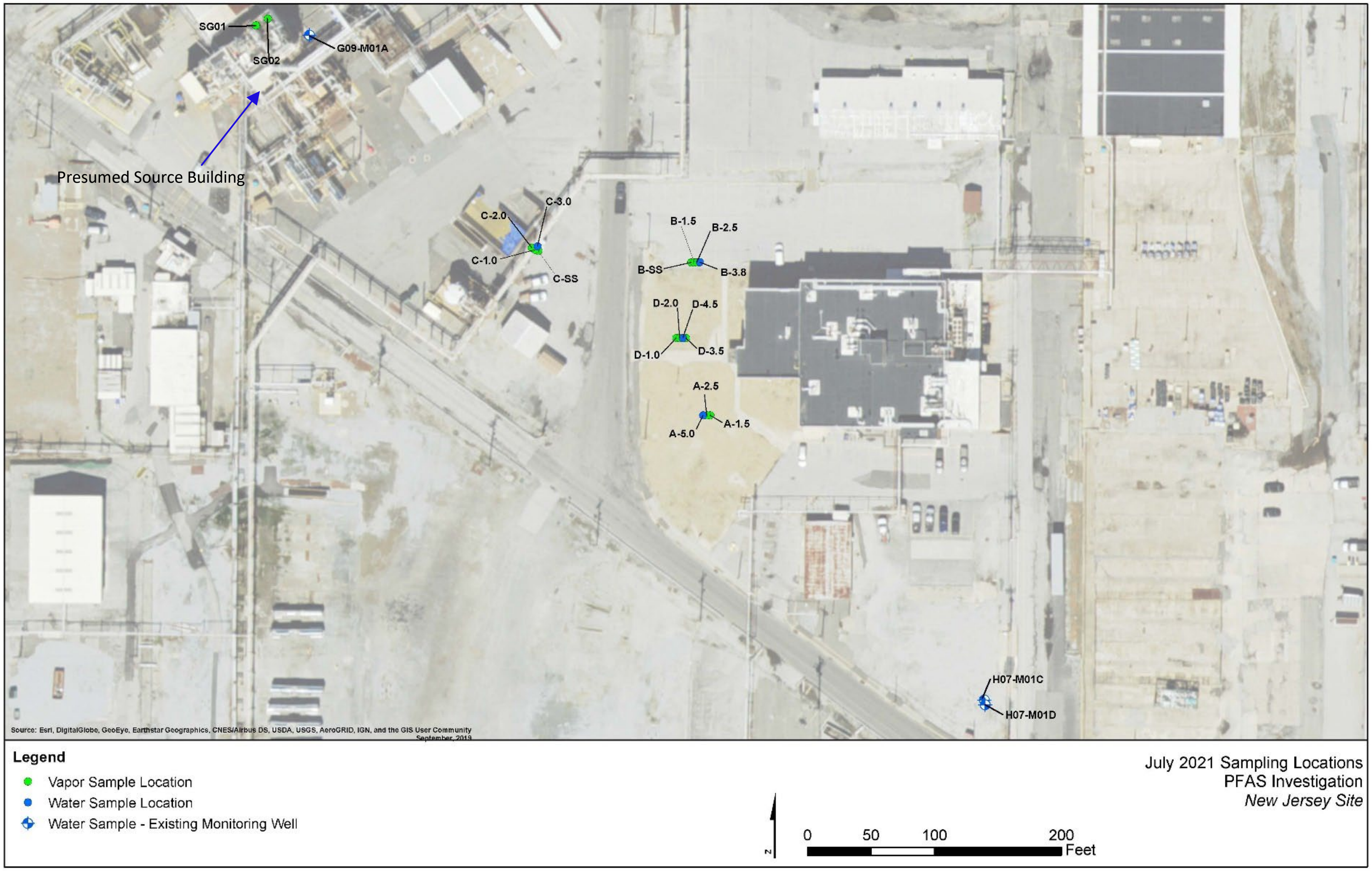


Figure 4. Sampling Locations for the NJ Site*.

* - letters designate sampling location. SS or numbers are the sampling depths bgs with SS = subslab.

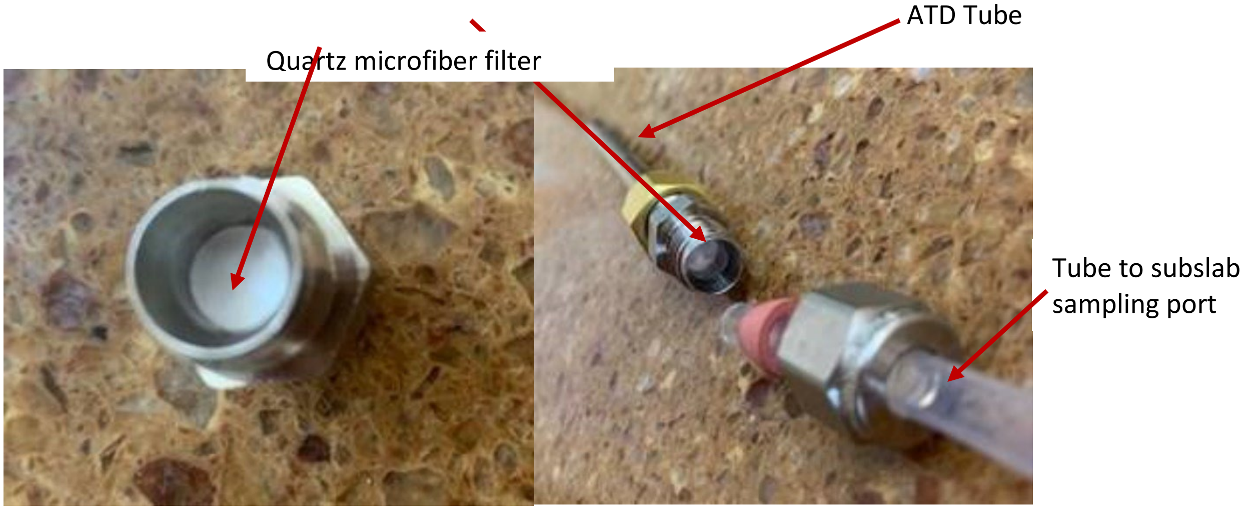


Figure 5. Filter Apparatus.

The bench-scale tests did not evaluate the potential adsorption of gas phase PFAS on the filter during sample collection. The effectiveness of the filter in retaining particulate-phase PFAS during sample collection was also not addressed. Additionally, no data were collected to determine the storage stability of PFAS on the filter. Further research to address these three concerns is being conducted under a separate research effort.

Exterior and subslab soil gas samples were collected using multibed thermal sorbent tubes. Each sampling probe was leak checked and purged prior to sampling to ensure that the probe seal was intact as described below.

3.5.4 Leak Checking

Exterior Soil Gas Probes. The exterior soil gas probes were leak checked using the “tracer leak check” method, using helium as the tracer (ITRC 2007). The method consisted of placing a leak enclosure over the sampling probe and flooding it with helium for approximately 5 minutes. At the same time, the probe was purged using a sampling manifold (consisting of stainless-steel Swagelok® gas-tight valves and fittings) and a vacuum pump. Approximately 1 liter (about three system volumes) of soil gas was purged at a rate of up to 200 milliliters per minute (mL/min) into a Tedlar® bag and screened with a helium detector (Dielectric MGD-2002). Readings that were less than 1 percent of the helium concentrations in the Tedlar® bag purge gas indicated that the probe passed the leak check. In contrast, He readings inside the shroud ranged between 13 and 25%. VOC readings were also collected from the purged gas using a handheld photoionization detector (MiniRAE).

Subslab Soil Gas Probes (Vapor Pins®). Vapor Pins® installed inside the selected building at the NJ site were leak checked using the “water dam leak check” method (Vapor Pin Enterprises, 2021b). This leak check was performed by adding water to the bore hole making sure to cover the connection point of all tubing and silicone sleeve of the Vapor Pin®. The probe was then purged using the sampling manifold and a vacuum pump. A total of 1 L (about three system volumes) of subslab soil gas was purged at a rate of 200 mL/min for a period of approximately 5 minutes into a Tedlar® bag. If no observable drawdown of the water or bubbles were noted during purge, the Vapor Pin® passed the leak check. Once the leak check was completed, the water was removed from the Vapor Pin® bore hole and VOC readings were collected from the purged soil gas.

3.5.5 Sample Volume

Sample volumes were guided by total soil gas photoionization detector (PID) readings obtained during vapor probe purging to minimize the chance of overloading the analytical system (**Table 5**). Two sample volumes were collected from each exterior and subslab soil gas sample location: (1) 100 mL sample and (2) based on PID readings (<2 ppm, 1 L sample collected; between 2 and 20, a second 100 mL sample collected; >20 ppm, 10 mL sample collected). Sample volumes of 100 mL or less were collected using a 60 mL gas-tight syringe while volumes greater than 100 mL were collected using a vacuum pump. Sampling flow rates were kept at less than 200 mL/min. The soil gas samples were collected on clean multibed perfluorochemical thermal sorbent tubes from CAMSCO (Thaxton et al., 2020). One field blank was collected from ambient air. All samples were shipped on ice to the analytical laboratory.

Table 5. Maximum Soil Gas Sample Volumes Collected as Determined by PID Reading.

PID Reading (ppm)	Maximum Sample Volume
< 2	1 L
2 to 20	Collect a 2nd 100 mL sample
>20	10 mL

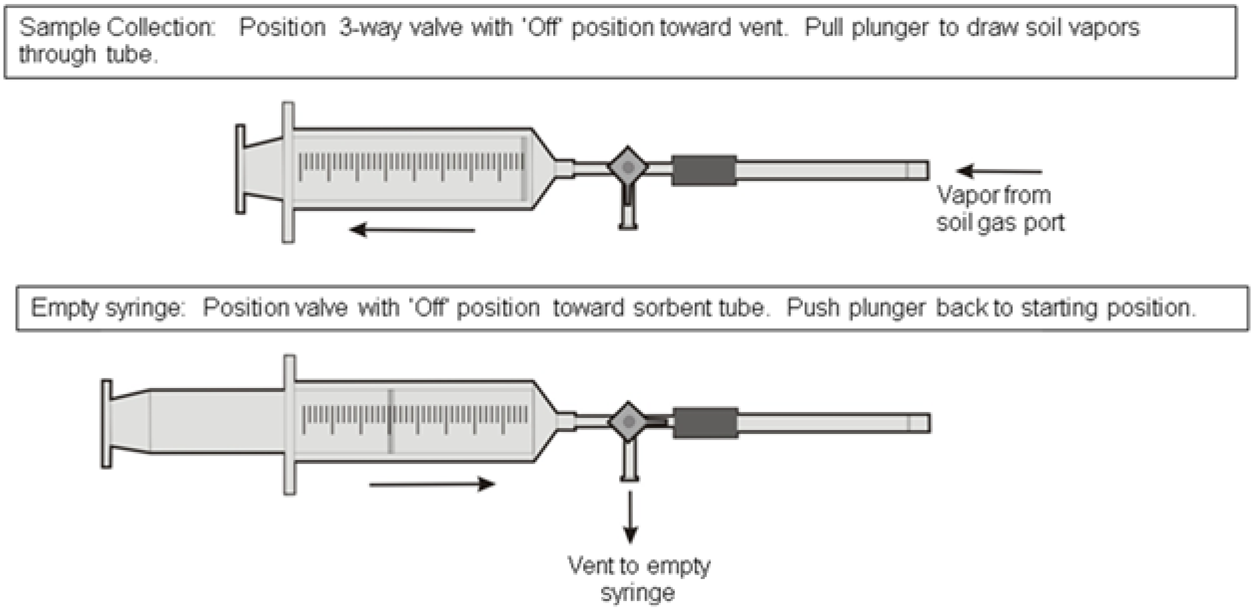
The laboratory analyzed the lower volume sample first. If substantial concentrations of PFAS compounds were observed in the lower volume sample, then the higher volume sample was not analyzed to avoid overloading the instrument.

3.5.5.1 Sample Collection—Volumes of 100 mLs or Less

PFAS in soil gas were determined by modified USEPA Compendium Method TO-17 following purging (USEPA, 1999). A measured volume of soil vapor was pulled through a CAMSCO sorbent tube using a gas-tight syringe.

3.5.5.2 Sample Collection—Volumes of 100 mLs or Less

Although Method TO-17 (USEPA, 1999) describes the use of sample pumps to pull a volume of vapor through the sorbent tube, the small soil vapor volumes often used in soil gas sampling is most efficiently collected using a gas-tight syringe. Syringes, such as the BD gas-tight 50 mL Luer-Lok™ syringes, have sufficient accuracy to meet the TO-17 performance criterion of ±10%. As noted above, prior to sampling, at least 1 L of soil gas was (three system volumes) purged at each probe. Samples were collected with a slow rate of draw at a rate of no greater than 200 mL/min. The syringe was connected to a 3-way valve to allow for multiple aliquots of soil vapor through the same sample tube, as shown in **Figure 6**. The outlet side of the tube was attached to the tube holder on the syringe assembly, and the inlet of the tube is attached to the soil gas probe tubing using a Swagelok® union and nut assembly. Any air discharged from the purging port was vented into a Tedlar® bag which was emptied outside once the sample was collected.



Sample Collection: Position 3-way valve with 'Off' position toward vent. Pull plunger to draw soil vapors through tube.

Empty syringe: Position valve with 'Off' position toward sorbent tube. Push plunger back to starting position.

Figure 6. Example Syringe Assembly for USEPA Method TO-17 Soil Gas Collection.

After sample collection, the Swagelok® caps with inert ferrules were used to seal the tube. Tubes were re-wrapped in foil and replaced in the metal containers for shipment. After packing in coolers with blue ice, the cooler was sent to the laboratory via overnight shipping.

3.5.5.3 Sample Collection—Volumes Greater than 100 mLs

Sample volumes of more than 100 mLs were collected using a low flow peristaltic pump (battery-powered) with rotameter capable of a flow rate set to less than 200 mL/min. The pump inlet was connected to the outlet side of the tube and the tube inlet was connected to the soil gas probe tubing using a Swagelok® fitting assembly. Once the system was set, the vacuum pump was turned on and ran for 5 minutes for a total volume of 1 L or less depending on the desired volume.

3.5.6 Quality Assurance/Quality Control

Two soil gas samples of differing volumes (see Section 3.5.5) were collected at each location to determine best sample volume and accuracy of field and laboratory procedures. Additionally, one field blank was collected from ambient air at the site. The volume of the field blank was chosen based on the maximum volume of sample collected during the sampling event.

The CAMSCO sorbent tubes were individually analyzed and shown to be non-detect at the reporting limit before they were sent to the field. A lab blank was prepared by spiking a sorbent tube with internal standard in the same manner as field samples and analyzed with each batch of samples after the initial QC samples and prior to field sample analysis.

3.5.7 Soil Gas Analysis

Soil gas and subslab soil gas samples were analyzed by TD-GC/MS/MS following Method TO-17, modified to include tandem MS (USEPA, 1999). Sample tubes and filters were thermally desorbed using a Gerstel TD 3.5+ with A/S onto an Agilent Technologies 8890 gas chromatograph configured with a Gerstel Cooled Injection System focusing trap at a contract laboratory (Folsom, California). The system was equipped with an Agilent 7000D triple quadrupole mass spectrometer operated in the electron ionization (EI) mode and using multiple reaction monitoring (MRM) for targeted analysis. Tubes and filters were desorbed at 300°C for 5 minutes in the splitless mode with transfer to a quartz wool focusing trap at -130°C. The trap was heated to 275°C with a hold time of 4 minutes at a split flow of 5 mL/min (low concentration configuration) or 200 mL/min (high concentration configuration). The GC oven was equipped with an Agilent DB-624 UI (60 m x 0.25 mm x 1.4 µm) with the oven program starting at 40°C and held for 3 minutes, followed by a 15°C/min ramp to a final temperature of 230°C and held for 4.34 minutes. The carrier gas was helium at a constant flow of 1 mL/min. The MS source temperature and transfer line were 250°C. Reporting Limits were 0.10 ng using the low concentration 5 mL/min split flow configuration or 5.0 ng using the high concentration 200 mL/min split flow configuration.

The method met all of the TO-17 (USEPA, 1999) calibration requirements for the PFCA compounds which were calibrated using National Institute of Standards and Technology traceable standard solutions introduced through the thermal desorption system and using characteristic MRM transitions based on precursor mass ions identified in the PFCA full scan spectra. However, subsequent detailed studies comparing direct injection of perfluorooctanoic acid (PFOA) standards into the GC inlet to PFOA standards thermally desorbed from a sorbent tube suggested that PFOA was breaking down during the thermal desorption sample introduction step. The primary peak resulting from the thermal desorption of PFOA standard had a spectrum consistent with perfluoro-1-heptene (PFHP), suggesting that an inadvertent derivatization was occurring. Therefore, the identification of the PFCA compounds using this method are currently subject to a potential positive interference from the corresponding perfluoroalkene. Studies investigating thermal treatment of PFAS-impacted soils and spent water purification filters report PFHP as a primary breakdown product of PFOA at temperatures 200-400°C as well as other perfluorinated products, specifically perfluoroalkenes, supporting our supposition (Alinez et al., 2022; Xiao et al., 2020.)

4 Sample Collection

4.1 NJ Site

4.1.1 NJ Site Sampling Locations

The soil vapor and groundwater sample locations for the NJ site are presented in **Figure 4**. Soil samples were collected from the borehole used to install monitoring well points. Soil vapor sampling points were installed within a 30 cm (12 in) radius of the groundwater well.

4.1.2 NJ Field Event 1 (July 2021)

4.1.2.1 Field Observations

Four exterior soil gas sample locations were selected at the NJ site. The selected areas are identified as Areas A, B, C, and D. Two subslab soil gas samples were also collected at the building located at the northwestern area of the NJ site area (**Figure 4**).

The areas at which the four exterior sample locations (A through D) were installed were unvegetated, industrial areas of the site at varying distances and directions downgradient from the presumed source building. Historical reports suggested that historical building foundations may have existed at planned sampling locations A and D. Those areas were covered with gravel which was removed before the utility clearance and soil gas probe installation. Field observations indicated that the soil beneath the gravel was mainly a mix of coarse and medium sand with cobbles. Location B was constructed in a paved parking lot. The ground surface at location C was right on the edge of a paved road. A subslab Vapor Pin® was installed in the pavement (at the edge of the road) at location C. The other subsurface samples were installed in a gravelly sand area at location C.

At location B, two attempts were made to reach the water table; however, refusal occurred at 122 cm (48 in) bgs. At location C, four attempts were made to reach the water table but refusal occurred at 91 cm (36 in) bgs. Soil stratigraphy at the sampling locations is reported in the soil sample log (**Table 3**).

4.1.2.2 Soil Sampling

Soil samples collected are described in **Table 3**. Soil composites were collected over the full length of the listed/logged intervals except for CW-B-SO01, where the composite was collected from 0 to 91 cm (0 to 36 in) because of the proximity to an underground water line.

4.1.2.3 Groundwater Sampling

Groundwater sampling was planned at all four locations (A through D). However, at locations B and C refusal was encountered before groundwater was reached so no groundwater could be collected. The collected groundwater samples are described in **Table 6**.

4.1.2.4 Soil Gas and Ambient Air Sampling

The soil gas and ambient air samples collected are summarized in **Table 4**. In addition to the soil gas samples, a 1 L ambient air sample (identified as the blank) was collected using a low flow peristaltic pump at about 200 mL/min near location B in the parking lot.

4.1.3 NJ Field Event 2 (December 2021)

A second field event was conducted (Field Event 2, December 2021) to confirm the first round subslab soil gas results in a different season and to attempt to empirically observe the distribution of PFAS between the vapor and any possible particulate or moisture-based transport phases. Six samples were collected at the two previously installed subslab locations. Samples were collected in an A/B/A/B/C/D pattern per subslab port, to separate the effects of sequential sample volume removals, where A was a 100 mL unfiltered sample, B was a 100 mL filtered sample, C was a 25 mL unfiltered sample, and D was a 25 mL filtered sample. Filtered samples were collected using an in-line quartz microfiber filter (Whatman quartz microfiber QM-A) placed between the thermal desorption tube and the sampling port in a Swagelok® union fitting prior to sample collection (**Figure 6**). The filter samples were analyzed separately for particulate phase PFAS. To evaluate filter cleanliness, the filter disk was inserted into the sampling inlet of a clean CAMSCO perfluorochemical sorbent tube, positioning the filter flat against the front sorbent bed to maintain analytical comparability. No compounds were detected above the analytical reporting limit.

The outside weather was cool 4°C (39°F), breezy, and clear on the sampling date. The doors to the area where the subslab sampling points were located were shut when the sampling team arrived, and indoor heaters had the inside temperature at approximately 27°C (80°F). The doors were propped open as the sampling team worked. Water on the floors was observed and was believed to be steam condensate from the various steam lines used to keep the manufactured products at the site warm and, thus, more flowable.

The soil vapor port was sealed between draws and waste soil vapors were discharged into Tedlar® bags rather than into the ambient atmosphere. Leak tests were performed before each sample was collected and Zip ties were used to further seal the tubing around sample port. One field blank sample was collected at the end of the sampling effort. The blank was collected by holding an uncapped sampling tube in the ambient air of the packaging room for two minutes.

Each sampling train was water dam leak checked and after any necessary tightening, all the sampling trains passed the test. All samples were collected while making sure the tubes were held vertical.

Fifteen TO-17 CAMSCO PFAS/PFCA sorbent tubes and seven quartz microfiber filters were received by the contract laboratory on December 10, 2021. Tubes and filters were received in a cooler preserved using ice packs with each capped tube and filter assembly stored in an aluminum vial sealed with a screw top cap. The receipt temperature was 5.6°C which was within 4+2°C. Sample tubes and filters were stored capped in their vials at 4+2°C until analysis.

4.2 GA Site

4.2.1 GA Site Sampling Locations

Table 7 summarizes the considerations used in the selection of each monitoring location. The ground surface at the site slopes downward from the landfill cap to a creek on the eastern side of the site. The water table is generally encountered between approximately 10 to 50 ft bgs but may be shallower or deeper throughout the site.

Three existing groundwater monitoring wells (B-2, GWC-4, and GWC-5a) and six existing gas monitoring locations (including the headspace of the three groundwater monitoring wells) were selected for initial soil gas sampling (B-2, GWC-4, GWC5a, Vent #2, Vent #7, and MM-7a) (**Figure 7**). The landfill clay cap is believed to follow the approximate limits of the waste placement; therefore, these monitoring locations are at various distances beyond the cap. Most of the vents at the sites are constructed as multi-depth clusters. Currently, under GAEPD guidance, the entire unsaturated zone, from approximately 4 ft bgs to the top of the saturated zone or competent rock, is required to be monitored for methane (GAEPD, 2015). This approach guided the construction of the methane monitoring point MM-2R. The other historical methane monitoring points (indicated with “MM” labels) within the property boundary were likely installed shallower than the groundwater table or top of bedrock, as previous custom was to install only as deep as the adjacent landfill cell.

Locations were selected based on their proximity to the landfill cap and each other, historical monitoring results, and their variability amongst each other in screened depth and natural attenuation assessments (that is, aerobic and anerobic environments). These locations exist nearby on the eastern side of the site, but not inside the limits of waste disposal. Existing buildings on site, consisting of an administrative office and historical vehicle maintenance area, are located on the western side of the property.

Table 6. Groundwater Sample Log, July 2021, NJ Site.

Sample ID	Sample Depth (ft bgs)	Sample Date	Sample Time	Composite or Grab	Contract Laboratory		USEPA		Comments
					Container	Analysis	Container	Analysis	
CW-A-GW01-05-072921	4.5 – 5.0	7/29/2021	15:00	Grab	(2) Preserved 250 mL HDPE (1) 1 L HDPE	PFC_IDA FTOH	(2) 250 mL HDPE	PFAS	
CW-A-GW01-05-072921-MS	4.5 – 5.0	7/29/2021	15:00	Grab	(1) Preserved 250 mL HDPE	PFC_IDA FTOH	(1) 250 mL HDPE	PFAS	QC Sample
CW-A-GW01-05-072921-MSD	4.5 – 5.0	7/29/2021	15:00	Grab	(1) Preserved 250 mL HDPE	PFC_IDA FTOH	(1) 250 mL HDPE	PFAS	QC Sample
CW-D-GW01-4.5-072921	4.5 – 5.0	7/29/2021	15:50	Grab	(2) Preserved 250 mL HDPE (1) 1 L HDPE	PFC_IDA FTOH	(2) 250 mL HDPE	PFAS	
CW-D-GW01-4.5-072921-DUP	4.5 – 5.0	7/29/2021	15:55	Grab	(1) Preserved 250 mL HDPE (1) 1 L HDPE	PFC_IDA FTOH	(2) 250 mL HDPE	PFAS	QC Sample
CW-Blank-073021	NA	7/30/2021	15:30	Grab	(2) Unpreserved 250 mL HDPE	PFC_IDA FTOH	(2) 250 mL HDPE	PFAS	Blank – PFAS free water
CW-EB-073021	NA	7/30/2021	16:00	Grab	(2) Preserved 250 mL HDPE (1) 1 L HDPE	PFC_IDA FTOH	(2) 250 mL HDPE	PFAS	DI water

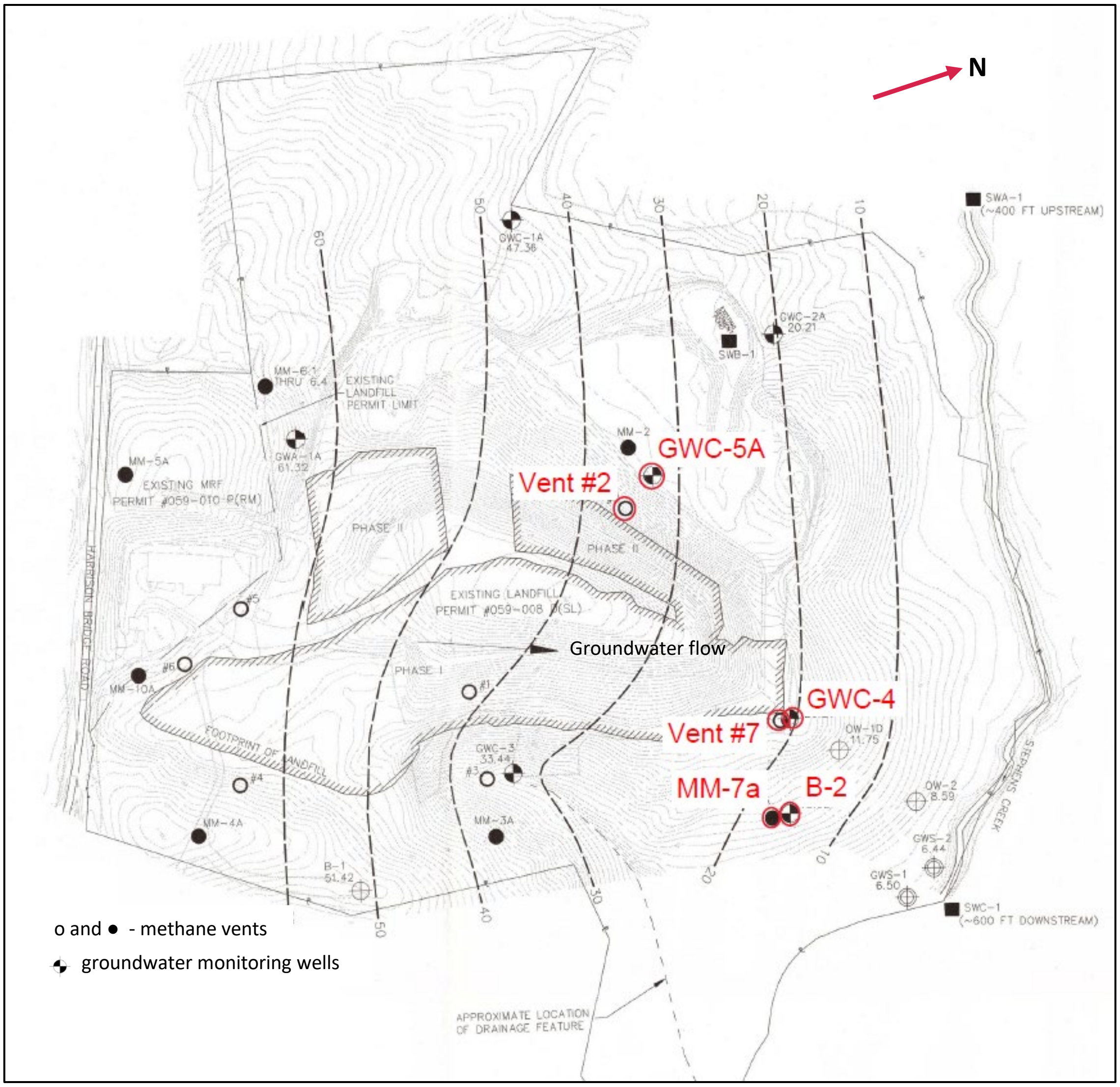


Figure 7. GA Landfill Monitoring Network.

Note: Locations emphasized in red font were initially proposed for groundwater and/or soil gas screening. Reference: Base map adapted from Jacobs, 2020.

Table 7. GA Site Monitoring Location Selection Considerations.

Monitoring Location	Location Type	Proximity to Waste Extent	Depth(s) (feet below ground surface)	Historical Data Trends	Selected Screening Media
B-2	Groundwater Monitoring Well	Approximately 300 ft downgradient of waste disposal limit	Bottom of well: 45.5 Water: 19.8	Anaerobic VOCs present (increase after 2002; decreasing trend since 2009 maximum). Increasing trend of chlorinated ethenes (primarily cis-1,2-dichloroethene [c-DCE]).	Groundwater Well-head gas
MM-7a	Methane Monitoring Point	Immediately adjacent to B-2	Bottom of well: 15 Screen: 5 – 15		Soil gas
GWC-4	Groundwater Monitoring Well	Immediately near the waste disposal limit	Bottom of well: 59.9 Water: 52.3	Aerobic VOCs present (increase after 1998; variable concentrations since 2009 maximum). Increasing trend of chlorinated ethenes (primarily c-DCE).	Groundwater Well-head gas
Vent #7 (field screen multiple depths, select for initial sampling a deep depth with high methane)	Methane Vent	Immediately adjacent to GWC-4	Depth of 7/1: 41.38 Depth of 7/2: 32.76 Depth of 7/3: 25.10 Depth of 7/4: 16.86 Depth of 7/5: 78.10	Passive gas vent.	Soil gas
GWC-5a	Groundwater Monitoring Well	Approximately 150 ft side-gradient of Phase II waste disposal limit	Bottom of well: 26.4 Water: 13.3	Generally lowest observed VOC and chlorinated ethene concentrations.	Groundwater Well-head gas
Vent #2	Methane Vent	Immediately adjacent to Phase II waste disposal limit, south of GWC-5a	Depth of well: unconfirmed	Passive gas vent.	Soil gas

4.2.2 GA Field Event 1 (September 2021)

4.2.2.1 *Initial Screening of Soil Gas*

Weather on the sampling date was reported as sunny to partly cloudy with temperatures above 21°C (70°F). Winds were 8-16 kilometers per hour (5-10 miles per hour) from the west. Initial screening of soil gas was completed using a MultiRAE portable chemical detector equipped with 10.7 eV bulb and GEM 5000 Landfill Gas Meter. Subsequent soil gas screening was conducted following the collection of sorbent tube samples. At the methane vents selected for soil gas monitoring, the space immediately at the outlet of the vent was monitored for total nonmethane VOCs, carbon monoxide, carbon dioxide, methane, hydrogen sulfide, and oxygen. Field operators were expected to keep the vent opening outside of their breathing zone. The headspace was monitored using the same protocol as the vents immediately upon opening the monitoring well and removing the protective cap at monitoring locations selected for both groundwater and soil gas screening.

4.2.2.2 Groundwater Sampling

Following the screening and sampling of soil gas, initial screening of groundwater was completed by using a low-flow, stainless-steel pump to extract groundwater from the three selected wells, at a rate no greater than the recharge rate of each monitoring well (225 to 300 mL/minute). Groundwater quality parameters were monitored with a YSI 6820 Multi-Parameter Water Quality Meter. Water quality parameters were continually measured and purging was continued until stabilized readings were obtained. Parameters measured included pH, oxidation reduction potential, dissolved oxygen, turbidity, temperature, salinity, and specific conductance. Before beginning purge and sample collection activities, a depth to water reading was recorded. The groundwater samples collected are summarized in **Table 8** and field parameters are presented in **Table 9**.

4.2.2.3 Soil Gas Sampling

Soil gas samples were collected from the vents and well headspaces with volumes collected from each location dependent upon the PID reading (**Table 10**). The sample locations collected are summarized in **Table 11**. Jewell and Wilson (2011) showed the approach of sampling soil gas from conventional groundwater monitoring wells could be as effective as sampling from vapor probes corroborating the validity of our sampling process.

5 Results

Data as well as conclusions presented in this report should be considered preliminary in nature and intended primarily to help guide future research. The amount and quality of sample data collected as part of the field research was limited and should not be assumed to be representative of similar potential PFAS source sites.

Information on the toxicity of the targeted, volatile PFAS is also very limited and the potential health risk posed by these specific compounds could not be quantified at the time of this report. Statements regarding the concentration of a compound being “low” or “high” should, therefore, be taken in relative terms only and not specifically indicative of actual risk.

5.1 Preliminary Screening of NJ Site Groundwater

5.1.1 Sample Results

Results of samples collected in January 2021 are presented in **Table 12** (FTOH) and **Table 13** (Perfluoroalkyl Acids; PFAA). FTOHs were only detected in G09-M01A located directly near the building. FTOHs were not detected in the deeper interval at sample location H07-MO1C located approximately 500 ft downgradient. The highest concentrations among the PFCAs were for perfluorohexanoic acid and perfluorooctanoic acid in the groundwater sample (G09-M01A) near the building. As indicated in **Table 12** and **Table 13,** a total of sixteen PFAS compounds were detectable in the G09-M01A sample.

5.1.2 QA/QC

As a result of suspected matrix interferences, the volume extracted was reduced from 274 mL to 2.5 mL for the second analytical attempt. Recovery of the FTOH laboratory control spike was outside QC acceptance limits. Recovery of the surrogates in the FTOH analysis was below the advisory range for the G09-MO1A sample which suggests a low bias in the sample analysis. In the LC/MS/MS analysis of the PFCA compounds, recoveries in the laboratory control spike were outside of QC acceptance limits as were recoveries of the labeled standards. The laboratory qualified the PFCA data as having a low bias in the G09-M01A sample. The laboratory qualified the PFOA result in sample H07-M01C as having a low bias and several of the PFCAs as having a low bias in the H07-M01C-D sample. There were no detections of target analytes in the equipment blank.

Table 8. Groundwater Sample Log, September 2021, GA Site.

Sample ID	Sample Date	Sample Time	Composite or Grab	Contract Laboratory		USEPA	
				Container	Analysis	Container	Analysis
FCL – Blank – GW – 081921 (QC sample)	8/19/2021	10:15	Grab	(2) 250 mL HDPE (1) 1 L HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)	(2) 250 mL HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)
FCL – GWC4 – GW – 081921	8/19/2021	11:15	Grab	(2) 250 mL HDPE (1) 1 L HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)	(2) 250 mL HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)
FCL – B2 – GW – 081921	8/19/2021	14:25	Grab	(2) 250 mL HDPE (1) 1 L HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)	(2) 250 mL HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)
FCL – GWC5A – GW – 081921	8/19/2021	15:45	Grab	(2) 250 mL HDPE (1) 1 L HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)	(2) 250 mL HDPE	PFC_IDA – Project Specific PFAS Compounds by ISO D FTOH – Fluorotelomer Alcohols (GC/MS/MS SIM)

Table 9. Groundwater Field Parameters, September 2021, GA Site.

Well ID	Water Level ft Below Top of Casing	Temperature, C	pH	ORP (MV)	Specific Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)
GWC-4	55.7	18.5	5.0	215.8	93.6	10.4	0.77
GWC-5a	18.0	19.3	5.22	68.2	93.	13.5	0.57
B-2	24.88	17.2	5.28	154.3	154.9	3.12	0.89

Table 10. Recommended Maximum Soil Gas Sample Volume Guidance Specific to Expected Interferences at the GA Site.

PID Reading (nonmethane)[1]	Maximum Sample Volume Per Tube
< 10 ppmV[2]	10 L
10 -100 ppmV	1 L
100 – 1,000 ppmV	100 mL
>1,000 ppmV	10 mL

[1] Isobutylene equivalents using 10.6 eV lamp.

[2] ppmV: parts per million by volume; note that PID does not respond to methane with the 10.6 eV lamp.

Table 11. Soil Gas Sampling Log, September 2021, GA Site.

Sample ID	Tube ID	Sample Date	Sample Time	Flow Rate (mL/min)	Volume Collected (mL)	PID Reading				
						VOCs (ppm)	Oxygen (% V/V)	LEL (%)[1]	H_2S (ppm)	CO (ppm)
FCL-FB-SG01-081921	1172901	8/19/2021	9:38	Syringe	100	0.0	20.9	0.0	0.0	0.0
FCL-GWC4-SG1-081921	1172984	8/19/2021	9:52	Syringe	1000	0.0	20.9	0.0	0.0	0.0
FCL-GWC4-SG01-081921	1172894	8/19/2021	9:55	Syringe	100					
FCL-V7-5-SG1-081921	1172730	8/19/2021	12:15	Syringe	1000	0.3	19.3	6.8	0.0	0.0
FCL-V7-5-SG01-081921	1172708	8/19/2021	12:19	Syringe	100					
FCL-B2-SG1-081921	1172784	8/19/2021	13:15	Syringe	1000	0.0	20.7	0.0	0.0	0.0
FCL-B2-SG01-081921	1172776	8/19/2021	13:25	Syringe	100					
FCL-MM7A-SG1-081921	1172546	8/19/2021	14:02	Syringe	1000	0.0	18.6	0.0	0.0	0.0
FCL-MM7A-SG01-081921	1172532	8/19/2021	14:20	Syringe	100					
FCL-GWC5A-SG1-081921	1171526	8/19/2021	14:57	Syringe	1000	0.0	20.3	5.0	0.0	0.0
FCL-GWC5A-SG01-081921	1171525	8/19/2021	15:05	Syringe	100					
FCL-MV2-SG1-081921	1162011	8/19/2021	15:30	Syringe	1000	0.0	7	56.7	0.0	0.0
FCL-MV2-SG01-081921	1162001	8/19/2021	15:40	Syringe	100					

[1] LEL=lower explosive limit. The LEL % for V7-5 and MV-2 is measured as percent by volume methane (CH_4) via GEM 5000 as CH_4 concentration greater than LEL.

Table 12. FTOH Results from Preliminary Groundwater Screening from Contract Laboratory (µg/L), January 2021, NJ Site.

Sample ID		C81H21-G09-M01A				C81H21-H07-M01C				C81H21-H07-M01C-D				C81H21-EQBLK-H07-M01C			
Lab Sample Number		410-26640-1				410-26640-2				410-26640-3				410-26640-4			
Chemical	**CAS#**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**
10:2 FTOH-2-Perfluorodecyl ethanol	865-86-1	**1.7**		1.0	0.30	<1.0	U H	1.0	0.30	<1.0	U H	1.0	0.30	<1.0	U H	1.0	0.30
8:2 FTOH-2-Perfluorooctyl ethanol	678-39-7	**3.9**		1.0	0.20	<1.0	U H	1.0	0.20	<1.0	U H	1.0	0.20	<1.0	U H	1.0	0.20
7:2 sFTOH-1-Perfluoroheptyl ethanol	24015-83-6	**5.7**	*-	1.0	0.20	<1.0	U H	1.0	0.20	<1.0	U H	1.0	0.20	<1.0	U H	1.0	0.20
6:2 FTOH-2-Perfluorohexyl ethanoic acid	647-42-7	**5.1**		1.0	0.20	<1.0	U H	1.0	0.20	<1.0	U H	1.0	0.20	<1.0	U H	1.0	0.20
4:2 FTOH-2-Perfluorobutyl ethanol	2043-47-2	<1.0	U	1.0	0.10	<1.0	U H	1.0	0.10	<1.0	U H	1.0	0.10	<1.0	U H	1.0	0.10
Total Concentration		**16.4**															

Note:	Analyses conducted by contract laboratory using Semivolatiles – SOP
*-:	LCS and/or LCSD is outside acceptance limits, low biased
H:	Sample was prepped or analyzed beyond the specified holding time
MDL:	Method detection limit
Q:	Qualifier flag
RL:	Reporting Limit
U:	Indicates the analyte was analyzed for but not detected
Bold:	Indicates detected result

Table 13. PFAA Results from Preliminary Groundwater Screening from Contract Laboratory (µg/L), January 2021, NJ Site.

Sample ID	C81H21-G09-M01A				C81H21-G09-M01A				C81H21-H07-M01C				C81H21-H07-M01C				C81H21-H07-M01C				C81H21-H07-M01C-D				C81H21-H07-M01C-D				C81H21-EQBLK-H07-M01C			
Lab Sample Number	410-26640-1				410-26640-1-DL				410-26640-2				410-26640-2-DL				410-26640-2-DL2				410-26640-3				410-26640-3-DL				410-26640-4			
Dilution Factor (µg/L)	100				100				10				100				100				10				100				1			
Chemical (CAS#)	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**
11Cl-PF3OudS (763051-92-9)	<0.18	U	0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
9Cl-PF3ONS (756426-58-1)	<0.18	U	0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
DONA (919005-14-4)	<0.18	U	0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
HFPODA (13252-13-6)	**0.40**		0.27	0.046	NR		NR		**0.20**		0.027	0.0044	NR		NR		NR		NR		**0.21**		0.027	0.0044	NR		NR		<0.0026	U	0.0026	0.00044
n-EtFOSAA (2991-50-6)	<0.27	U	0.27	0.046	NR		NR		<0.027	U	0.027	0.0044	NR		NR		NR		NR		<0.027	U	0.027	0.0044	NR		NR		<0.0026	U	0.0026	0.00044
n-MeFOSAA (2355-31-9)	<0.18	U	0.18	0.055	NR		NR		<0.018	U	0.018	0.0053	NR		NR		NR		NR		<0.018	U	0.018	0.0053	NR		NR		<0.0017	U	0.0017	0.00052
Perfluorobutanesulfonic acid (375-73-5)	<0.18	U	0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluorobutanoic acid (375-22-4)	NR		NR		**70**	*1 *-	50	20	**1.6**		0.044	0.018	NR		NR		NR		NR		**1.6**		0.044	0.018	NR		NR		<0.0044	U	0.0044	0.0017
Perfluorodecanoic acid (335-76-2)	NR		NR		**140**	*1	20	5.0	**0.71**		0.018	0.0044	NR		NR		NR		NR		**0.65**		0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluorododecanoic acid (307-55-1)	**1.1**		0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluoroheptanoic acid (375-85-9)	NR		NR		**170**		20	5.0	NR		NR		**2.9**		0.18	0.044	NR		NR		NR		NR		**3.1**		2.0	0.49	<0.0017	U	0.0017	0.00044
Perfluorohexanesulfonic acid (355-46-4)	<0.18	U	0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluorohexanoic acid (307-24-4)	NR		NR		**1200**	*1 *-	20	5.0	NR		NR		**11**		0.18	0.044	NR		NR		NR		NR		**11**	*- *1	2.0	0.49	<0.0017	U	0.0017	0.00044
Perfluorononanoic acid (375-95-1)	NR		NR		**110**	*1	20	5.0	**0.79**		0.018	0.0044	NR		NR		NR		NR		**0.77**		0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluorooctanesulfonic acid (1763-23-1)	<0.18	U	0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044

Sample ID	C81H21-G09-M01A				C81H21-G09-M01A				C81H21-H07-M01C				C81H21-H07-M01C				C81H21-H07-M01C				C81H21-H07-M01C-D				C81H21-H07-M01C-D				C81H21-EQBLK-H07-M01C			
Lab Sample Number	410-26640-1				410-26640-1-DL				410-26640-2				410-26640-2-DL				410-26640-2-DL2				410-26640-3				410-26640-3-DL				410-26640-4			
Dilution Factor (µg/L)	100				100				10				100				100				10				100				1			
Chemical (CAS#)	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**	**Result**	**Q**	**RL**	**MDL**
Perfluorooctanoic acid (335-67-10)	NR		NR		**590**	*1 *-	20	5.0	NR		NR		NR		NR		**50**	*- *1	2.0	0.49	NR		NR		**57**	*- *1	2.0	0.49	<0.0017	U	0.0017	0.00044
Perfluoropentanoic acid (2706-90-3)	NR		NR		**180**	*1	20	5.0	**2.8**		0.018	0.0044	NR		NR		NR		NR		**2.8**		0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluorotetradecanoic acid (376-06-7)	**1.1**		0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluorotridecanoic acid (72629-94-8)	**0.26**		0.18	0.046	NR		NR		<0.018	U	0.018	0.0044	NR		NR		NR		NR		<0.018	U	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044
Perfluoroundecanoic acid (2058-94-8)	**1.9**		0.18	0.046	NR		NR		**0.039**		0.018	0.0044	NR		NR		NR		NR		**0.040**	I	0.018	0.0044	NR		NR		<0.0017	U	0.0017	0.00044

Note: Analyses conducted by contract laboratory using LCMS – T-WI21398 ver7. Results are in some cases reported from the full strength sample and sometimes from a dilution. Multiple attempts were made to analyze some samples in this set. The best results were reported. The extension “-DL” for diluted was appended to some sample IDs to allow the data system to report data from multiple analysis attempts of the sample; however, not all diluted results have that “-DL” code appended to the sample IDs.

*-:	LCS and/or LCSD is outside acceptance limits, low biased
*1:	LCS/LCSD RPD exceeds control limits
H:	Sample was prepped or analyzed beyond the specified holding time
I:	Value is estimated maximum possible concentration
MDL:	Method detection limit
NR:	Not reported
Q:	Quality flag
RL:	Reporting Limit
U:	Indicates the analyte was analyzed for but not detected
Bold:	indicates detected result

5.2 NJ Field Event 1 Results

5.2.1 Soil Gas

5.2.1.1 Sample Results

Soil gas results for the NJ site are presented in **Table 14**. Combined soil gas, soil, and groundwater results for the two NJ site sampling events from the multiple laboratories are reported in **Appendix B**.

In general, FTOH concentrations observed in soil gas were greatest in the subslab locations beneath the building (SG01 and SG02) and decreased with distance from the building (**Table 14**). Subslab soil gas concentrations ranged from 160 to 12,000E µg/m^3 for individual FTOHs. Some of the highest concentration samples were 'E' flagged as estimated because they exceeded the upper end of the calibration range. 4:2 FTOH was only detected in the subslab soil gas sample beneath the presumed source building. Sampling location C, the external sampling point closest to the building, approximately 43 m (140 ft) distant, had increasing concentrations of 5:2 and 7:2 secondary fluorotelomer alcohol (sFTOH) with depth while 6:2, 8:2, and 10:2 FTOH concentrations were greatest immediately under the pavement (i.e., subslab), least at 30 cm (12 in) bgs, and with slightly elevated concentrations at 61 cm (24 in) bgs. The peak 5:2 sFTOH concentrations of 590 µg/m^3 at location C were found at 61 cm (24 in) bgs. At location B, approximately 76 m (250 ft) east-southeast of the building, concentrations between 2.2 and 14 µg/m^3 of 6:2, 8:2, and 10:2 FTOH were observed but 4:2, 5:2s, and 7:2 sFTOH were not detected. At locations D and A, the furthest from the building at 84 and 104 m (275 and 340 ft) distant, respectively, FTOHs were not detected except for 5:2 sFTOH at 30 cm (12 in) bgs at location A and 6:2 FTOH at 46 cm (18 in) bgs at location D. In contrast, ambient air concentrations of FTOHs at remote locations are typically below 1 ng/m^3 (Lai et al., 2016; Wang 2015; Cai et al., 2012). Reported indoor air concentrations at background sites are below 25 ng/m^3 (Shoeib et al., 2011).

The patterns of relative abundance among the FTOHs differed between locations. The highest concentrations for the 6:2, 8:2, and 10:2 FTOH were in the subslab soil gas at the building and at location C. In contrast, the 5:2 and 7:2 sFTOHs had the highest concentrations in the deeper intervals 30 cm and 61 cm bgs at location C.

Detections of FTOHs were rare at the gravel covered locations A and D. It should be noted that locations B and C were in or near paved areas, which could suggest a role for less permeable materials to retain FTOHs in shallow soil gas.

Three PFCA compounds, perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), and PFOA, were detected in the subslab soil gas sample directly beneath the building at concentrations ranging from 59 to 650E µg/m^3 (**Table 15**). These three PFCAs as well as two additional compounds, perfluoropentanoic acid (PFPeA) and perfluoroheptanoic acid (PFHpA), were detected at location C with concentrations ranging from 0.7 to 180 µg/m^3. Only PFBA was observed at location D and no PFCAs were observed at location A. With the higher PFAS concentrations in the subslab soil gas samples and in the soil gas at location C than typically found in ambient air samples, the presence of a fine entrained particulate or moisture-based PFAS in the soil gas samples cannot be ruled out, although the aspiration potential of the low volume syringe sampling method used should have been negligible.

PFCAs are generally considered to be predominantly partitioned to the particulate phase in the atmosphere (Cai, 2012; Lai, 2016; Wang, 2015; ITRC, 2020). Reports of PFCA compounds PFBA, PFHpA, PFHxA, PFOA, and PFPeA in the gas phase at some land ambient air sites at concentrations below 0.025 ng/m^3 exist in the literature (Ahrens et al., 2012; Shoeib et al., 2011; Kim and Kannan, 2007). Gas phase PFHpA, PFHxA, and PFOA at concentrations below 2.5 ng/m^3 have been reported in

Table 14. Soil Gas Sample Results for Event 1 (July 2021) from Contract Laboratory, NJ Site.

Compound	Contract Laboratory Soil Gas Sample Results (µg/m^3)														
	CW-1156-SG01	CW-1156-SG02	CW-A-SV01-1_5	CW-A-SV02-2_5	CW-Blank	CW-B-SV01-SS	CW-B-SV02-1_5	CW-B-SV03-2_5	CW-C-SV01-SS	CW-C-SV02-01	CW-C-SV03-02	CW-C-SV03-02	CW-D-SV01-01	CW-D-SV02-2_5	CW-D-SV03-3_5
1-Perfluoroheptyl ethanol (7:2 sFTOH)	220	180	<1.0 U	<1.0 U	<0.1 U	<50.0 U	<1.0 U	<1.0 U	1.1	22 E	160 E	59	<1.0 U	<1.0 U	<1.0 U
1-Perfluoropentyl ethanol (5:2 sFTOH)	930	2800	<1.0 U	<1.0 U	<0.1 U	<50.0 U	<1.0 U	<1.0 U	4.9	64 E	590 E	230	1.0 J	<1.0 U	<1.0 U
2-Perfluorobutyl ethanol (4:2 FTOH)	300	290	<1.0 U	<1.0 U	<0.1 U	<50.0 U	<1.0 U	<1.0 U	<0.1 U	<0.1 U	<0.1	<50.0 U	<1.0 U	<1.0 U	<1.0 U
2-Perfluorodecyl ethanol (10:2 FTOH)	930	160	<1.0 U	<1.0 U	<0.1 U	<50.0 U	2.2	<1.0 U	14 E	1.3	7.7 E	<50.0 U	<1.0 U	<1.0 U	<1.0 U
2-Perfluorohexyl ethanol (6:2 FTOH)	12000 E	8800 E	2.6	<2.0 U	5.5 E	<50.0 U	3.0	3.1	85 E	0.23	1.3	<50.0 U	<2.0 U	<2.0 U	<2.0 U
2-Perfluorooctyl ethanol (8:2 FTOH)	6100 E	1700	<1.0 U	<1.0 U	<0.1 U	<50.0 U	14	6.0	27 E	0.15	2.1	<50.0 U	<1.0 U	<1.0 U	<1.0 U
n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	<50.0 J,U	<50.0 J,U	<10.0 J,U	<10.0 J,U	<1.0 J,U	<50.0 J,U	<10.0 J,U	<10.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U	<50.0 J,U	<10.0 J,U	<10.0 J,U	<10.0 J,U
n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	<50.0 J,U	<50.0 J,U	<10.0 J,U	<10.0 J,U	<1.0 J,U	<50.0 J,U	<10.0 J,U	<10.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U	<50.0 J,U	<10.0 J,U	<10.0 J,U	<10.0 J,U
Perfluorobutanoic acid (PFBA)	140	99	<1.0 U	<1.0 U	0.12	<50.0 U	<1.0 U	<1.0 U	0.84	7.1 E	23 E	<50.0 U	1.0 J	<1.0 U	<1.0 U
Perfluoroheptanoic acid (PFHpA)	<50.0 U	<50.0 U	<1.0 U	<1.0 U	<0.1 U	<50.0 U	<1.0 U	<1.0 U	<0.1 U	1.3	3.8	<50.0 U	<1.0 U	<1.0 U	<1.0 U
Perfluorohexanoic acid (PFHxA)	460	650 E	<1.0 U	<1.0 U	0.16	<50.0 U	<1.0 U	<1.0 U	7.1 E	49 E	180 E	71	<1.0 U	<1.0 U	<1.0 U
Perfluorooctanoic acid (PFOA)	59	62	<1.0 U	<1.0 U	<0.1 U	<50.0 U	<1.0 U	<1.0 U	0.72	1.7	7.0 E	<50.0 U	<1.0 U	<1.0 U	<1.0 U
Perfluoropentanoic acid (PFPeA)	<50.0 U	<50.0 U	<1.0 U	<1.0 U	<0.1 U	<50.0 U	<1.0 U	<1.0 U	4.0 I	25 E,I	62 E,I	<50.0 U	<1.0 U	<1.0 U	<1.0 U

E: Results exceeded calibration range
I: Matrix interference affecting qualifier ion(s) used for compound identification
J: Estimated value
U: Indicates the analyte was analyzed for but not detected

indoor air at background sites (Shoeib et al., 2011). As discussed in sections 2.2.2 and 7.1.3, the presence of a fine entrained particulate or mist in the soil gas samples cannot be ruled out.

Only three out of 30 quantitated analytes were detected in the 1 liter ambient air blank: 6:2 FTOH at 5.5 $\mu g/m^3$, PFBA at 0.12 $\mu g/m^3$ and PFHxA at 0.16 $\mu g/m^3$. As shown in **Appendix C**, except for 6:2 FTOH, these concentrations were at least seven times below the concentrations measured in the soil gas, which suggests that the soil gas is significantly different from the ambient air at the site. For 6:2 FTOH, the subslab samples at the building as well as at location C, were at least fifteen times greater than ambient air, again suggesting that soil gas is different from ambient air.

5.2.1.2 QA/QC

Additional information on data flags applied to individual samples is provided in **Appendix C** in the sample receipt summary and sample analysis portions of the contract laboratory reports 2107653 (subslab soil gas samples at building) and 2107701 (all other soil gas samples are from the July 2021 sampling).

No target compounds were detected in any of the five lab blanks (documented in analysis report 2107701). Only one compound (6:2 FTOH) was outside the acceptance limits in one of the five continuing calibration verifications (CCVs) with a recovery of 68% versus the laboratory acceptance limits of 70-130%.

Nine laboratory control sample/duplicate (LCS/LCSD) samples were reported, with the vast majority of the results within the laboratory acceptance limits (documented in analysis report 2107701):

- The recovery of 6:2 FTOH in the daily CCV analyzed on 8/26/2021 was 68%, which was outside the laboratory acceptance limits of 70-130%.
- The recoveries of n-MeFOSA and n-EtFOSA in the LCS analyzed on 8/20/2021 were less than 50%, below the laboratory acceptance limits of 50-150%.
- Precision of n-MeFOSA and n-EtFOSA in the LCS/LCSD analyzed on 8/20/2021 and 8/25/2021 exceeded the laboratory acceptance limit of 25% RPD.
- Precision of 5:2 sFTOH in the LCS/LCSD analyzed on 8/20/21 slightly exceeded the 25% RPD laboratory acceptance limit at 26% RPD.

The laboratory blank for the subslab samples at the building had no detectable compounds (documented in analysis report 2107653). The continuing calibration verification was within acceptance limits. The LCS/LCSD precision was within acceptance limits.

5.2.2 Groundwater

5.2.2.1 Sample Results

Results are reported for shallow groundwater locations A and D in **Table 15**. Refusal was encountered at locations B and C before groundwater could be reached using the hand operated shallow sampling equipment.

FTOHs were not detected in the groundwater samples at any location (**Table 15**). PFCAs with carbon chain lengths ranging from perfluorobutanoic acid (C4) to perfluoroundecanoic acid (C11) were detected. The highest PFCA concentrations were for PFHxA with concentrations ranging from 37 to 49 µg/L. The anticipated spatial pattern having higher concentrations nearer to the building than at locations further away was generally observed in the PFCAs, with concentrations being generally higher in samples from location D than location A.

Table 15. Groundwater Sample Results for Event 1 (July 2021) from Contract Laboratory, NJ Site.

Analyte	Groundwater Sample Results (µg/L)			
	CW-A-GW01-05	CW-BLANK	CW-D-GW01-4_5	CW-D-GW01-4_5-DUP
10:2 FTOH-2-Perfluorodecyl ethanol	<1.0 H		<1.0 H	<1.0 H
4:2 FTOH-2-Perfluorobutyl ethanol	<1.0 H *1		<1.0 H *1	<1.0 H *1
6:2 FTOH-2-Perfluorohexyl ethanoic acid	<1.0 H		<1.0 H	<1.0 H
7:2 sFTOH-1-Perfluoroheptyl ethanol	<1.0 H *- *1		<1.0 H *- *1	<1.0 H *- *1
8:2 FTOH-2-Perfluorooctyl ethanol	<1.0 H *1		<1.0 H *1	<1.0 H *1
HFPO-DA	0.11	<0.0026	0.25	0.26
n-EtFOSA	<0.029	<0.0026	<0.030	<0.029
n-MeFOSA	<0.019	<0.0017	<0.020	<0.019
Perfluorobutanesulfonic acid (PFBS)	<0.019	<0.0017	<0.020	<0.019
Perfluorobutanoic acid (PFBA)	1.9 F1	<0.0044	4.3	4.3
Perfluorodecanoic acid (PFDA)	5.2	<0.0017	1.8	1.8
Perfluorododecanoic acid (PFDoA)	0.069	<0.0017	<0.020	<0.019
Perfluoroheptanoic acid (PFHpA)	1.5	<0.0017	4.5	4.7
Perfluorohexanesulfonic acid (PFHxS)	<0.019	<0.0017	<0.020	<0.019
Perfluorohexanoic acid (PFHxA)	49	<0.0017	39	37
Perfluorononanoic acid (PFNA)	4.3	<0.0017	7.8	7.2
Perfluorooctanesulfonic acid (PFOS)	0.063	<0.0017	0.024	0.024
Perfluorooctanoic acid (PFOA)	1.2	<0.0017	7.2	7.3
Perfluoropentanoic acid (PFPeA)	5.3	<0.0017	8.7	8.4
Perfluorotetradecanoic acid (PFTeDA)	<0.019	<0.0017	<0.020	<0.019
Perfluorotridecanoic acid (PFTrDA or PFTeA)	<0.019	<0.0017	<0.020	<0.019
Perfluoroundecanoic acid (PFUnA (or PFUndA)	0.045	<0.0017	0.052	0.053

*-:	LCS and/or LCSD is outside acceptance limits, low biased
*1:	LCS/LCSD RPD exceeds control limits
H:	Sample was prepped or analyzed beyond the specified holding time
F1:	MS and/or MSD recovery exceeds control limits

5.2.2.2 QA/QC

There were no detections of the FTOHs or PFCAs in the blank prepared with PFAS free water in the field or the equipment blank using deionized water. The first time the FTOH analysis of the field samples was attempted all the recoveries were <20% and the samples were reextracted and reported from the second analysis. The results for the field samples for the 7:2 sFTOH were qualified as likely biased low

(**Appendix C**). The recovery of 7:2 sFTOH was below the acceptance limit in the LCSD. One of two surrogates for the FTOH analyses was consistently recovered in the 30 to 45% range across the field samples and the laboratory control spike. Several of the FTOH analytes had somewhat higher variability between the LCS and LCSD than allowed and were, therefore, flagged with an *1 designation. Most of the FTOH analytes in the LCS and LCSD were recovered within control limits.

Results for perfluorobutanesulfonic acid were flagged because the recovery in the matrix spike was slightly below the control limits (65% actual versus the 70-130% range), suggesting the concentration in the original sample may have been underestimated. The other QC results for the PFCAs were acceptable.

Comparing the concentrations of the PFOA concentration across reports and mobilizations (**Table 15**) there was 590 µg/L at the source area well, 57 µg/L at the downgradient well, and 1.2 to 7.3 µg/L at the grab samples in between. These results suggest depletion or dilution at the water table.

5.2.3 Soil

5.2.3.1 Sample Results

Soil sample results from the first sampling event are presented in **Table 16** (for both the Laboratories 1 and 2). Combined soil gas, soil, and groundwater results for the two NJ site sampling events from the multiple laboratories are reported in **Appendix B**.

All target PFCAs were identified in soil samples at locations A, B, and C (**Table 16**). Location D had PFCA chain lengths ranging from only C4 to C10. No FTOHs were detected in the soil samples analyzed by Laboratory 1; however, Laboratory 2 did identify FTOHs at concentrations lower than the contract laboratory's RLs. Laboratory 1's reporting limits for soil were 20 ng/g. Laboratory 2's reporting limits for soil varied by compound from 0.4 to 5.0 ng/g. Laboratory 2 detections for FTOHs are all below Laboratory 1's reporting limits for the same compounds, with the exception of detections of 10:2 FTOH. Laboratory 2 reported up to approximately 2x the Laboratory 1 reporting limit, indicating the data sets are generally consistent (**Appendix D**). Laboratory 2 also detected longer chain FTOH species in some samples such as 12:2 FTOH through 20:2 FTOH that were not in the contract laboratory's analyte list.

The anticipated spatial pattern of location C having higher concentrations than the other locations further away from the building was observed for the PFCAs. Concentrations at location C ranged from 4.3 to 810 ng/g while at locations B, D (when detected), and A, the concentrations ranged from nondetect to 220 ng/g, nondetect to 53 ng/g, and nondetect to 30 ng/g, respectively. Higher PFAS concentrations can be related to the greater sorptive capacity associated with higher total organic carbon contents (TOC) (**Table S1**) at location C (**Table 17**) leading to greater sorption (Jai et al., 2023; He et al., 2022). In contrast, while location C had the highest concentrations of PFAS than the other locations, it also had the lowest clay contents. Loganathan and Wilson (2022) found that as kaolinite clay content increased, so did the sorption of PFAS irrespective of the functional group (Loganathan and Wilson, 2022). While the clay mineralogy of the locations is unknown, the marked contrast in TOC (~8 versus ~2%) may be the controlling factor of PFAS sorption at location C.

When common compounds were present on the analyte list, the agreement between Laboratories 1 and 2 was generally good. Laboratory 1 also reported detections of 6:2, 8:2 and 10:2 fluorotelomer sulfonic acids in sample C that were not observed in the samples collected further from the building.

Comparing Laboratory 1 water results in µg/L = µg/kg (ppb) to the soil results in ng/g (ppb) shows that the soil results and groundwater results are in the same concentration range for the short chain PFCAs. In contrast, higher soil concentrations were observed compared to groundwater for the long chain compounds, which fits with a general reported pattern of lower aqueous solubility for the longer chain PFCAs (ITRC, 2021).

5.2.4 Soil Characterization

During the collection of composite soil columns, select visible soil characteristics were recorded. The soil columns were segmented for visual characterization into layers based on texture, color, and redox features (i.e., mottling). Soils at the New Jersey site were sandy loams at locations A-C, with location D having slightly more sand and less silt resulting in a loamy sand texture (**Table 17**). The pH values ranged from a low of 6.5 at location D to a high of 7.85 at location C. Total organic carbon contents ranged between 1 and 2% at locations A and B, nearly 8% at location C, and under 0.2% at location D.

5.2.4.1 QA/QC

Laboratory 1 nondetectable results for all FTOHs except 7:2 sFTOH were flagged as low biased based on the LCS results, which ranged from 59 to 69% compared to an acceptance limit of 70 to 130%. Recoveries in the matrix spikes for the FTOHs ranged from 64 to 82% as compared to an acceptance limit of 70 to 130%. There were no detections in the method blank.

There were no detections in the method blank for the PFCA and PFSA analyses by Laboratory 1. Recoveries in the LCS/LCSD and MS were within the acceptance limits.

Table 16. Soil Sample Results for Event 1 (July 2021), NJ Site; USEPA ORD Laboratory and Contract Laboratory.

Chemical Identification				Contract Laboratory 2 (CL2) and USEPA ORD Laboratory Sample Location (A, B, C, and D)								
				CL2, A	USEPA ORD, A	CL2, B	CL2, B Dup	USEPA ORD, B	CL2, C	USEPA ORD, C	CL2, D	USEPA ORD, D
Chemical Class	Chemical Name	CASRN	Substance Acronym	Soil Concentration (ng/g)								
Perfluorinated carboxylic acids (PFCAs)	Perfluorobutanoic acid	375-22-4	PFBA	<2.2	NA	<2.2	<2.2	NA	4.3	NA	<2.1	NA
	Perfluoropentanoic acid	2706-90-3	PFPeA	2	NA	0.95	0.97	NA	18	NA	2.9	NA
	Perfluorohexanoic acid	307-24-4	PFHxA	16	NA	3.7	3.8	NA	190	NA	12	NA
	Perfluoroheptanoic acid	375-85-9	PFHpA	1.5	NA	<0.66	<0.66	NA	71	NA	14	NA
	Perfluorooctanoic acid	335-67-1	PFOA	3.3	NA	1.5	1.5	NA	480	NA	53	NA
	Perfluorononanoic acid	375-95-1	PFNA	5.6	NA	1.4	1.4	NA	180	NA	23	NA
	Perfluorodecanoic acid	335-76-2	PFDA	30	NA	6.1	6	NA	810	NA	2.2	NA
	Perfluoroundecanoic acid	2058-94-8	PFUnA, or PFUnDA	13	NA	8.5	13	NA	290	NA	<0.63	NA
	Perfluorododecanoic acid	307-55-1	PFDoA, or PFDoDA	27	NA	92	120	NA	640	NA	<0.63	NA
	Perfluorotridecanoic acid	72629-94-8	PFTrDA, or PFTriA	9.2	NA	50	45	NA	140	NA	<0.63	NA
	Perfluorotetradecanoic acid	376-06-7	PFTeDA, or PFTeA	24	NA	220	140	NA	410	NA	<0.63	NA
	Perfluorohexadecanoic acid	--	--	7.8	NA	78	47	NA	190	NA	<0.63	NA
	Perfluorooctadecanoic acid	--	--	3.1	NA	23	17	NA	61	NA	<0.63	NA
Perfluorinated telomer alcohols (FtOHs)	2-perfluorobutyl ethanol	--	4:2 FtOH	<20	0.05	<20	<20	0.06, 0.38	<20	0.12	<20	0.09
	1-perfluoropentyl ethanol	--	5:2 sFtOH	NA	0.15	NA	NA	<0.22, <0.22	NA	4.78	NA	<0.22
	1-perfluoroheptyl ethanol	--	7:2 sFtOH	<20	<0.13	<20	<20	<0.13, <0.13	<20	4.91	<20	<0.13
	2-perfluorohexyl ethanol	--	6:2 FtOH	<20	1.45 J	<20	<20	3.24 J, 1.71	<20	2.38	<20	<0.21
	2-perfluorooctyl ethanol	--	8:2 FtOH	<20	1.01 J	<20	<20	2.92 J, 6.71 J	<20	3.56	<20	0.48 J
	2-perfluorodecyl ethanol	--	10:2 FtOH	<20	4.48 J	<20	<20	20.85, 3.44 J	<20	36.15	<20	<0.26
--	n-Methylperfluoro-1-octanesulfonamide	--	n-MeFOSA	<2.2	NA	<2.2	<2.2	NA	<2.3	NA	<2.1	NA
--	n-Ethylperfluoro-1-octanesulfonamide	--	n-EtFOSA	<2.2	NA	<2.2	<2.2	NA	<2.3	NA	<2.1	NA
--	Perfluorooctanesulfonamide	754-91-6	PFOSA, or FOSA	<0.67	NA	<0.66	<0.66	NA	<0.7	NA	<0.63	NA

Chemical Identification				**Contract Laboratory 2 (CL2) and USEPA ORD Laboratory Sample Location (A, B, C, and D)**								
				CL2, A	**USEPA ORD, A**	**CL2, B**	**CL2, B Dup**	**USEPA ORD, B**	**CL2, C**	**USEPA ORD, C**	**CL2, D**	**USEPA ORD, D**
Perfluorinated sulfonic acids (PFSAs)	Perfluorobutanesulfonic acid	375-73-5	PFBS	<2.2	NA	<0.66	<2.2	NA	<2.3	NA	<2.1	NA
	Perfluorohexanesulfonic acid	355-46-4	PFHxS	<0.67	NA	<0.66	<0.66	NA	<0.7	NA	<0.63	NA
	Perfluorooctanesulfonic acid	1763-23-1	PFOS	<0.67	NA	<0.66	<0.66	NA	<0.7	NA	<0.63	NA
	Perfluorodecanesulfonic acid	67906-42-7	PFDS	<0.67	NA	<0.66	<0.66	NA	<0.7	NA	<0.63	NA
--	HFPO-DA	--	--	<2.2	NA	<2.2	<2.2	NA	<2.3	NA	<2.1	NA
--	10:2 FTS	--	--	<2.2	NA	<2.2	<2.2	NA	6.1	NA	<2.1	NA
--	6:2 fluorotelomer sulfonic acid	--	--	<2.2	NA	<2.2	<2.2	NA	3.2	NA	<2.1	NA
--	8:2 fluorotelomer sulfonic acid	--	--	<3.4	NA	<3.3	<3.3	NA	5.8	NA	<3.1	NA
--	12:2 FTOH	--	--	NA	1.4	NA	NA	12.47, 6.55	NA	125.41	NA	0.1
--	14:2 FTOH	--	--	NA	1.17	NA	NA	4.63, 4.9	NA	90.29	NA	0.06
--	16:2 FTOH	--	--	NA	0.55	NA	NA	2.55, 2.14	NA	35.64	NA	0.02
--	18:2 FTOH	--	--	NA	0.12	NA	NA	0.89, 0.3	NA	2.86	NA	nd

CL2:	Contract Laboratory 2, Eurofins Lancaster Laboratory
EPA ORD:	EPA Office of Research and Development Laboratory
Dup:	Duplicate
J:	Estimated value
NA:	Not analyzed
nd:	Not detected

Table 17. Soil Characteristics and Field Notes at the New Jersey Site.

Location	pH	TOC	Sand	Silt	Clay	Texture	Field Notes
		%		%			
A	7.31	1.16	71.2	14.4	14.4	Sandy loam	0 to 15 cm – coarse sand with cobbles 46 to 106 cm – coarse brown sand 106 cm – water table
B	7.06	1.98	76.6	14.2	9.2	Sandy loam	122 cm – refusal
C	7.85	7.96	69.7	22.2	8.1	Sandy loam	0 to 30 cm – coarse sand with cobbles 30 to 46 cm – coarse dark sand 46 to 61 cm – pale light brown silt, cohesive non-plastic trace clay, reddish/brown redox lamination features. 61 – 76 cm – redox features increase 91 cm – refusal
D	6.50	0.14	83.3	6.3	10.4	Loamy Sand	0 to 76 cm – fine to medium sand 107 cm – white silt layer with redox features 122 cm – water table

5.3 NJ Field Event 2 Results

5.3.1 Soil Gas

5.3.1.1 Sample Results

Only subslab soil gas was sampled at the building in the second field event in December 2021. This sampling event focused on evaluating soil/vapor partitioning by testing with and without a filter. Soil gas results from the December 2021 event are presented in **Table 18**. Combined soil gas, soil, and groundwater results for the two NJ site sampling events from the multiple laboratories are reported in **Appendix B**.

The observed concentrations of 6:2, 7:2s, 8:2 and 10:2 FTOH were higher in the unfiltered Field Event 2 than in Field Event 1 samples at SG01 (**Table 19**). Conversely, concentrations of 4:2 and 5:2s FTOH were slightly lower in Field Event 2. Concentrations of most FTOHs at SG02 were substantially lower in Field Event 2 than Field Event 1 with the exception of 7:2 sFTOH, which was essentially the same between the 2 field events.

When quartz microfiber filters were placed between the sorbent tube and sample probe, two patterns of FTOH sorption were identified. For 6:2 FTOH and longer chained FTOHs, most of the FTOH mass was found on the filters (**Table 19**). Some 6:2 FTOH did break through the filter to the sorbent tube but only at the highest 6:2 FTOH concentrations (i.e., 16000 to 18000 $\mu g/m^3$). In contrast, the two smaller chain FTOHs, 4:2 and 5:2s FTOH, had discernable concentrations on both the filter and on the sorbent tubes when 100 mL samples were collected. Certain gas phase PFCAs have been reported to adsorb to quartz or glass fiber filters (Bidleman et al., 1986; Arp and Goss, 2008; Johansson et al., 2017) but the authors are not aware of reports of this happening for FTOHs. As a mass balance check, the total FTOH concentrations on the filter and its associated sorbent tube were similar to the total FTOH concentration on the unfiltered sorbent tube (e.g., A1T ~ B1T + B1F).

Only two PFCAs, PFHxA and PFHpA, were found during the Field Event 2 and only in the unfiltered sorbent tubes at location SG02 (**Table 19**). Although the PFHxA concentration was lower than from Field

Event 1 at SG02, PFHxA had the highest PFCA concentrations during both sampling events. Partitioning calculations between the ionized and unionized forms based on pKa for the PFCA species and site-specific pH observations are assumed to occur both on the stationary solids in the soil column and in the extracted soil "gas" sample. It is presumed that the extracted soil "gas" includes either fine particulate capable of being entrained at low sampling velocity, or a condensed mist. The potential for such a condensed mist to exist at this site is elevated based on shallow groundwater at the site. Literature reports show that vadose zone soils can reach the saturation soil-moisture content that corresponds to 100% relative humidity and condensation in the vadose zone is possible depending on the temperature profile (Smith et al., 1990; Sakai et al., 2009; Assouline et al., 2019). The hypothesized existence of such mists may help explain the unexpectedly high concentrations of PFCAs observed in soil "gas" at the New Jersey site.

Agreement between sequential like sample pairs (e.g., unfiltered, filtered tube, and filters) taken at the same location and analyzed by the same method during the same sampling event was generally close in FTOH concentrations (**Table 19**), indicating that the removal of subslab soil gas during sampling did not change the subslab soil gas environment and subsequent PFAS concentrations. Concentration differences of the PFAS related to sample volumes, — 100 mL for A and B samples versus 25 mL for C and D samples — were also generally small except for the filter samples which had much greater variability associated with the sample volume differences. Moreover, more FTOHs were detectable in the 100 mL samples than their comparable 25 mL samples and the reporting limits for the 25 mL samples were four-fold greater, leading to the potential for false negatives in the FTOH data due to lower method sensitivity.

5.3.1.2 QA/QC

Results from the 25 mL unfiltered samples were similar to the 100 mL unfiltered samples. The Laboratory 1 report states the following about the lower volume 25 mL filtered samples: "Review of the replicate samples collected at SG01 and SG02 suggests that filter samples identified as CW-1156-SG01-120921-D1F and CW-1156-SG02-120921-D1F may have been switched. No unique identifiers were present on the filter or the filter assembly to determine if the incorrect filters were analyzed for these two samples." The containers in which the filters were placed were prelabeled and field sampling was independently observed, so it is unlikely that an interchange occurred in the field. It is possible an inadvertent interchange of those two samples occurred at the laboratory.

Target compounds were not detected in the blanks. Internal standard recoveries were outside of control limits for sample CW-1156-SG01-120921-B1F and were "Q" flagged (**Appendix F**). Several sample results for 6:2 and 8:2 FTOH were "E" flagged as estimated because they exceeded the upper end of the calibration range.

Table 18. Soil Gas Sampling Results for Event 2 (December 2021), NJ Site, Contract Laboratory.

Compound	Soil Gas Sample Results (µg/m^3) Contract Laboratory																	
	CW-1156-SG01-A1T	CW-1156-SG01-A2T	CW-1156-SG01-B1F	CW-1156-SG01-B1T	CW-1156-SG01-B2F	CW-1156-SG01-B2T	CW-1156-SG01-C1T	CW-1156-SG01-D1F	CW-1156-SG01-D1T	CW-1156-SG02-A1T	CW-1156-SG02-A2T	CW-1156-SG02-B1F	CW-1156-SG02-B1T	CW-1156-SG02-B2F	CW-1156-SG02-B2T	CW-1156-SG02-C1T	CW-1156-SG02-D1F	CW-1156-SG02-D1T
1-Perfluoroheptyl ethanol (7:2 sFTOH)	290	280	220 Q	<50.0 U	210	<50.0 U	250	<200.0 U	<200.0 U	200	180	150	<50.0 U	190	<50.0 U	<200.0 U	250	<200.0 U
1-Perfluoropentyl ethanol (5:2 sFTOH)	620	560	340 Q	510	140	540	560	440	<200.0 U	700	700	270	270	270	340	600	360	<200.0 U
2-Perfluorobutyl ethanol (4:2 FTOH)	150	140	87 Q	120	<50.0 U	130	<200.0 U	<200.0 U	<200.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U
2-Perfluorodecyl ethanol (10:2 FTOH)	1400	1500	140 Q	<50.0 U	2100	<50.0 U	2200	360	<200.0 U	99	140	230	<50.0 U	210	<50.0 U	260	3000	<200.0 U
2-Perfluorohexyl ethanol (6:2 FTOH)	18000 E	16000 E	9900 E,Q	900	13000 E	250	15000	840	<200.0 U	1100	960	860	<50.0 U	970	<50.0 U	1100	14000	<200.0 U
2-Perfluorooctyl ethanol (8:2 FTOH)	16000 E	15000 E	2300 Q	<50.0 U	12000 E	<50.0 U	10000	800	<200.0 U	460	420	660	<50.0 U	640	<50.0 U	560	14000	<200.0 U
n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	<50.0 J,U	<50.0 J,U	<50.0 J,U,Q	<50.0 J,U	<50.0 J,U	<50.0 J,U	<200.0 U,J	<200.0 J,U	<200.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<200.0 J,U	<200.0 J,U	<200.0 J,U
n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	<50.0 J,U	<50.0 J,U	<50.0 J,U,Q	<50.0 J,U	<50.0 J,U	<50.0 J,U	<200.0 U,J	<200.0 J,U	<200.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<50.0 J,U	<200.0 J,U	<200.0 J,U	<200.0 J,U
Perfluorobutanoic acid (PFBA)	<50.0 U	<50.0 U	<50.0 U,Q	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U
Perfluoroheptanoic acid (PFHpA)	<50.0 U	<50.0 U	<50.0 U,Q	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U	52	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U
Perfluorohexanoic acid (PFHxA)	<50.0 U	<50.0 U	<50.0 U,Q	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U	180	160 I	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U
Perfluorooctanoic acid (PFOA)	<50.0 U	<50.0 U	<50.0 U,Q	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U
Perfluoropentanoic acid (PFPeA)	<50.0 U	<50.0 U	<50.0 U,Q	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<50.0 U	<200.0 U	<200.0 U	<200.0 U

E:	Results exceeded calibration range
I:	Matrix interference affecting qualifier ion(s) used for compound identification
J:	Estimated value
Q:	Quality flag
U:	Indicates the analyte was analyzed for but not detected

Contract Laboratory = Eurofins Air Toxics

Table 19. Soil Gas Vapor Concentration in Subslab, Field Event 1 (July 2021, orange shaded) and Field Event 2 (December 2021, dark blue shaded), NJ Site.

Chemical Identification		Sample CW1156-SG01-072121 RL = 50 µg/m3	Sample CW1156-SG01-120921-A1T Unfiltered; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG01-120921-B1T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG01-120921-B1F Filter; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG01-120921-A2T Unfiltered; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG01-120921-B2T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG01-120921-B2F Filter; Sample Volume=100 mL, RL= 50 µg/m³	Sample CW1156-SG01-120921-C1T Unfiltered Tube; Sample Volume=25 mL, RL=200 µg/m³	Sample CW1156-SG01-120921-D1T Filtered Tube; Sample Volume=25 mL, RL=200 µg/m³	Sample CW1156-SG01-120921-D1F Filter; Sample Volume=25 mL, RL=200 µg/m³	Sample CW1156-SG02-072121 RL=50 µg/m³	Sample CW1156-SG02-120921-A1T Unfiltered; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG02-120921-B1T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG02-120921-B1F Filter; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG02-120921-A2T Unfiltered; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG02-120921-B2T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG02-120921-B2F Filter; Sample Volume=100 mL, RL=50 µg/m³	Sample CW1156-SG02-120921-C1T Unfiltered Tube; Sample Volume=25 mL, RL=200 µg/m³	Sample CW1156-SG02-120921-D1T Filtered Tube; Sample Volume=25 mL, RL=200 µg/m³	Sample CW1156-SG02-120921-D1F Filter; Sample Volume=25 mL, RL=200 µg/m³	Sample CW1156-120921-T Tube Blank	Sample CW1156-SG02-120921-F Filter Blank	Sample Laboratory Blanks (3) Tubes
Chemical Class	**Chemical Name, (CASRN, where applicable), Acronym**	**Vapor Concentration Subslab (µg/m³)**																						
Perfluorinated carboxylic acids (PFCAs)	Perfluorobutanoic acid (375-22-4) PFBA	140	nd	nd	nd	nd	nd	nd	nd	nd	nd	99	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Perfluoropentanoic acid (2706-90-3) PFPeA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Perfluorohexanoic acid (307-24-4) PFHxA	460	nd	nd	nd	nd	nd	nd	nd	nd	nd	650 E	180	nd	nd	160 I	nd	nd	nd	nd	nd	nd	nd	nd
	Perfluoroheptanoic acid (375-85-9) PFHpA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	52	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Perfluorooctanoic acid (335-67-1) PFOA	59	nd	nd	nd	nd	nd	nd	nd	nd	nd	62	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Perfluorononanoic acid (375-95-1) PFNA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Perfluorodecanoic acid (335-76-2) PFDA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Perfluoroundecanoic acid (2058-94-8) PFUnA, or PFUndA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Perfluorododecanoic acid (307-55-1) PFDoA, or PFDoDA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Perfluorotridecanoic acid (72629-94-8) PFTrDA, or PFTriA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Chemical Identification		Sample CW1156-SG01-072121 RL = 50 µg/m3	Sample CW1156-SG01-120921-A1T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B1T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B1F Filter; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-A2T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B2T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B2F Filter; Sample Volume=100 mL, RL= 50 µg/m^3	Sample CW1156-SG01-120921-C1T Unfiltered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG01-120921-D1T Filtered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG01-120921-D1F Filter; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG02-072121 RL=50 µg/m^3	Sample CW1156-SG02-120921-A1T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B1T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B1F Filter; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-A2T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B2T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B2F Filter; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-C1T Unfiltered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG02-120921-D1T Filtered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG02-120921-D1F Filter; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-120921-T Tube Blank	Sample CW1156-SG02-120921-F Filter Blank	Sample Laboratory Blanks (3) Tubes
Chemical Class	Chemical Name, (CASRN, where applicable), Acronym	Vapor Concentration Subslab (µg/m^3)																						
	Perfluorotetradecanoic acid (376-06-7) PFTeDA, or PFTeA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Perfluorinated telomer alcohols (FtOHs)	2-perfluorobutyl ethanol 4:2 FtOH	300	150	120	87 Q	140	130	nd	nd	nd	nd	290	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	1-perfluoropentyl ethanol 5:2 sFtOH	930	620	510	340 Q	560	540	140	560	nd	440	2800	700	270	270	700	340	270	560	nd	360	nd	nd	nd
	1-perfluoroheptyl ethanol 7:2 sFtOH	220	290	nd	220 Q	280	nd	210	250	nd	nd	180	200	nd	150	180	nd	190	nd	nd	250	nd	nd	nd
	2-perfluorohexyl ethanol 6:2 FtOH	12000 E	18000 E	900	9900 E,Q	16000 E	250	13000 E	15000	nd	840	8800 E	1100	nd	860	960	nd	970	1100	nd	14000	nd	nd	nd
	2-perfluorooctyl ethanol 8:2 FtOH	6100 E	16000 E	nd	2300 Q	15000 E	nd	12000 E	10000	nd	800	1700	460	nd	660	420	nd	640	560	nd	14000	nd	nd	nd
	2-perfluorodecyl ethanol 10:2 FtOH	930	1400	nd	140 Q	1500	nd	2100	2200	nd	360	160	99	nd	230	140	nd	210	260	nd	3000	nd	nd	nd
--	n-Methylperfluoro-1-octanesulfonamide n-MeFOSA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
--	n-Ethylperfluoro-1-octanesulfonamide n-EtFOSA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
--	Perfluorooctanesulfonamide (754-91-6) PFOSA, or FOSA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Perfluorinated sulfonic acids (PFSAs)	Perfluorobutanesulfonic acid (375-73-5) PFBS	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Chemical Identification		Sample CW1156-SG01-072121 RL = 50 µg/m3	Sample CW1156-SG01-120921-A1T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B1T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B1F Filter; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-A2T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B2T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG01-120921-B2F Filter; Sample Volume=100 mL, RL= 50 µg/m^3	Sample CW1156-SG01-120921-C1T Unfiltered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG01-120921-D1T Filtered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG01-120921-D1F Filter; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG02-072121 RL=50 µg/m^3	Sample CW1156-SG02-120921-A1T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B1T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B1F Filter; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-A2T Unfiltered; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B2T Filtered Tube; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-B2F Filter; Sample Volume=100 mL, RL=50 µg/m^3	Sample CW1156-SG02-120921-C1T Unfiltered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG02-120921-D1T Filtered Tube; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-SG02-120921-D1F Filter; Sample Volume=25 mL, RL=200 µg/m^3	Sample CW1156-120921-T Tube Blank	Sample CW1156-SG02-120921-F Filter Blank	Sample Laboratory Blanks (3) Tubes
Chemical Class	Chemical Name, (CASRN, where applicable), Acronym	Vapor Concentration Subslab (µg/m^3)																						
	Perfluorohexanesulfonic acid (355-46-4) PFHxS	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Perfluorooctanesulfonic acid (1763-23-1) PFOS	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Perfluorodecanesulfonic acid (67906-42-7) PFDS	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
--	HFPO-DA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
--	10:2 FTS	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
--	6:2 fluorotelomer sulfonic acid	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
--	8:2 fluorotelomer sulfonic acid	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

All laboratory analyses completed by Eurofins Air Toxics.

For the FTOH samples, the green shadings are all unfiltered samples, the yellow shadings are all the filtered samples, and the lighter blue shadings are the filter samples. Lighter green, yellow, and blue columns are for the 25 mL sample volumes vs 100 mL samples for the other soil gas samples.

E: Exceeds calibration range
Q: Qualifier flag
NA: Not analyzed
nd: Not detected

6 GA Field Event 1 Results

6.1 Groundwater

6.1.1 Sample Results

Groundwater samples at the Georgia MSW landfill had very low concentrations of PFBA, PFPeA, PFHxA, PFHpA, and PFOA at monitoring well B2 as well as low concentrations of perfluorohexanesulfonic acid with a concentration of 0.0029 µg/L (**Table 20**). Similarly, concentrations less than 0.004 µg/L were found for PFPeA and PFHxA at monitoring well GWC-4 and for PFOA at monitoring well GWC-5A. No FTOHs were detected in any of the samples. The FTOH detection limit of 1 µg/L corresponds to easily detectable concentrations in the soil gas at equilibrium (as discussed in regard to **Table 21**).

No peaks were observed by Laboratory 2 for the neutral PFAS compounds by GC/QTOF-MS.

Table 20. Groundwater Results, September 2021, GA Site.

Chemical	Groundwater Concentration (µg/L)			
	FCL-B2	**FCL-Blank**	**FCL-GWC4**	**FCL-GWC5A**
10:2 FTOH-2-Perfluorodecyl ethanol	<1.0	<1.0	<1.0	<1.0
4:2 FTOH-2-Perfluorobutyl ethanol	<1.0	<1.0	<1.0	<1.0
6:2 FTOH-2-Perfluorohexyl ethanoic acid	<1.0	<1.0	<1.0	<1.0
7:2 FTOH-1-Perfluoroheptyl ethanol	<1.0	<1.0	<1.0	<1.0
8:2 FTOH-2-Perfluorooctyl ethanol	<1.0	<1.0	<1.0	<1.0
HFPO-DA	<0.0025	<0.0027	<0.0025	<0.0026
n-EtFOSAA	<0.0025	<0.0027	<0.0025	<0.0026
n-MeFOSAA	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorobutanesulfonic acid	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorobutanoic acid (PFBA)	0.0082	<0.0045	<0.0042	<0.0043
Perfluorodecanoic acid (PFDA)	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorododecanoic acid (PFDoA)	<0.0017	<0.0018	<0.0017	<0.0017
Perfluoroheptanoic acid (PFHpA)	0.0028	<0.0018	<0.0017	<0.0017
Perfluorohexanesulfonic acid (PFHxS)	0.0029	<0.0018	<0.0017	<0.0017
Perfluorohexanoic acid (PFHxA)	0.017	<0.0018	0.0039	<0.0017
Perfluorononanoic acid (PFNA)	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorooctanesulfonic acid (PFOS)	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorooctanoic acid (PFOA)	0.0034	<0.0018	<0.0017	0.0023
Perfluoropentanoic acid (PFCA)	0.0080	<0.0018	0.0018	<0.0017
Perfluorotetradecanoic acid (PFTA)	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorotridecanoic acid (PFTrDA or PFTeA)	<0.0017	<0.0018	<0.0017	<0.0017
Perfluoroundecanoic acid (PFUnA)	<0.0017	<0.0018	<0.0017	<0.0017

Note: Laboratory analyses completed by the contract laboratory.

Table 21. Upper Limits of Vapor Concentrations at Equilibrium with Aqueous Detection Limits From Contract Laboratory, NJ Site.

Compound	Range of Henry's Law Value	HLC* (dimensionless)	Aqueous Concentration (µg/L)	Vapor Concentration** (µg/m³)
4:2 Fluorotelomer alcohol	Low	0.03	1.0	30
	High	18.20	1.0	18,200
6:2 Fluorotelomer alcohol	Low	0.23	1.0	230
	High	2.30	1.0	2,300
8:2 Fluorotelomer alcohol	Low	2.00	1.0	2,000
	High	3,500	1.0	3,500,000
10:2 Fluorotelomer alcohol	Low	3.10	1.0	3,100
	High	47,000	1.0	47,000,000

* HLC: Henry's Law Constant

** Reference: ITRC, 2021 (experimental values only)

6.1.2 QA/QC

No analytes were detected in the field blank. Other QA considerations are discussed in the laboratory reports included in **Appendix G**.

6.2 Soil Gas

The soil gas data are summarized in **Table 22**. The field samples were collected at two volumes: 1 L and 0.1 L to provide the laboratory with flexibility since the loading was not known in advance. All of the field samples were analyzed from the 1 L volume sample, but the field blank was analyzed from the only collected sample volume of 0.1 L.

The only field sample that is distinguishable from the field blank is sample FCL-MM7A-SG1, where the 8:2 FTOH is barely detected and the 6:2 FTOH is a bit higher than the field blank/other samples on a mass per sorption tube basis. In sample FCL-MM7A, the 8:2 FTOH concentration was found to be 0.11 µg/m^3, just above the reporting limit of 0.1 µg/m^3. The reported concentration of 6:2 FTOH in FCL-MM7A was 0.48 µg/m^3. Five other samples had concentrations at or below the reporting limit of 0.20 µg/m^3 (0.2 ng/tube), but the field blank had a reported concentration of 2.2 µg/m^3 based on a volume of 0.1 L. Additionally, in sample FCL-MM7A, the 6:2 FtOH mass was the highest of any analyzed tube (0.48 ng per sorbent tube versus 0.22 ng per sorbent tube in the field blank, and lower masses in the other 5 samples). Sample FCL-MM7A is the furthest downgradient and co-located with the location B-2 that had the most groundwater impact from the PFCAs.

Sample FCL-MM7A had no PFCAs but had the highest values for FTOHs (**Table 22**). In contrast, sample FCL-MV2 had an elevated screened lower explosive limit (an indicator of hydrocarbon build-up) at 56.7% by volume. It is possible that the GW well screens were totally saturated, thereby, limiting soil gas from entering the well.

Table 22. Soil Gas Results, September 2021, GA Site.

	Soil Gas Concentration (µg/m^3)						
Chemical	**FCL-B2**	**FCL-FB**	**FCL-GWC4**	**FCL-GWC5A**	**FCL-MM7A**	**FCL-MV2**	**FCL-V7-5**
1-Perfluoroheptyl ethanol (7:2 sFTOH)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
1-Perfluoropentyl ethanol (5:2 sFTOH)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
2-Perfluorobutyl ethanol (4:2 FTOH)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
2-Perfluorodecyl ethanol (10:2 FTOH)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
2-Perfluorohexyl ethanol (6:2 FTOH)	<0.2 U	2.2	0.20	<0.2 U	0.48	<0.2 U,Q	<0.2 U
2-Perfluorooctyl ethanol (8:2 FTOH)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	0.11	<0.1 U,Q	<0.1 U
n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	<1.0 J,U	<10.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U,Q	<1.0 J,U
n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	<1.0 J,U	<10.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U,Q	<1.0 J,U
Perfluorobutanoic acid (PFBA)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluoroheptanoic acid (PFHpA)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluorohexanoic acid (PFHxA)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluorooctanoic acid (PFOA)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluoropentanoic acid (PFPeA)	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U

Note: Laboratory analyses completed by the contract laboratory.

J:	Estimated value
Q:	Qualifier flag
U:	Compounds analyzed for but not detected above the reporting limit, limit of detection, or method detection limit value

7 Predicted Versus Measured Equilibrium Partitioning of PFAS

Approximate equilibrium calculations were completed (see **Appendix A** for both equations and results) to explore the interrelationship between the concentrations measured in soil, groundwater, and soil gas at the NJ site. These calculations for locations A through D were based on samples from the first field event. Key findings are described in the following subsections.

7.1 Calculation of Equilibrium Partitioning

7.1.1 Methodology

Equilibrium partitioning calculations were carried out to explore the interrelationship between the concentrations measured in soil, groundwater, and soil gas at the NJ site. A summary of the methods used in the calculations is provided in Appendix A. Factors considered in the calculations include:

- Physical and chemical properties information from ITRC (2021).
- Partitioning between the ionized and unionized forms based on pKa for the PFCA species and site specific pH observations is assumed to occur both on the stationary solids in the soil column and in the extracted soil "gas" sample. It is thus presumed that the extracted soil "gas" could include entrained fine particulate matter or condensed mist, causing a positive bias in the sample data.
- The potential for such a condensed mist to exist at this site is elevated based on the shallow observed groundwater. Literature reports show that vadose zone soils can reach the saturation soil-moisture content that corresponds to 100% relative humidity and condensation in the vadose zone is possible depending on the temperature profile (Smith et al., 1990; Sakai et al., 2009; Assouline and Kamai, 2019). The hypothesized existence of such mists may help explain the PFCA concentrations observed in soil "gas" that are greater than expected from equilibrium partitioning at the NJ site (see Section 4).
- Evidence for the existence of a particulate or aerosol phase in soil "gas" includes the common practice of using in-line filters and moisture knockouts in soil vapor extraction systems (Fam, 1996). Atmospheric aerosols are known to include moisture layers (Wu et al., 2018) so it is reasonable to assume that any aerosols in the vadose zone would also include moisture layers.
- Soil to groundwater partitioning using linear equilibrium partitioning and an assumed soil TOC fraction of 0.001.
- Equilibrium groundwater to vapor phase concentration conversions through Henry's Law.

7.1.2 Location A

Findings at the downgradient location A are as follows:

- Soil gas concentrations at equilibrium with the observed soil concentrations of PFCAs would be expected to be below the detection limit. The PFCAs were reported as nondetect at both depths, which was consistent with expectations.
- Soil gas concentrations expected at equilibrium with the observed soil concentrations of FTOHs were several orders of magnitude above the actual observations. Most of the actual observations were reported as nondetect. This result suggests that the shallow soil gas may not be at equilibrium, which might be expected due to barometric pumping of atmospheric air in and out of the very shallow vadose zone (Tillman & Smith, 2005; USEPA, 2012).
- Groundwater concentrations of PFCAs are within the range of calculated groundwater concentrations based on soil concentration observations.
- Groundwater concentrations of FTOHs were not detected, which is consistent with the calculated groundwater concentrations from measured soil concentrations.

7.1.3 Location B

Findings at the downgradient location B are as follows:

- Soil gas concentrations at equilibrium with the observed soil concentrations of PFCAs would be expected to be below the detection limit. The PFCAs were reported as nondetect at three depths, which is consistent with expectations.
- The soil gas concentrations of 4:2 FTOH, 6:2 FTOH, 8:2 FTOH, and 10:2 FTOH expected at equilibrium was several orders of magnitude above the observed concentration. This result suggests that the

shallow soil gas may not be at equilibrium, which might be expected due to barometric pumping of atmospheric air in and out of the very shallow vadose zone.

- No groundwater data was available for comparison.

7.1.4 Location C

Findings at the midgradient location C are as follows:

- Soil gas concentrations expected at equilibrium with the observed soil concentrations of PFCAs were generally lower than the observed soil gas concentrations. One exception to this was PFOA, where the observed soil gas concentrations in all 3 samples were within the range of calculated concentrations at equilibrium.
  - One possible explanation for the higher-than-expected equilibrium concentrations would be direct sublimation from unsaturated soils. In sublimation, vapors are directly generated without proceeding through the liquid or dissolved state. Sublimation of PFCAs has been reported to be significant in some neutral pH cases (Kaiser et al., 2010; Zhang et al., 2020).
  - Although we have not conducted any thermodynamic equilibrium calculations for the sublimation pathway, **Appendix A** shows that the rate of sublimation expected is sufficient to produce the excess concentrations observed in soil gas within 3 minutes.
  - Alternatively, degradation of FTOHs into PFCAs may be occurring, resulting in greater soil gas concentrations than expected at equilibrium.
- Soil gas concentrations at equilibrium with the observed soil concentrations for 4:2 FTOH, 6:2 FTOH, 8:2 FTOH, and 10:2 FTOH were predicted to be approximately two orders of magnitude above the observed concentrations. This result suggests that the shallow soil gas may not be at equilibrium, which might be expected due to barometric pumping of atmospheric air in and out of the very shallow vadose zone. Chemical and physical properties are not available for calculation from soil lab results for the 5:2 sFTOH and 7:2 sFTOH, which are the highest concentration FTOHs in these soil gas samples.
- No groundwater results were available for comparison at this location.

7.1.5 Location D

Findings at the downgradient location D are as follows:

- Soil gas concentrations at equilibrium with the observed soil concentrations of PFCAs were expected to be below the detection limit. Most of the PFCAs were reported as nondetect at three depths, which is consistent with expectations; however, 1 $\mu g/m^3$ of PFBA was observed in the shallowest soil gas sample, which was above the predicted soil gas concentration at this location.
- For 4:2 FTOH, 6:2 FTOH, 8:2 FTOH, and 10:2 FTOH, the calculated soil gas concentration was substantially greater than the reporting limits for the nondetectable results reported by the contract laboratory. This suggests that the shallow soil gas may not be at equilibrium, which might be expected due to barometric pumping of atmospheric air in and out of the very shallow vadose zone. Most of the observations were reported as nondetect except for a small detection of 5:2 sFTOH for which there are no corresponding physical or chemical properties to estimate values for comparison.
- The observed groundwater concentrations of PFCAs were within the range of calculated groundwater concentrations based on soil concentrations.

- Groundwater concentrations of FTOHs were not detected, which is consistent with the calculated groundwater concentrations from measured soil concentrations.

7.1.6 Locations Near the Production Facility: Equilibrium Concentration Results

Calculations for these locations were based on comparisons between the preliminary screening round sampling of groundwater from well G09-M01A to sample results from subslab soil gas locations SG-01 and SG-02. The measurements were not contemporaneous.

At the locations near the presumed source building, findings were as follows:

- Soil gas concentrations expected at equilibrium with the observed groundwater concentrations of PFCAs were generally higher than the observed soil gas concentrations when the likely existence of a mist or aerosol fraction of the soil gas is presumed.
    - For some of the PFCA compounds, the predicted range is wide due to a wide range of reported pKa constants.
    - Lower concentrations in soil gas than expected from groundwater could indicate that the shallow soil gas may not be at equilibrium, which might be expected due to barometric pumping of atmospheric air in and out of the very shallow vadose zone.
    - Soil samples were not collected at this location.
    - Calculations presented in **Appendix A** predict soil concentrations at equilibrium with the observed groundwater concentrations.
- Conversely, groundwater concentrations for PFCAs expected at equilibrium with the observed subslab soil gas concentrations were substantially lower than the actual groundwater concentration observed at GO9-M01A.
- Calculated soil gas concentrations expected for FTOHs based on groundwater concentrations were higher than the actual subslab soil gas concentrations observed. In two cases (4:2 FTOH and 6:2 FTOH), the calculated and observed concentrations came within one order of magnitude of each other.

8 Discussion

8.1 New Jersey Field Site

8.1.1 Measured Versus Predicted PFAS in Soil Gas

Multiple PFAS were found in groundwater, soil, and soil gas at the New Jersey site. The PFAS, including both PFCAs, which occur primarily in their ionic form based on their pKas (**Table 1)**; and FTOHs, which occur primarily in their neutral form based on their pKas (**Table 1**); found in the soil gas phase had concentrations above those in ambient air, which may indicate a subsurface source (**Table 14**). Soil concentrations of FTOHs were generally low (<10 ng/g) while the concentrations of the PFCAs ranged from non-detect to 810 ng/g (**Table 16**). Comparing the analytical laboratory water results in ppb (µg/L) to the soil results in ppb (ng/g) shows that the two results are in the same concentration range for the short chain PFCAs. In contrast, higher soil concentrations were observed compared to groundwater for the long chain compounds, which fits with a general reported pattern of lower aqueous solubility for the longer chain PFCAs (ITRC, 2007).

At location C, where detectable concentrations of nearly all the FTOHs were found, comparing soil gas concentrations expected at equilibrium with the observed soil concentrations of PFCAs, the theoretical soil gas concentrations were generally lower than the observed equilibrium soil gas concentrations. One exception to this trend was PFOA, where the observed soil gas concentrations at all 3 sampled depths were within the range of calculated equilibrium concentrations. Soil gas concentrations for 4:2, 6:2, 8:2, and 10:2 FTOH were predicted to be approximately two orders of magnitude above the observed concentrations. This difference suggests that the shallow soil gas may not be at equilibrium due to barometric pumping of atmospheric air in and out of the very shallow vadose zone. Barometric pumping from surficial openings during weather events (large storm events with or without precipitation; ITRC, 2007), is in part, a driving force for vapor phase transport under slabs (Tillman and Smith, 2005). Diffusive mass transfer may play a strong role in moving the FTOHs to areas at the site where barometric pumping can then lead to their loss to the atmosphere (USEPA, 2012).

Higher soil gas concentrations of PFCAs were observed at location C than were expected based on equilibrium calculations from observed soil concentrations (**Table 14**), leading to the hypothesis that a mist or vapor phase was present. This result is attributable to the assumption in the equilibrium calculation that the PFCAs are partitioned into the soil pore space water or water associated with the mineral and/or organic particles. When partitioned, the PFCAs would be ionized at the observed circumneutral pH values and the ionized forms would not volatilize to the gas phase. However, Bastow et al. (2022) has recently argued that when organic solvents are present (including fuels or asphalt), PFAS have very different pKas and are, thus, less likely to be ionized in their presence. An alternate hypothesis to explain the field data is that the source of the soil gas is sublimation (direct transition from solid phase to gas phase) in these soils in the vadose zone (Ahrens et al., 2012).

Partitioning calculations between the ionized and un-ionized forms based on pKa for the PFCA species and site-specific pH observations are assumed to occur both on the stationary solids in the soil column and in the extracted soil “gas” sample. It is presumed that the extracted soil “gas” includes either fine particulate capable of being entrained at low sampling velocity, or a condensed mist. The potential for such a condensed mist to exist is elevated based on shallow groundwater at the site. Literature reports show that vadose zone soils can reach the saturation soil-moisture content that corresponds to 100% relative humidity and condensation in the vadose zone is possible depending on the temperature profile (Smith et al., 1990; Sakai et al., 2009; Assouline and Kamai, 2019). The hypothesized existence of such mists may help explain the unexpectedly high concentrations of PFCAs observed in soil “gas” at the New Jersey site.

8.1.2 PFAS Distribution

PFAS concentrations in the soil gas phase were greatest (when detected) in the subslab soil gas underneath the building and tended to decrease with distance from the building with virtually no PFAS being present at locations A and D. This distribution pattern suggests that PFCAs and FTOHs could be migrating in either the vapor phase in the vadose zone (including the coarse subslab environment), PFCAs in groundwater, or both (i.e., PFCAs), away from the presumed source area. Alternately, if there are cracks, openings in the concrete/asphalt covering the ground surface, or grass or gravel covered open areas between the building and the sampling locations, atmospheric deposition of PFAS may have occurred. PFAS deposited on the ground surface may be washed through the openings into the subsurface during rainfall or snowmelt events (Jai et al., 2023).

No FTOHs were found in groundwater regardless of distance from the presumed source area (**Table 15**). The lack of FTOHs in groundwater and their presence in the soil gas phase would indicate vapor phase transport. Supporting the vapor phase transport hypothesis, when examining the FTOH distribution within the soil column, the greatest concentrations were found in subslab soil gas followed by the deepest sampling depth for the nFTOHs. The driving force for this vapor phase transport can be attributed to diffusion and advection due to barometric pumping from surficial openings during weather events. Lateral advective driving forces in the vadose zone can exist due to pressure gradients around the several buildings visible in Figure S1.53 (USEPA, 2012).

In contrast, the sFTOH and PFCA concentrations were greater at depth and decreased towards the surface. This distribution would indicate groundwater transport from the building to the sampling locations. However, while the PFCAs were found in groundwater, supporting a groundwater transport hypothesis, no sFTOHs were quantified in the groundwater. There are some apparent inconsistencies between the data and expectations from theory, which may provide clues to alternative transport mechanisms or may be attributable to unavoidable data bias and variability in the current methods of sampling and analysis. The presence of the sFTOHs in greater concentrations at depth could be the result of concomitant vertical diffusion/dispersion of the nFTOHs into the underlying soils going through cycles of reduction and oxidation to produce sFTOHs following transformation pathways described by Evich et al. (2022). Changing redox conditions in the subsurface are indicated in the field notes (**Table 17**) by the presence of “redox features”. If sFTOHs are generated in relatively high concentrations, such as at location C, they can diffuse or advect towards the surface into the oxidizing coarse sand and cobble layer found under the slab, degrade further, and contribute to the vapor phase PFCA concentrations. Balgooyen and Remucal (2023) stated that there are likely some active ingredients that underwent transformation in the subsurface leading to increased concentrations of PFCAs at soil depth and in the groundwater.

8.1.3 PFAS Transport Phases

While the presence of PFAS at the site was not unexpected, since the site has long been used to produce fluoroelastomers and fluorotelomers, the presence of PFCAs (PFBA, PFHxA, PFHpA, and PFOA) in the soil gas phase was unexpected due their very low volatility. Refinement of the analytical methods for PFCAs in soil gas is in progress to minimize potential biases due to interferences and to confirm study findings. PFCAs are generally considered to be predominantly partitioned to the particulate phase in the atmosphere; however, reports of PFBA, PFHpA, PFHxA, PFOA, and PFPeA in the gas phase at some ambient air sites at concentrations below 0.025 ng/m^3 exist in the literature (Assouline and Kamai, 2019; Shoeb et al., 2011; Kim and Kannan, 2007). Gas phase PFHpA, PFHxA, and PFOA at concentrations below 2.5 ng/m^3 have been reported in indoor air at background sites (Assouline and Kamai, 2019). Kaiser et al. (2010) was able to measure sublimation of PFOA at 45°C and also measured some partitioning into the air phase from aqueous solution at pH 7. Zhang et al. (2020) also recently reported sublimation vapor pressures for FTOH and PFCA compounds using a method that involves observing mass loss under vacuum at near ambient temperatures.

Although PFBA, PFHxA, and PFOA were detected during Field Event 1 (**Table 14**), only PFHxA and PFHpA were found and only on the unfiltered thermal desorption tubes during Field Event 2 (data not presented). The short chain 4:2 and 5:2s FTOHs were quantified in unfiltered thermal desorption tubes, filters, and the post-filter thermal desorption tubes (**Table 19**). In contrast, 6:2, 7:2s, 8:2, and 10:2 FTOHs were found in the unfiltered thermal desorption tube or on the filter with little to no measurable concentrations on the subsequent post-filter thermal desorption tube. These results indicate that the 4:2 and 5:2s FTOH are moving in both the vapor and particulate phase while the other FTOHs are moving in the particulate phase and were trapped on the quartz microfiber filter. Whether the FTOH concentrations detected on the filter represent the particulate phase as a solid particle, a liquid phase (mist), or vapor phase sorption of longer chain FTOHs to the quartz microfiber filter is currently under investigation.

8.2 Georgia Muncipal Solid Waste Landfill Site

In contrast to the New Jersey site, PFCA concentrations in the well head gas and groundwater samples were relatively low (<0.5 µg/m^3 and <0.02 µg/L, respectively) at the Georgia MSW landfill. The primary PFAS identified in groundwater included: PFBA, PFPeA, PFHxA, PFHpA, and PFOA (**Table 20**). Only 8:2 FTOH was reliably detected in the well head space of location GWC-5A. These results provided the landfill operators with information that PFAS are migrating into groundwater.

9 Summary

This project demonstrated that multiple PFAS species, both neutral and ionic, were observed in the soil gas environment at concentrations clearly above those in ambient air at the NJ site. The NJ site was expected to exhibit substantial concentrations due to its long history of producing and using fluoroelastomers and fluorotelomers. The PFAS in greatest concentrations at the NJ site included 6:2 FTOH, 8:2 FTOH, 10:2 FTOH, 5:2 sFTOH, and PFHxA. FTOH concentrations in the soil gas phase were generally greatest in the subslab soil gas underneath the presumed source building and tended to decrease with distance from the presumed source building. However, sFTOH concentrations were generally greater at depth towards the groundwater. The two distributional patterns (i.e., lateral and vertical) for the FTOHs indicate likely migration in the vapor phase while for the sFTOHs, migration in the groundwater is indicated. Degradation in the soil leading to the formation of sFTOHs also cannot be ruled out as a possible explanation for their distribution in the soil gas. While the PFCAs followed the same lateral distribution as the FTOHs, their concentrations were generally greater at depth towards the groundwater, indicating migration in and release from the groundwater source.

In the soils at the NJ site, FTOH concentrations were present in low concentrations (<37 ng/kg). The anticipated pattern of location C having higher concentrations than the other locations further away from the presumed source was observed for the PFCAs. Since the PFCA concentrations were generally greater at depth towards the groundwater, migration in and release from the groundwater source is indicated.

No FTOHs were detected in the groundwater at any location at the NJ site. PFCAs with carbon chains from C4 to C10 were detected in all collected samples. While refusal was encountered during attempts to sample the groundwater at locations B and C, the anticipated spatial pattern having higher concentrations nearer to the presumed source building than at locations further away was generally observed, with PFCAs concentrations being generally higher in samples from location D than location A.

In marked contrast to the NJ site, the source of PFAS in the GA MSW landfill is presumed to be release from consumer products or other wastes amassed between the mid-1970s and 1995 when the landfill was open. At the GA MWS landfill, concentrations of PFAS in the groundwater were virtually non-existent except for PFHxA, which was detected at one location FCL-GWC4. Soil and wellhead vent gas had detections of 6:2 FTOH at 3 of the 7 sampling locations while the other FTOHs were generally absent.

The multibed sorbent tube approach, based on USEPA Method TO-17 (USEPA 1999), was found to be feasible for field use and the analytical QC measurements were generally acceptable. Only a very small sample volume of 0.1 L was required at the NJ site but at the GA MSW landfill site, volumes of 0.1 and 1.0 L were collected to improve PFAS detection in the relatively PFAS free environment.

Examination of whether PFAS were traveling as vapors or particulates was performed by placing quartz microfiber filters ahead of the adsorbents in the thermal desorption tubes. Most of the FTOH mass was reported on the filters. The fraction observed on the filter as compared to the sorbent was highest for the longer chained FTOH compounds. The shorter chain 4:2 and 5:2s FTOHs were detected on both the filter and in the subsequent thermal desorption tube. These results indicate that the 4:2 and 5:2s FTOH are moving in both the vapor and particulate phase while the other FTOHs are moving in the particulate phase and were trapped on the quartz microfiber filter.

The presence of PFAS in soil, soil gas, and groundwater at the NJ site indicates the potential for but does not confirm VI as an exposure pathway. Concurrent indoor air measurements would be needed to confirm a complete VI pathway. Given the known health risks associated with PFAS exposure and the presence of volatile PFAS in the environment, PFAS VI assessment is warranted at facilities where high PFAS concentrations are present or suspected in shallow soils and groundwater.

Based on our findings, several areas of additional research have been identified. There is a need to:

- Establish whether the observations at the NJ site are the result of groundwater transport, atmospheric transport and/or deposition, or multiple locations of historic PFAS discharge. This study would address the source of the contamination at the NJ site and help define what processes are influencing PFAS distribution.
- Develop a more effective vapor/particle separation approach than the quartz microfiber filter approach is needed to determine if particulate transport, either in particulate or liquid phase moisture, was occurring versus an apparent particulate phase transport which could be, in essence, an artifact of charged surfaces on the filter sorbing PFAS from the soil gas.
- Determine the effectiveness of the soil gas sampling approach. This approach needs to be further verified before developing a field sampling method using thermal desorption tubes to collect gas phase PFAS in the subsurface. This study would also provide information on method sensitivity and other relevant QA/QC parameters related to the method.
- Validate the causes, presence, and extent of the potential biasing of PFOA concentrations from perfluoro-1-heptene.

Acknowledgements

The assistance of Gwen Buckley, B. T. Thomas, Taylor Salsburg, Carol Mowder and Scott Terrell of Jacobs, as well as Chase Holton and Helen Dawson of Geosyntec is acknowledged. The logistical support of Tom Ei, John Phillips, Andrew Hartten, Scott Northey, Scott Norcross, Thomas McGee, and Scott Morgan is appreciated. Management and data analysis support was provided by RTI International including Robert Truesdale, Katherine Bronstein, and Linda Andrews. Laboratory analyses were performed by, among other, Kerri Sachtelben and Charles Neslund of Eurofins Scientific laboratories. We thank Gina Ferreira of USEPA-Region 2; Erica Snyder, Jennifer Willemsen, Nicole Kalaigian, and Allan Motter of the NJ Department of Environmental Protection; John Washington and Marina Evich of USEPA ORD-Athens, and Matthew Gordon of The Chemours Company for their technical input and reviews.

10 References

Ahrens, L., M. Shoeib, T. Harner, S.C. Lee, R. Guo, and E.J. Reiner. 2011. Wastewater treatment plant and landfills as sources of polyfluoroalkyl compounds to the atmosphere. *Environ. Sci. Techol.*, 45 (19) 8098-8105.

Ahrens, L., T. Harner, S. C. Lee, R. Guo, and E. J. Reiner. 2012. Improved Characterization of Gas-Particle Partitioning for Per- and Polyfluoroalkyl Substances in the Atmosphere Using Annular Diffusion Denuder Samplers. *Environ. Sci. Technol.*, 46, 7199-7206.

Alinez, A., P. C. Sasi, P. Zhang, B. Yao, A. Kubatova, S.A. Golovko, M.Y. Golovko, F. Xioa. 2022. An Investigation of Thermal Air Degradation and Pyrolysis of PFAS and AFFF in Soil. *ACS EST Engg.*, 2, 198-209.

Arp, H. P. H., and K-U. Goss. 2008. Irreversible sorption of trace concentrations of perfluorocarboxylic acids to fiber filters used for air sampling. *Atmos. Environ.*, 42 (28), 6869-6872.

Assouline, S. and T. Kamai. 2019. Liquid and vapor water in vadose zone profiles above deep aquifers in hyper-arid environments. *Water Resources Res.*,. 55 (5), 3619-3631.

Balgooyen, S. and C.K. Remucal. 2023. Impacts of Environmental and Engineered Processes on the PFAS Fingerprint of Fluorotelomer-Based AFFF. *Environ. Sci. Technol*., 57 (1), 244-254.

Bastow, T.P., G.B. Douglas, G.B. Davis. 2022. Volatilization Potential of Per-and Poly-fluoroalkyl Substances from Airfield Pavements and during Recycling of Asphalt. Environ. Toxicol. Chem. 41 (9), 2202-2208. https://doi.org/10.1002/etc.5425.

Bidleman, T.F., W. N. Billings, and W.T. Foreman. 1986. Vapor-particle partitioning of semivolatile organic compounds: estimates from field collections. *Environ. Sci. Technol.*, 20 (10), 1038-1043.

Brewer, R., J. Nagashima, M. Rigby, M. Schmidt, and H. O'Neil. 2014. Estimation of Generic Subslab Attenuation Factors for Vapor Intrusion Investigations: *Groundwater Monitoring & Remediation*, 34: 79–92. doi: 10.1111/gwmr.12086, https://doi.org/10.1111/gwmr.12086

Brewer, R., J. Peard, and M. Heskett. 2017a. A critical review of discrete soil sample reliability: Part 1 – Field study results. *Soil and Sediment Contamination,* Vol 26, No 1. Available from: http://dx.doi.org/10.1080/15320383.2017.1244171

Brewer, R., J. Peard, and M. Heskett. 2017b. A critical review of discrete soil sample reliability: Part 2 – Implications. *Soil and Sediment Contamination*, Vol 26, No 1. Available from: http://dx.doi.org/10.1080/15320383.2017.1244172

Brusseau, M.L. 2018. Assessing the potential contributions of additional retention processes to PFAS retardation in the subsurface. *Sci. Total Environ.*, 613-614:176-185.

Cai, M., Z. Xie, A. Moller, Z. Yin, P. Huang, M. Cai, H. Yang, R. Sturm, J. He, and R. Ebinghaus. 2012. Polyfluorinated compounds in the atmosphere along a cruise pathway from the Japan Sea to the Arctic Ocean. *Chemosphere*, 87, 989-997.

Ellington, J.J., J.W. Washington, J.J. Evans, T.M. Jenkins, S.C. Hafner, and M.P. McNeill. 2009.Analysis of fluorotelomer alcohols in soils: Optimization of extraction and chromatography. *J Chromatog. A*, 12:16:5347-5354.

Evich, M.G., M.J.B. Davis, J.P. McCord, B. Acrey, J.A. Awkerman, D.R.U. Knappe, A.B. Lindstrom, T.F. Speth, C. Tebes-Stevens, M.J. Strynar, Z. Wang, E.J. Weber, W.M. Hendersons, and J.W. Washington. 2022. Per- and Polyfluoroalkyl Substances in the Environment. *Science*, 375, 6580.

Fam, S. 1996. Vapor Extraction and Bioventing, Chapter 4 in Nyer, E.K. et al. In-situ Treatment Technology, Lewis Publishers, Boca Raton.

Georgia Environmental Protection Division (GAEPD). 2015. Guidance Document, Methane Monitoring at Solid Waste Disposal Facilities., 391-3-4-.07(3)(h). 391-3-4-.07(4)(c)4. September.

Gomis, M.I.,Z. Wang, M. Scheringerblan, and I.T. Cousins. 2015. A modeling assessment of the physicochemical properties and environmental fate of emerging and novel per- and polyfluoroalkyl substances. *Sci. Total Environ*., 505, 981-991.

He, A., Y. Liang, F. Li, Y. Lu, C. Liu, J. Li, Z. Zhou, N. Zhu, C. Liao, Y. Wang, and G. Jiang. 2022. Vital Environmental Sources for Multitudinous Fluorinated Chemicals: New Evidence from Industrial Byproducts in Multienvironmental Matrices in a Fluorochemical Manufactory. *Environ. Sci. Technol*., 56, 16789-16800.

Interstate Technology & Regulatory Council. 2007. Vapor Intrusion Pathway: A Practical Guideline. Washington DC.

Interstate Technology & Regulatory Council. 2020. Technical/Regulatory Guidance: Per- and Polyfluoralkyl Substances (PFAS). Washington, DC.

Interstate Technology & Regulatory Council. 2021. PFAS Technical and Regulatory Guidance Document (updated) - External Table 4-1: Physical and Chemical Property Values for Select PFAS. Washington DC.

Jacobs. 2020. Final Report: Semi-Annual Groundwater and Surface Water Monitoring Report and Monitored Natural Attenuation Evaluation, Harrison Bridge Road Ph 1 Sanitary Landfill.

Jewell, K.P. and J.T. Wilson. 2011. A New Screening Method for Methane in Soil Gas Using Existing Groundwater Monitoring Wells. *Ground Water Monit. Remed*., 31 (3), 82-94.

Jia, X., X. Li, L. Zhou, Y. Hui, W. Li, Y. Cai, and Y. Shi. 2023. Variations of the Level, Profile, and Distribution of PFAS around POSF Manufacturing Facilities in China: An Overlooked Source of PFCA. *Environ. Sci. Technol.*, 57, 5264-5274.

Johansson, J. H., U. Berger, and I. T. Cousins. 2017. Can the use of deactivated glass fibre filters eliminate sorption artefacts associated with active air sampling of perfluorooctanoic acid?. *Environ. Pollut.*, 224, 779-786.

Jordan, Jones & Goulding. 2003. Corrective Action Program for Harrison Bridge Road Municipal Solid Waste Landfill, prepared for Board of Commissioners Franklin County, GA.

Kaiser, M.A., B.J. Dawson, C.A. Barton, and M.A. Botelho. 2010. Understanding potential exposure sources of perfluorinated carboxylic acids in the workplace. *Ann. Occup. Hyg.*, 54 (8), 915-922.

Kim, S., and Kannan, K. 2007. Perfluorinated Acids in Air, Rain, Snow, Surface Runoff, and Lakes: Relative Importance of Pathways to Contamination of Urban Lakes. *Environ. Sci. Technol.*, 41, 8328-8334.

Kissel, D.E. and L.S. Sonon. 2011. Soil test handbook for Georgia. University of Georgia Cooperative Extension Service. Special Bulletin 62.

Lai, S., J. Song, T. Song, Z. Huang, Y. Zhang, Y. Zhao, G. Liu, J. Zheng, W. Mi, J. Tang, S. Zou, R. Ebinghaus, and Z. Xie. 2016. Neutral polyfluoroalkyl substances in the atmosphere over the northern South China Sea. *Environ. Pollut.*, 214, 449-455.

Liu, J, N. Wang, B. Szostek, R.C. Buck, P.K. Panciroli, P.W. Folsom, L.M. Sulecki, and C.A. Bellin. 2010. 6-2 Fluorotelomer alcohol aerobic biodegradation in soil and mixed bacterial culture. *Chemosphere***,** 78 (4) 437-444.

Loganathan, N. and A.K. Wilson. 2022. Adsorption, Structure, and Dynamics of Short- and Long-Chain PFAS Molecules in Kaolinite: Molecular-Level Insights. *Environ. Sci. Technol*., 56, 8043-8052.

Sakai, M., N. Toride, and J. Šimůnek. 2009. Water and vapor movement with condensation and evaporation in a sandy column. *Soil Sci. Soc. Am. J.*, 73 (3) 707-717.

Shoeib, M, T. Harner, G. M. Webster, and S. C. Lee. 2011. Indoor Sources of Poly- and Perfluorinated Compounds (PFCS) in Vancouver, Canada: Implications for Human Exposure. *Environ. Sci. Technol*., 45, 7999-8005.

Smith, J.A., C.T. Chiou, J.A. Kammer, and D.E. Kile. 1990. Effect of soil moisture on the sorption of trichloroethene vapor to vadose-zone soil at Picatinny Arsenal, New Jersey. *Environ. Sci. Technol*., 24 (5), 676-683.

Thaxton, K., J. Stuff, J.A. Whitecavage, H. Hayes, and J. Miller. 2020. Analysis of PFAS Compounds in Air using Solid Sorbent Tubes with Thermal Desorption Gas Chromatography Mass Spectrometry. Presented at National Environmental Monitoring Conference. https://apps.nelac-institute.org/nemc/2020/docs/presentations/pdf/8-4-20-Air%20Methods,%20Monitoring,%20and%20Technology-3.03-Thaxton.pdf

Tian, Y., Y. Yao, S. Chang, Z. Zhao, Y. Zhao, X. Yuan, F. Wu, and H. Sun. 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. *Environ. Sci. Technol.*, 52, 3, 1301-1310.

Tillman Jr, F.D. and J.A. Smith. 2005. Site characteristics controlling airflow in the shallow unsaturated zone in response to atmospheric pressure changes. *Environ. Eng. Sci.*, 22, 25-37.

United States Census Bureau (USCB). Retrieved **2021**. https://www.census.gov.

USEPA. 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air Second Edition, Compendium Method TO-17 Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes. EPA/625/R-96/010b.

USEPA. 2007. Method 3546 Microwave Extraction. https://www.epa.gov/sites/default/files/2015-12/documents/3546.pdf.

USEPA. 2009. Method 537. Determination Of Selected Perfluorinated Alkyl Acids In Drinking Water By Solid Phase Extraction And Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), Version 1.1. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NERL&dirEntryId=198984&simpleSearch=1&searchAll=EPA%2F600%2FR-08%2F092.

USEPA. 2012. Conceptual Model Scenarios for the Vapor Intrusion Pathway. EPA 530-R-10-003.

USEPA. 2015. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. Office of Solid Waste and Emergency Response (OSWER), OSWER Publication 9200.2-154.

USEPA. 2018. Method 8270E. Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC-MS). https://www.epa.gov/sites/default/files/2020-10/documents/method_8270e_update_vi_06-2018_0.pdf.

USEPA. 2022. Screening Levels for Chemical Contaminants: U.S. Environmental Protection Agency. Prepared by Oak Ridge National Laboratories.

Vapor Pin Enterprises, Inc. 2021a. Standard operating procedure: Installation and extraction of the Vapor Pin® sampling device. Retrieved August 18, 2022, from https://www.vaporpin.com/wp-content/uploads/2021/02/Vapor-Pin-Installation-and-Extraction-SOP-3-16-2018-Web-02022021.pdf.

Vapor Pin Enterprises, Inc. 2021b. Standard Operating Procedure Leak Testing the VAPOR PIN® Sampling Device Via Water Dam. Retrieved October 31, 2022, from https://www.vaporpin.com/wp-content/uploads/2021/02/VP-Leak-Testing-with-Water-Dam-SOP-02022021.pdf.

Wang, Z., Z. Xie, W. Mi, A. Möller, H. Wolschke, and R. Ebinghaus. 2015. Neutral Poly/Per-Fluoroalkyl Substances in Air from the Atlantic to the Southern Ocean and in Antarctic Snow. *Environ. Sci. Technol*., 49: 7770-7775.

Wang, B., Y. Yao, H. Chen, S. Chang, Y. Tian, and H. Sun. 2020. Per-and polyfluoroalkyl substances and the contribution of unknown precursors and short-chain (C2–C3) perfluoroalkyl carboxylic acids at solid waste disposal facilities. *Sci. Total Environ*., 705, 135832.

Weinberg, I., A. Dreyer, and R. Ebinghaus. 2011. Landfills as sources of polyfluorinated compounds, polybrominated diphenyl ethers and musk fragrances to ambient air. *Atmos. Environ.* 45, 4, 935-941.

Wu, Z., J. Chen, Y. Wang, Y. Zhu, Y. Liu, B. Yao, Y. Zhang, and M. Hu. 2018. Interactions between water vapor and atmospheric aerosols have key roles in air quality and climate change. *Nat. Sci. Rev.,* 5, no. 4 (2018):452-454.

Xiao, F., P. C. Sasi, B.Yao, A, Kubatova, S.A. Golovko, M.Y. Golovko, D. Soli, 2020. Thermal Stability and Decomposition of Perfluoroalkyl Substances on Spent Activated Carbon, *Environ. Sci. Technol. Lett.*, 7, 343-350.

Yamazaki E., S. Taniyasu, X. Wang, and N. Yamashita. 2021. Per- and polyfluoroalkyl substances in surface water, gas and particle in open ocean and coastal environment. *Chemosphere*, 129869.

Zhang, M., K. Yamada, S. Bourguet, J. Guelfo, and E.M. Suuberg. 2020. Vapor pressure of nine perfluoroalkyl substances (PFASs) determined using the Knudsen Effusion Method. *J Chem. Eng. Data*., 65 (5), 2332-2342.

Appendix A. Equilibrium Calculations for the NJ Site

NOTE: To see entire spreadsheet, double click anywhere on the “Read Me” page of spreadsheet below and be patient as it may take a minute or two to load the spreadsheet.

Appendix B. Combined Vapor Concentration on Subslab, Soil Gas, Soil, Ambient Air, and Groundwater Sampling Results for Event 1 (July 2021), NJ Site

Chemical Identification			Contract Laboratory 1															Contract Laboratory 2							
Class	Chemical Name	Acronym	Sample CW1156-SG01-072121 RL = 50 µg/m^3	Sample CW1156-SG02-072121 RL = 50 µg/m^3	Sample Location A 1.5'	Sample Location A 2.5'	Sample Location B SS	Sample Location B 1.5'	Sample Location B 2.5'	Sample Location C SS	Sample Location C 1'	Sample Location C 2'; 1 liter sample	Sample Location C 2'; 100 mL	Sample Location D 1'	Sample Location D 2.5'	Sample Location D 3.5'	Blank Site (1 L sample)	Sample Location A	Sample Location B	Sample Location B Dup	Sample Location C	Sample Location D	Sample Location A	Sample Location D	Sample Location D - Duplicate
			Vapor Concentration on Subslab (µg/m^3)		Soil Gas Concentration (µg/m^3)												Ambient Air	Soil Concentration (ng/g)					Groundwater Concentration (µg/L)		
Perfluorinated carboxylic acids (PFCAs)	Perfluorobutanoic acid	PFBA	140	99	nd	nd	nd	nd	nd	0.84	7.1 E	23	nd	1.0 J	nd	nd	0.12	nd	nd	nd	4.3	nd	1.9	4.3	4.3
	Perfluoropentanoic acid	PFPeA	<50	<50	nd	nd	nd	nd	nd	4 I	25 E,I	62	nd	nd	nd	nd	nd	2	0.95	0.97	18	2.9	5.3	8.7	8.4
	Perfluorohexanoic acid	PFHxA	460	650 E	nd	nd	nd	nd	nd	7.1 E	49 E	180	71	nd	nd	nd	0.16	16	3.7	3.8	190	12	49	39	37
	Perfluoroheptanoic acid	PFHpA	<50	<50	nd	nd	nd	nd	nd	nd	1.3	3.8	nd	nd	nd	nd	nd	1.5	nd	nd	71	14	1.5	4.5	4.7
	Perfluorooctanoic acid	PFOA	59	62	nd	nd	nd	nd	nd	0.72	1.7	7	nd	nd	nd	nd	nd	3.3	1.5	1.5	480	53	1.2	7.2	7.3
	Perfluorononanoic acid	PFNA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.6	1.4	1.4	180	23	4.3	7.8	7.2
	Perfluorodecanoic acid	PFDA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	30	6.1	6	810	2.2	5.2	1.8	1.8
	Perfluoroundecanoic acid	PFUnA, or PFUndA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	13	8.5	13	290	nd	nd	nd	nd
	Perfluorododecanoic acid	PFDoA, or PFDoDA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	27	92	120	640	nd	0.069	nd	nd
	Perfluorotridecanoic acid	PFTrDA, or PFTriA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.2	50	45	140	nd	nd	nd	nd
	Perfluorotetradecanoic acid	PFTeDA, or PFTeA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24	220	140	410	nd	nd	nd	nd
	Perfluorohexadecanoic acid	PFHxDA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.8	78	47	190	nd	nd	nd	nd
	Perfluorooctadecanoic acid	PFODA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.1	23	17	61	nd	nd	nd	nd
Perfluorinated	2-perfluorobutyl ethanol	4:2 FtOH	300	290	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Chemical Identification			Contract Laboratory 1															Contract Laboratory 2							
Class	Chemical Name	Acronym	Sample CW1156-SG01-072121 RL = 50 $\mu g/m^3$	Sample CW1156-SG02-072121 RL = 50 $\mu g/m^3$	Sample Location A 1.5'	Sample Location A 2.5'	Sample Location B SS	Sample Location B 1.5'	Sample Location B 2.5'	Sample Location C SS	Sample Location C 1'	Sample Location C 2'; 1 liter sample	Sample Location C 2'; 100 mL	Sample Location D 1'	Sample Location D 2.5'	Sample Location D 3.5'	Blank Site (1 L sample)	Sample Location A	Sample Location B	Sample Location B Dup	Sample Location C	Sample Location D	Sample Location A	Sample Location D	Sample Location D - Duplicate
			Vapor Concentration on Subslab ($\mu g/m^3$)		Soil Gas Concentration ($\mu g/m^3$)												Ambient Air	Soil Concentration (ng/g)					Groundwater Concentration (µg/L)		
	1-perfluoropentyl ethanol	5:2 sFtOH	930	2800	nd	nd	nd	nd	nd	4.9	64 E	590	230	1.0 J	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	1-perfluoroheptyl ethanol	7:2 sFtOH	220	180	nd	nd	nd	nd	nd	1.1	22 E	160	59	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	2-perfluorohexyl ethanol	6:2 FtOH	12000 E	8800 E	2.6	nd	nd	3	3.1	85 E	0.23	1.3	nd	nd	nd	nd	5.5	nd	nd	nd	nd	nd	nd	nd	nd
	2-perfluorooctyl ethanol	8:2 FtOH	6100 E	1700	nd	nd	nd	14	6	27 E	0.15	2.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	2-perfluorodecyl ethanol	10:2 FtOH	930	160	nd	nd	nd	2.2	nd	14 E	1.3	7.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
n-Methylperfluoro-1-octanesulfonamide		n-MeFOSA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
n-Ethylperfluoro-1-octanesulfonamide		n-EtFOSA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Perfluorooctanesulfonamide		PFOSA, or FOSA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	nd	nd	nd	nd	nd
Perfluorinated sulfonic acids (PFSAs)	Perfluorobutanesulfonic acid	PFBS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	nd	nd	nd	nd	nd
	Perfluorohexanesulfonic acid	PFHxS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	nd	nd	nd	nd	nd
	Perfluorooctanesulfonic acid	PFOS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	nd	nd	0.063	0.024	0.024
	Perfluorodecanesulfonic acid	PFDS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	nd	nd	nd	nd	nd
HFPO-DA		--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	nd	nd	0.11	0.25	0.26
10:2 FTS		--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	6.1	nd	nd	nd	nd
6:2 fluorotelomer sulfonic acid		--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	3.2	nd	nd	nd	nd
8:2 fluorotelomer sulfonic acid		--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	nd	nd	nd	5.8	nd	nd	nd	nd
Soil pH		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.31	7.06	7.00	7.85	6.50	--	--	--

--: Not applicable

[1] No water collected here - refusal at 4 feet before water table

[2] Refusal at 3 feet before water table

Contract Laboratory 1: Eurofins Air Toxics Laboratory
Contract Laboratory 2: Eurofins Lancaster Laboratory

E:	Results exceeded calibration range
I:	Matrix interference affecting qualifier ion(s) used for compound identification
J:	Estimated value
NA:	Not analyzed
nd:	Not detected

Appendix C: QA/QC Data from Contract Laboratory Report, NJ Site, Sampling Event 1 (July 2021)

File Name: 2017653R1_EDD.xlsx - For subslab soil gas data from building. Blank cells mean not applicable or non-existent information. For example, PFBA in first line of table has no flag so QA/QC associated with that data point is acceptable.

LabID	SampleID	Compound	RL	Units	AMT	Units	RL µg/m^3	Units µg/m^3	AMT µg/m^3	Units µg/m^3	Flag
2107653R1-02A	CW-1156-SG02-072821 (2)	Perfluorobutanoic acid (PFBA)	5	ng	9.9	ng	50	µg/m^3	99	µg/m^3	
2107653R1-02A	CW-1156-SG02-072821 (2)	Perfluoropentanoic acid (PFPeA)	5	ng	ND	ng	50	µg/m^3	ND	µg/m^3	µg/m3
2107653R1-02A	CW-1156-SG02-072821 (2)	Perfluorohexanoic acid (PFHxA)	5	ng	65	ng	50	µg/m^3	650	µg/m^3	µg/m3
2107653R1-02A	CW-1156-SG02-072821 (2)	Perfluoroheptanoic acid (PFHpA)	5	ng	ND	ng	50	µg/m^3	ND	µg/m^3	µg/m3
2107653R1-02A	CW-1156-SG02-072821 (2)	Perfluorooctanoic acid (PFOA)	5	ng	6.2	ng	50	µg/m^3	62	µg/m^3	
2107653R1-02A	CW-1156-SG02-072821 (2)	2-Perfluorobutyl ethanol (4:2 FTOH)	5	ng	29	ng	50	µg/m^3	290	µg/m^3	
2107653R1-02A	CW-1156-SG02-072821 (2)	1-Perfluoropentyl ethanol (5:2 sFTOH)	5	ng	280	ng	50	µg/m^3	2800	µg/m^3	
2107653R1-02A	CW-1156-SG02-072821 (2)	1-Perfluoroheptyl ethanol (7:2 sFTOH)	5	ng	18	ng	50	µg/m^3	180	µg/m^3	
2107653R1-02A	CW-1156-SG02-072821 (2)	2-Perfluorohexyl ethanol (6:2 FTOH)	5	ng	880	ng	50	µg/m^3	8800	µg/m^3	µg/m3
2107653R1-02A	CW-1156-SG02-072821 (2)	2-Perfluorooctyl ethanol (8:2 FTOH)	5	ng	170	ng	50	µg/m^3	1700	µg/m^3	
2107653R1-02A	CW-1156-SG02-072821 (2)	2-Perfluorodecyl ethanol (10:2 FTOH)	5	ng	16	ng	50	µg/m^3	160	µg/m^3	

LabID	SampleID	Compound	RL	Units	AMT	Units	RL µg/m^3	Units µg/m^3	AMT µg/m^3	Units µg/m^3	Flag
2107653R1-02A	CW-1156-SG02-072821 (2)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2107653R1-02A	CW-1156-SG02-072821 (2)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2107653R1-04A	CW-1156-SG01-072821 (2)	Perfluorobutanoic acid (PFBA)	5	ng	14	ng	50	µg/m^3	140	µg/m^3	
2107653R1-04A	CW-1156-SG01-072821 (2)	Perfluoropentanoic acid (PFPeA)	5	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107653R1-04A	CW-1156-SG01-072821 (2)	Perfluorohexanoic acid (PFHxA)	5	ng	46	ng	50	µg/m^3	460	µg/m^3	
2107653R1-04A	CW-1156-SG01-072821 (2)	Perfluoroheptanoic acid (PFHpA)	5	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107653R1-04A	CW-1156-SG01-072821 (2)	Perfluorooctanoic acid (PFOA)	5	ng	5.9	ng	50	µg/m^3	59	µg/m^3	
2107653R1-04A	CW-1156-SG01-072821 (2)	2-Perfluorobutyl ethanol (4:2 FTOH)	5	ng	30	ng	50	µg/m^3	300	µg/m^3	
2107653R1-04A	CW-1156-SG01-072821 (2)	1-Perfluoropentyl ethanol (5:2 sFTOH)	5	ng	93	ng	50	µg/m^3	930	µg/m^3	
2107653R1-04A	CW-1156-SG01-072821 (2)	1-Perfluoroheptyl ethanol (7:2 sFTOH)	5	ng	22	ng	50	µg/m^3	220	µg/m^3	
2107653R1-04A	CW-1156-SG01-072821 (2)	2-Perfluorohexyl ethanol (6:2 FTOH)	5	ng	1200	ng	50	µg/m^3	12000	µg/m^3	E
2107653R1-04A	CW-1156-SG01-072821 (2)	2-Perfluorooctyl ethanol (8:2 FTOH)	5	ng	610	ng	50	µg/m^3	6100	µg/m^3	E
2107653R1-04A	CW-1156-SG01-072821 (2)	2-Perfluorodecyl ethanol (10:2 FTOH)	5	ng	93	ng	50	µg/m^3	930	µg/m^3	
2107653R1-04A	CW-1156-SG01-072821 (2)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U

LabID	SampleID	Compound	RL	Units	AMT	Units	RL µg/m3	Units µg/m3	AMT µg/m3	Units µg/m3	Flag
2107653R1-04A	CW-1156-SG01-072821 (2)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	J,U
2107653R1-05A	Lab Blank	Perfluorobutanoic acid (PFBA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	Perfluoropentanoic acid (PFPeA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	Perfluorohexanoic acid (PFHxA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	Perfluoroheptanoic acid (PFHpA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	Perfluorooctanoic acid (PFOA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	2-Perfluorobutyl ethanol (4:2 FTOH)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	1-Perfluoropentyl ethanol (5:2 sFTOH)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	1-Perfluoroheptyl ethanol (7:2 sFTOH)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	2-Perfluorohexyl ethanol (6:2 FTOH)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	2-Perfluorooctyl ethanol (8:2 FTOH)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	2-Perfluorodecyl ethanol (10:2 FTOH)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	U
2107653R1-05A	Lab Blank	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	J,U
2107653R1-05A	Lab Blank	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5	ng	ND	ng	50	µg/m3	ND	µg/m3	J,U
2107653R1-06A	CCV	Perfluorobutanoic acid (PFBA)							74	%R	
2107653R1-06A	CCV	Perfluoropentanoic acid (PFPeA)							78	%R	
2107653R1-06A	CCV	Perfluorohexanoic acid (PFHxA)							81	%R	
2107653R1-06A	CCV	Perfluoroheptanoic acid (PFHpA)							82	%R	
2107653R1-06A	CCV	Perfluorooctanoic acid (PFOA)							72	%R	
2107653R1-06A	CCV	2-Perfluorobutyl ethanol (4:2 FTOH)							86	%R	

LabID	SampleID	Compound	RL	Units	AMT	Units	RL $\mu g/m^3$	Units $\mu g/m^3$	AMT $\mu g/m^3$	Units $\mu g/m^3$	Flag
2107653R1-06A	CCV	1-Perfluoropentyl ethanol (5:2 sFTOH)							84	%R	
2107653R1-06A	CCV	1-Perfluoroheptyl ethanol (7:2 sFTOH)							86	%R	
2107653R1-06A	CCV	2-Perfluorohexyl ethanol (6:2 FTOH)							83	%R	
2107653R1-06A	CCV	2-Perfluorooctyl ethanol (8:2 FTOH)							75	%R	
2107653R1-06A	CCV	2-Perfluorodecyl ethanol (10:2 FTOH)							71	%R	
2107653R1-06A	CCV	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							52	%R	
2107653R1-06A	CCV	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							56	%R	
2107653R1-07A	LCS	Perfluorobutanoic acid (PFBA)							114	%R	
2107653R1-07A	LCS	Perfluoropentanoic acid (PFPeA)							131	%R	
2107653R1-07A	LCS	Perfluorohexanoic acid (PFHxA)							113	%R	
2107653R1-07A	LCS	Perfluoroheptanoic acid (PFHpA)							113	%R	
2107653R1-07A	LCS	Perfluorooctanoic acid (PFOA)							80	%R	
2107653R1-07A	LCS	2-Perfluorobutyl ethanol (4:2 FTOH)							72	%R	
2107653R1-07A	LCS	1-Perfluoropentyl ethanol (5:2 sFTOH)							78	%R	
2107653R1-07A	LCS	1-Perfluoroheptyl ethanol (7:2 sFTOH)							77	%R	
2107653R1-07A	LCS	2-Perfluorohexyl ethanol (6:2 FTOH)							83	%R	
2107653R1-07A	LCS	2-Perfluorooctyl ethanol (8:2 FTOH)							73	%R	
2107653R1-07A	LCS	2-Perfluorodecyl ethanol (10:2 FTOH)							81	%R	
2107653R1-07A	LCS	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							88	%R	
2107653R1-07A	LCS	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							86	%R	
2107653R1-07AA	LCSD	Perfluorobutanoic acid (PFBA)							90	%R	

LabID	SampleID	Compound	RL	Units	AMT	Units	RL µg/m^3	Units µg/m^3	AMT µg/m^3	Units µg/m^3	Flag
2107653R1-07AA	LCSD	Perfluoropentanoic acid (PFPeA)							110	%R	
2107653R1-07AA	LCSD	Perfluorohexanoic acid (PFHxA)							101	%R	
2107653R1-07AA	LCSD	Perfluoroheptanoic acid (PFHpA)							102	%R	
2107653R1-07AA	LCSD	Perfluorooctanoic acid (PFOA)							74	%R	
2107653R1-07AA	LCSD	2-Perfluorobutyl ethanol (4:2 FTOH)							75	%R	
2107653R1-07AA	LCSD	1-Perfluoropentyl ethanol (5:2 sFTOH)							76	%R	
2107653R1-07AA	LCSD	1-Perfluoroheptyl ethanol (7:2 sFTOH)							76	%R	
2107653R1-07AA	LCSD	2-Perfluorohexyl ethanol (6:2 FTOH)							76	%R	
2107653R1-07AA	LCSD	2-Perfluorooctyl ethanol (8:2 FTOH)							67	%R	
2107653R1-07AA	LCSD	2-Perfluorodecyl ethanol (10:2 FTOH)							67	%R	
2107653R1-07AA	LCSD	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							64	%R	
2107653R1-07AA	LCSD	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							68	%R	

%R = percent recovery
E: Results exceeded calibration range
I: Matrix interference affecting qualifier ion(s) used for compound identification
J: Estimated value
NA: Not analyzed
nd: Not detected

File Name: 2017653R1_EDD.xlsx - For soil gas data associated with other sampling locations.

LabID	SampleID	Compound	RL	Units	AMT	Units	RL µg/m^3	Units µg/m^3	AMT µg/m^3	Units µg/m^3	Flag
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	0.26	ng	2.0	µg/m^3	2.6	µg/m^3	
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-02A	CW-A-SV01-1.5-073021 (1172504)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U

2107701-04A	CW-A-SV02-2.5-073021 (1161953)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	ND	ng	2.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-04A	CW-A-SV02-2.5-073021 (1161953)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2107701-05A	CW-B-SV01-SS-073021 (1172827)	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2107701-05A	CW-B-SV01-SS-073021 (1172827)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	0.30	ng	2.0	µg/m^3	3.0	µg/m^3	
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	1.4	ng	1.0	µg/m^3	14	µg/m^3	
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	0.22	ng	1.0	µg/m^3	2.2	µg/m^3	
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-07A	CW-B-SV02-1.5-073021 (1172823)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U

2107701-09A	CW-B-SV03-2.5-073021 (1161824)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	0.31	ng	2.0	µg/m^3	3.1	µg/m^3	
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	0.60	ng	1.0	µg/m^3	6.0	µg/m^3	
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-09A	CW-B-SV03-2.5-073021 (1161824)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-10A	CW-C-SV01-SS-073021 (1172537)	Perfluorobutanoic acid (PFBA)	0.10	ng	0.84	ng	0.10	µg/m^3	0.84	µg/m^3	
2107701-10A	CW-C-SV01-SS-073021 (1172537)	Perfluoropentanoic acid (PFPeA)	0.10	ng	4.0	ng	0.10	µg/m^3	4.0	µg/m^3	I
2107701-10A	CW-C-SV01-SS-073021 (1172537)	Perfluorohexanoic acid (PFHxA)	0.10	ng	7.1	ng	0.10	µg/m^3	7.1	µg/m^3	E
2107701-10A	CW-C-SV01-SS-073021 (1172537)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-10A	CW-C-SV01-SS-073021 (1172537)	Perfluorooctanoic acid (PFOA)	0.10	ng	0.72	ng	0.10	µg/m^3	0.72	µg/m^3	

2107701-10A	CW-C-SV01-SS-073021 (1172537)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-10A	CW-C-SV01-SS-073021 (1172537)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	4.9	ng	0.10	µg/m^3	4.9	µg/m^3	
2107701-10A	CW-C-SV01-SS-073021 (1172537)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	1.1	ng	0.10	µg/m^3	1.1	µg/m^3	
2107701-10A	CW-C-SV01-SS-073021 (1172537)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	85	ng	0.20	µg/m^3	85	µg/m^3	E
2107701-10A	CW-C-SV01-SS-073021 (1172537)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	27	ng	0.10	µg/m^3	27	µg/m^3	E
2107701-10A	CW-C-SV01-SS-073021 (1172537)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	14	ng	0.10	µg/m^3	14	µg/m^3	E
2107701-10A	CW-C-SV01-SS-073021 (1172537)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-10A	CW-C-SV01-SS-073021 (1172537)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-12A	CW-C-SV02-01-073021 (1161802)	Perfluorobutanoic acid (PFBA)	0.10	ng	7.1	ng	0.10	µg/m^3	7.1	µg/m^3	E
2107701-12A	CW-C-SV02-01-073021 (1161802)	Perfluoropentanoic acid (PFPeA)	0.10	ng	25	ng	0.10	µg/m^3	25	µg/m^3	E,I
2107701-12A	CW-C-SV02-01-073021 (1161802)	Perfluorohexanoic acid (PFHxA)	0.10	ng	49	ng	0.10	µg/m^3	49	µg/m^3	E
2107701-12A	CW-C-SV02-01-073021 (1161802)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	1.3	ng	0.10	µg/m^3	1.3	µg/m^3	
2107701-12A	CW-C-SV02-01-073021 (1161802)	Perfluorooctanoic acid (PFOA)	0.10	ng	1.7	ng	0.10	µg/m^3	1.7	µg/m^3	
2107701-12A	CW-C-SV02-01-073021 (1161802)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-12A	CW-C-SV02-01-073021 (1161802)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	64	ng	0.10	µg/m^3	64	µg/m^3	E
2107701-12A	CW-C-SV02-01-073021 (1161802)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	22	ng	0.10	µg/m^3	22	µg/m^3	E
2107701-12A	CW-C-SV02-01-073021 (1161802)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	0.23	ng	0.20	µg/m^3	0.23	µg/m^3	
2107701-12A	CW-C-SV02-01-073021 (1161802)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	0.15	ng	0.10	µg/m^3	0.15	µg/m^3	

2107701-12A	CW-C-SV02-01-073021 (1161802)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	1.3	ng	0.10	µg/m^3	1.3	µg/m^3	
2107701-12A	CW-C-SV02-01-073021 (1161802)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-12A	CW-C-SV02-01-073021 (1161802)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-14A	CW-C-SV03-02-073021 (1162393)	Perfluorobutanoic acid (PFBA)	0.10	ng	23	ng	0.10	µg/m^3	23	µg/m^3	E
2107701-14A	CW-C-SV03-02-073021 (1162393)	Perfluoropentanoic acid (PFPeA)	0.10	ng	62	ng	0.10	µg/m^3	62	µg/m^3	E,I
2107701-14A	CW-C-SV03-02-073021 (1162393)	Perfluorohexanoic acid (PFHxA)	0.10	ng	180	ng	0.10	µg/m^3	180	µg/m^3	E
2107701-14A	CW-C-SV03-02-073021 (1162393)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	3.8	ng	0.10	µg/m^3	3.8	µg/m^3	
2107701-14A	CW-C-SV03-02-073021 (1162393)	Perfluorooctanoic acid (PFOA)	0.10	ng	7.0	ng	0.10	µg/m^3	7.0	µg/m^3	E
2107701-14A	CW-C-SV03-02-073021 (1162393)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	
2107701-14A	CW-C-SV03-02-073021 (1162393)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	590	ng	0.10	µg/m^3	590	µg/m^3	E
2107701-14A	CW-C-SV03-02-073021 (1162393)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	160	ng	0.10	µg/m^3	160	µg/m^3	E
2107701-14A	CW-C-SV03-02-073021 (1162393)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	1.3	ng	0.20	µg/m^3	1.3	µg/m^3	
2107701-14A	CW-C-SV03-02-073021 (1162393)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	2.1	ng	0.10	µg/m^3	2.1	µg/m^3	
2107701-14A	CW-C-SV03-02-073021 (1162393)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	7.7	ng	0.10	µg/m^3	7.7	µg/m^3	E
2107701-14A	CW-C-SV03-02-073021 (1162393)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-14A	CW-C-SV03-02-073021 (1162393)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-15A	CW-C-SV03-02-073021 (1172983)	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-15A	CW-C-SV03-02-073021 (1172983)	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2107701-15A	CW-C-SV03-02-073021 (1172983)	Perfluorohexanoic acid (PFHxA)	5.0	ng	7.1	ng	50	$\mu g/m^3$	71	$\mu g/m^3$	
2107701-15A	CW-C-SV03-02-073021 (1172983)	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-15A	CW-C-SV03-02-073021 (1172983)	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-15A	CW-C-SV03-02-073021 (1172983)	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-15A	CW-C-SV03-02-073021 (1172983)	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	23	ng	50	$\mu g/m^3$	230	$\mu g/m^3$	
2107701-15A	CW-C-SV03-02-073021 (1172983)	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	5.9	ng	50	$\mu g/m^3$	59	$\mu g/m^3$	
2107701-15A	CW-C-SV03-02-073021 (1172983)	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-15A	CW-C-SV03-02-073021 (1172983)	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-15A	CW-C-SV03-02-073021 (1172983)	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-15A	CW-C-SV03-02-073021 (1172983)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	J,U
2107701-15A	CW-C-SV03-02-073021 (1172983)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	$\mu g/m^3$	ND	$\mu g/m^3$	J,U
2107701-17A	CW-D-SV01-01-073021 (1172862)	Perfluorobutanoic acid (PFBA)	0.10	ng	0.10	ng	1.0	$\mu g/m^3$	1.0	$\mu g/m^3$	J
2107701-17A	CW-D-SV01-01-073021 (1172862)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	$\mu g/m^3$	ND	$\mu g/m^3$	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	0.10	ng	1.0	$\mu g/m^3$	1.0	$\mu g/m^3$	J

2107701-17A	CW-D-SV01-01-073021 (1172862)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	ND	ng	2.0	µg/m^3	ND	µg/m^3	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-17A	CW-D-SV01-01-073021 (1172862)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-17A	CW-D-SV01-01-073021 (1172862)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	ND	ng	2.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-19A	CW-D-SV02-2.5-073021 (1162013)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U

2107701-19A	CW-D-SV02-2.5-073021 (1162013)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	ND	ng	2.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-21A	CW-D-SV03-3.5-073021 (1172663)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-22A	CW-Blank-073021 (1172950)	Perfluorobutanoic acid (PFBA)	0.10	ng	0.12	ng	0.10	µg/m^3	0.12	µg/m^3	
2107701-22A	CW-Blank-073021 (1172950)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-22A	CW-Blank-073021 (1172950)	Perfluorohexanoic acid (PFHxA)	0.10	ng	0.16	ng	0.10	µg/m^3	0.16	µg/m^3	
2107701-22A	CW-Blank-073021 (1172950)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U

2107701-22A	CW-Blank-073021 (1172950)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-22A	CW-Blank-073021 (1172950)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-22A	CW-Blank-073021 (1172950)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-22A	CW-Blank-073021 (1172950)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-22A	CW-Blank-073021 (1172950)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	5.5	ng	0.20	µg/m^3	5.5	µg/m^3	E
2107701-22A	CW-Blank-073021 (1172950)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-22A	CW-Blank-073021 (1172950)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	0.10	µg/m^3	ND	µg/m^3	U
2107701-22A	CW-Blank-073021 (1172950)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-22A	CW-Blank-073021 (1172950)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	J,U
2107701-24A	Lab Blank (8/18/21)	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2107701-24A	Lab Blank (8/18/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24A	Lab Blank (8/18/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2107701-24A	Lab Blank (8/18/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2107701-24B	Lab Blank (8/20/21)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	ND	ng	2.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24B	Lab Blank (8/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-24B	Lab Blank (8/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-24C	Lab Blank (8/23/21)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U

2107701-24C	Lab Blank (8/23/21)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	ND	ng	2.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m^3	ND	µg/m^3	U
2107701-24C	Lab Blank (8/23/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-24C	Lab Blank (8/23/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-24D	Lab Blank (8/25/21)	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24D	Lab Blank (8/25/21)	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24D	Lab Blank (8/25/21)	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24D	Lab Blank (8/25/21)	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24D	Lab Blank (8/25/21)	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2107701-24D	Lab Blank (8/25/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2107701-24D	Lab Blank (8/25/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2107701-24D	Lab Blank (8/25/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2107701-24D	Lab Blank (8/25/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2107701-24D	Lab Blank (8/25/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2107701-24D	Lab Blank (8/25/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2107701-24D	Lab Blank (8/25/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	J,U
2107701-24D	Lab Blank (8/25/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	J,U
2107701-24E	Lab Blank (8/26/21)	Perfluorobutanoic acid (PFBA)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	Perfluoropentanoic acid (PFPeA)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	Perfluorohexanoic acid (PFHxA)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	Perfluoroheptanoic acid (PFHpA)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	Perfluorooctanoic acid (PFOA)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	0.20	ng	ND	ng	2.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U
2107701-24E	Lab Blank (8/26/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	0.10	ng	ND	ng	1.0	µg/m³	ND	µg/m³	U

2107701-24E	Lab Blank (8/26/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-24E	Lab Blank (8/26/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	1.0	ng	ND	ng	10	µg/m^3	ND	µg/m^3	J,U
2107701-25A	CCV (8/18/21)	Perfluorobutanoic acid (PFBA)							76	%R	
2107701-25A	CCV (8/18/21)	Perfluoropentanoic acid (PFPeA)							85	%R	
2107701-25A	CCV (8/18/21)	Perfluorohexanoic acid (PFHxA)							83	%R	
2107701-25A	CCV (8/18/21)	Perfluoroheptanoic acid (PFHpA)							92	%R	
2107701-25A	CCV (8/18/21)	Perfluorooctanoic acid (PFOA)							82	%R	
2107701-25A	CCV (8/18/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							94	%R	
2107701-25A	CCV (8/18/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							93	%R	
2107701-25A	CCV (8/18/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							91	%R	
2107701-25A	CCV (8/18/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							92	%R	
2107701-25A	CCV (8/18/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							90	%R	
2107701-25A	CCV (8/18/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							87	%R	
2107701-25A	CCV (8/18/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							91	%R	
2107701-25A	CCV (8/18/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							93	%R	
2107701-25B	CCV (8/20/21)	Perfluorobutanoic acid (PFBA)							96	%R	
2107701-25B	CCV (8/20/21)	Perfluoropentanoic acid (PFPeA)							90	%R	
2107701-25B	CCV (8/20/21)	Perfluorohexanoic acid (PFHxA)							101	%R	

2107701-25B	CCV (8/20/21)	Perfluoroheptanoic acid (PFHpA)							101	%R	
2107701-25B	CCV (8/20/21)	Perfluorooctanoic acid (PFOA)							91	%R	
2107701-25B	CCV (8/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							84	%R	
2107701-25B	CCV (8/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							85	%R	
2107701-25B	CCV (8/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							95	%R	
2107701-25B	CCV (8/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							72	%R	
2107701-25B	CCV (8/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							81	%R	
2107701-25B	CCV (8/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							87	%R	
2107701-25B	CCV (8/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							107	%R	
2107701-25B	CCV (8/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							102	%R	
2107701-25C	CCV (8/23/21)	Perfluorobutanoic acid (PFBA)							97	%R	
2107701-25C	CCV (8/23/21)	Perfluoropentanoic acid (PFPeA)							96	%R	
2107701-25C	CCV (8/23/21)	Perfluorohexanoic acid (PFHxA)							95	%R	
2107701-25C	CCV (8/23/21)	Perfluoroheptanoic acid (PFHpA)							97	%R	
2107701-25C	CCV (8/23/21)	Perfluorooctanoic acid (PFOA)							95	%R	
2107701-25C	CCV (8/23/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							86	%R	
2107701-25C	CCV (8/23/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							88	%R	
2107701-25C	CCV (8/23/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							94	%R	

2107701-25C	CCV (8/23/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							76	%R	
2107701-25C	CCV (8/23/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							81	%R	
2107701-25C	CCV (8/23/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							92	%R	
2107701-25C	CCV (8/23/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							144	%R	
2107701-25C	CCV (8/23/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							128	%R	
2107701-25D	CCV (8/25/21)	Perfluorobutanoic acid (PFBA)							78	%R	
2107701-25D	CCV (8/25/21)	Perfluoropentanoic acid (PFPeA)							88	%R	
2107701-25D	CCV (8/25/21)	Perfluorohexanoic acid (PFHxA)							86	%R	
2107701-25D	CCV (8/25/21)	Perfluoroheptanoic acid (PFHpA)							92	%R	
2107701-25D	CCV (8/25/21)	Perfluorooctanoic acid (PFOA)							85	%R	
2107701-25D	CCV (8/25/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							102	%R	
2107701-25D	CCV (8/25/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							102	%R	
2107701-25D	CCV (8/25/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							102	%R	
2107701-25D	CCV (8/25/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							99	%R	
2107701-25D	CCV (8/25/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							98	%R	
2107701-25D	CCV (8/25/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							96	%R	
2107701-25D	CCV (8/25/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							79	%R	
2107701-25D	CCV (8/25/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							79	%R	

2107701-25E	CCV (8/26/21)	Perfluorobutanoic acid (PFBA)							93	%R	
2107701-25E	CCV (8/26/21)	Perfluoropentanoic acid (PFPeA)							92	%R	
2107701-25E	CCV (8/26/21)	Perfluorohexanoic acid (PFHxA)							102	%R	
2107701-25E	CCV (8/26/21)	Perfluoroheptanoic acid (PFHpA)							104	%R	
2107701-25E	CCV (8/26/21)	Perfluorooctanoic acid (PFOA)							92	%R	
2107701-25E	CCV (8/26/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							86	%R	
2107701-25E	CCV (8/26/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							88	%R	
2107701-25E	CCV (8/26/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							88	%R	
2107701-25E	CCV (8/26/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							68	%R	Q
2107701-25E	CCV (8/26/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							80	%R	
2107701-25E	CCV (8/26/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							90	%R	
2107701-25E	CCV (8/26/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							118	%R	
2107701-25E	CCV (8/26/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							107	%R	
2107701-26A	LCS (8/18/21)	Perfluorobutanoic acid (PFBA)							116	%R	
2107701-26A	LCS (8/18/21)	Perfluoropentanoic acid (PFPeA)							134	%R	
2107701-26A	LCS (8/18/21)	Perfluorohexanoic acid (PFHxA)							122	%R	
2107701-26A	LCS (8/18/21)	Perfluoroheptanoic acid (PFHpA)							119	%R	
2107701-26A	LCS (8/18/21)	Perfluorooctanoic acid (PFOA)							88	%R	

2107701-26A	LCS (8/18/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							78	%R	
2107701-26A	LCS (8/18/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							82	%R	
2107701-26A	LCS (8/18/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							81	%R	
2107701-26A	LCS (8/18/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							81	%R	
2107701-26A	LCS (8/18/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							76	%R	
2107701-26A	LCS (8/18/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							78	%R	
2107701-26A	LCS (8/18/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							89	%R	
2107701-26A	LCS (8/18/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							87	%R	
2107701-26B	LCS (8/20/21)	Perfluorobutanoic acid (PFBA)							112	%R	
2107701-26B	LCS (8/20/21)	Perfluoropentanoic acid (PFPeA)							126	%R	
2107701-26B	LCS (8/20/21)	Perfluorohexanoic acid (PFHxA)							115	%R	
2107701-26B	LCS (8/20/21)	Perfluoroheptanoic acid (PFHpA)							103	%R	
2107701-26B	LCS (8/20/21)	Perfluorooctanoic acid (PFOA)							90	%R	
2107701-26B	LCS (8/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							94	%R	
2107701-26B	LCS (8/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							104	%R	
2107701-26B	LCS (8/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							105	%R	
2107701-26B	LCS (8/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							73	%R	
2107701-26B	LCS (8/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							72	%R	

2107701-26B	LCS (8/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							73	%R	
2107701-26B	LCS (8/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							43	%R	Q
2107701-26B	LCS (8/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							48	%R	Q
2107701-26BB	LCSD (8/20/21)	Perfluorobutanoic acid (PFBA)							96	%R	
2107701-26BB	LCSD (8/20/21)	Perfluoropentanoic acid (PFPeA)							106	%R	
2107701-26BB	LCSD (8/20/21)	Perfluorohexanoic acid (PFHxA)							97	%R	
2107701-26BB	LCSD (8/20/21)	Perfluoroheptanoic acid (PFHpA)							92	%R	
2107701-26BB	LCSD (8/20/21)	Perfluorooctanoic acid (PFOA)							80	%R	
2107701-26BB	LCSD (8/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							74	%R	
2107701-26BB	LCSD (8/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							80	%R	
2107701-26BB	LCSD (8/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							81	%R	
2107701-26BB	LCSD (8/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							67	%R	
2107701-26BB	LCSD (8/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							67	%R	
2107701-26BB	LCSD (8/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							73	%R	
2107701-26BB	LCSD (8/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							83	%R	
2107701-26BB	LCSD (8/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							83	%R	
2107701-26C	LCS (8/23/21)	Perfluorobutanoic acid (PFBA)							105	%R	
2107701-26C	LCS (8/23/21)	Perfluoropentanoic acid (PFPeA)							118	%R	

2107701-26C	LCS (8/23/21)	Perfluorohexanoic acid (PFHxA)							110	%R	
2107701-26C	LCS (8/23/21)	Perfluoroheptanoic acid (PFHpA)							102	%R	
2107701-26C	LCS (8/23/21)	Perfluorooctanoic acid (PFOA)							87	%R	
2107701-26C	LCS (8/23/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							90	%R	
2107701-26C	LCS (8/23/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							92	%R	
2107701-26C	LCS (8/23/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							102	%R	
2107701-26C	LCS (8/23/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							76	%R	
2107701-26C	LCS (8/23/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							79	%R	
2107701-26C	LCS (8/23/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							82	%R	
2107701-26C	LCS (8/23/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							58	%R	
2107701-26C	LCS (8/23/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							61	%R	
2107701-26CC	LCSD (8/23/21)	Perfluorobutanoic acid (PFBA)							106	%R	
2107701-26CC	LCSD (8/23/21)	Perfluoropentanoic acid (PFPeA)							127	%R	
2107701-26CC	LCSD (8/23/21)	Perfluorohexanoic acid (PFHxA)							120	%R	
2107701-26CC	LCSD (8/23/21)	Perfluoroheptanoic acid (PFHpA)							110	%R	
2107701-26CC	LCSD (8/23/21)	Perfluorooctanoic acid (PFOA)							97	%R	
2107701-26CC	LCSD (8/23/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							93	%R	
2107701-26CC	LCSD (8/23/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							99	%R	

2107701-26CC	LCSD (8/23/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							101	%R	
2107701-26CC	LCSD (8/23/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							77	%R	
2107701-26CC	LCSD (8/23/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							81	%R	
2107701-26CC	LCSD (8/23/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							93	%R	
2107701-26CC	LCSD (8/23/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							74	%R	
2107701-26CC	LCSD (8/23/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							77	%R	
2107701-26D	LCS (8/25/21)	Perfluorobutanoic acid (PFBA)							107	%R	
2107701-26D	LCS (8/25/21)	Perfluoropentanoic acid (PFPeA)							129	%R	
2107701-26D	LCS (8/25/21)	Perfluorohexanoic acid (PFHxA)							125	%R	
2107701-26D	LCS (8/25/21)	Perfluoroheptanoic acid (PFHpA)							121	%R	
2107701-26D	LCS (8/25/21)	Perfluorooctanoic acid (PFOA)							89	%R	
2107701-26D	LCS (8/25/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							101	%R	
2107701-26D	LCS (8/25/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							98	%R	
2107701-26D	LCS (8/25/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							99	%R	
2107701-26D	LCS (8/25/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							105	%R	
2107701-26D	LCS (8/25/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							103	%R	
2107701-26D	LCS (8/25/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							107	%R	
2107701-26D	LCS (8/25/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							128	%R	

2107701-26D	LCS (8/25/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							116	%R	
2107701-26DD	LCSD (8/25/21)	Perfluorobutanoic acid (PFBA)							124	%R	
2107701-26DD	LCSD (8/25/21)	Perfluoropentanoic acid (PFPeA)							141	%R	Q
2107701-26DD	LCSD (8/25/21)	Perfluorohexanoic acid (PFHxA)							127	%R	
2107701-26DD	LCSD (8/25/21)	Perfluoroheptanoic acid (PFHpA)							130	%R	
2107701-26DD	LCSD (8/25/21)	Perfluorooctanoic acid (PFOA)							95	%R	
2107701-26DD	LCSD (8/25/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							96	%R	
2107701-26DD	LCSD (8/25/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							96	%R	
2107701-26DD	LCSD (8/25/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							98	%R	
2107701-26DD	LCSD (8/25/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							98	%R	
2107701-26DD	LCSD (8/25/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							88	%R	
2107701-26DD	LCSD (8/25/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							91	%R	
2107701-26DD	LCSD (8/25/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							67	%R	
2107701-26DD	LCSD (8/25/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							71	%R	
2107701-26E	LCS (8/26/21)	Perfluorobutanoic acid (PFBA)							109	%R	
2107701-26E	LCS (8/26/21)	Perfluoropentanoic acid (PFPeA)							126	%R	
2107701-26E	LCS (8/26/21)	Perfluorohexanoic acid (PFHxA)							116	%R	
2107701-26E	LCS (8/26/21)	Perfluoroheptanoic acid (PFHpA)							110	%R	

2107701-26E	LCS (8/26/21)	Perfluorooctanoic acid (PFOA)							99	%R	
2107701-26E	LCS (8/26/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							86	%R	
2107701-26E	LCS (8/26/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							86	%R	
2107701-26E	LCS (8/26/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							87	%R	
2107701-26E	LCS (8/26/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							73	%R	
2107701-26E	LCS (8/26/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							79	%R	
2107701-26E	LCS (8/26/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							98	%R	
2107701-26E	LCS (8/26/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							138	%R	
2107701-26E	LCS (8/26/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							122	%R	
2107701-26EE	LCSD (8/26/21)	Perfluorobutanoic acid (PFBA)							106	%R	
2107701-26EE	LCSD (8/26/21)	Perfluoropentanoic acid (PFPeA)							123	%R	
2107701-26EE	LCSD (8/26/21)	Perfluorohexanoic acid (PFHxA)							115	%R	
2107701-26EE	LCSD (8/26/21)	Perfluoroheptanoic acid (PFHpA)							108	%R	
2107701-26EE	LCSD (8/26/21)	Perfluorooctanoic acid (PFOA)							96	%R	
2107701-26EE	LCSD (8/26/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							86	%R	
2107701-26EE	LCSD (8/26/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							88	%R	
2107701-26EE	LCSD (8/26/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							90	%R	
2107701-26EE	LCSD (8/26/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							72	%R	

2107701-26EE	LCSD (8/26/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							78	%R	
2107701-26EE	LCSD (8/26/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							94	%R	
2107701-26EE	LCSD (8/26/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							114	%R	
2107701-26EE	LCSD (8/26/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							108	%R	

%R = percent recovery
E: Results exceeded calibration range
I: Matrix interference affecting qualifier ion(s) used for compound identification
J: Estimated value
Q: Sample held beyond the accepted holding time
U: Indicates that the compound was analyzed for but not detected
NA: Not analyzed
nd: Not detected

Appendix D: Laboratory 2 Reports, July 2021 Mobilization

Table D-1. Soil Concentration Data for FTOHs (ppb)

Sample ID	5:2 sFTOH		6:2 FTOH		7:2 sFTOH		8:2 FTOH		9:2 sFTOH	
	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier
a1-1	ND	U	1.81	J	ND	U	1.40	J	ND	U
a2-1	0.30		1.08	J	ND	U	0.63	J	ND	U
b29 1-1	ND	U	3.21	J	ND	U	2.45	J	ND	U
b29 2-1	ND	U	3.27	J	ND	U	3.39	J	ND	U
b29dup 1-1	ND	U	2.05	J	ND	U	1.92	J	ND	U
b29 dup 2-1	ND	U	0.11		ND	U	1.50	J	ND	U
c1-1	5.27	J	3.20	J	5.48	J	2.12		7.53	J
c2-1	4.28	J	1.55		4.34	J	5.00		5.07	J
d1-1	ND	U	ND	U	ND	U	ND	U	ND	U
d2-1	ND	U	ND	U	ND	U	0.95	J	ND	U
dms1-1_2 (J-)	ND	U	0.01		ND	U	0.88	J	ND	U
dms 2-1	0.25	J	ND	U	ND	U	ND	U	ND	U

USEPA ORD GC/MS data summary
Blank cells mean not applicable or non-existent information.
J: Estimated value
U: Indicates that the compound was analyzed for but not detected
ND: Not detected

Table D-2. Soil Concentration Data for FTOHs (ppb) continued

Sample ID	6:2 FTAcr		8:2 FTAce (J)		8:2 FTAcr		10:2 FTOH		11:2 sFTOH	
	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier
a1-1	ND	U	ND	U	0.62	J	7.10	J	ND	U
a2-1	ND	U	ND	U	ND	U	1.86	J	ND	U
b29 1-1	ND	U	ND	U	0.34	J	33.14		2.31	J
b29 2-1	ND	U	ND	U	0.50	J	8.56	J	ND	U
b29dup 1-1	ND	U	ND	U	ND	U	4.58	J	1.69	J
b29 dup 2-1	ND	U	ND	U	ND	U	2.29	J	ND	U
c1-1	ND	U	ND	U	0.75	J	31.77		7.03	J
c2-1	ND	U	ND	U	2.94	J	40.53		5.11	J
d1-1	ND	U	ND	U	ND	U	ND	U	ND	U
d2-1	ND	U	ND	U	ND	U	ND	U	ND	U
dms1-1_2 (J-)	ND	U	ND	U	ND	U	ND	U	ND	U
dms 2-1	ND	U	ND	U	ND	U	ND	U	ND	U

Blank cells mean not applicable or non-existent information.

J: Estimated value

U: Indicates that the compound was analyzed for but not detected

ND: Not detected

Table D-3. Soil Concentration Data for FTOHs (ppb) continued

Sample ID	10:2 FTAce		12:2 FTOH		10:2 FTAcr		14:2 FTOH		12:2 FTAcr	
	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier
a1-1	ND	U	0.38		ND	U	7.12	J	ND	U
a2-1	ND	U	2.98	J	ND	U	4.15	J	ND	U
b29 1-1	ND	U	31.59		0.57	J	27.36		ND	U
b29 2-1	ND	U	21.42		ND	U	25.64		1.22	J
b29dup 1-1	ND	U	5.33		ND	U	7.93		ND	U
b29 dup 2-1	ND	U	0.33		ND	U	3.56		ND	U
c1-1	ND	U	110.79		1.97	J	83.17		0.55	
c2-1	ND	U	141.53		3.26	J	89.00		2.78	
d1-1	ND	U	ND	U	ND	U	ND	U	ND	U
d2-1	ND	U	ND	U	ND	U	ND	U	ND	U
dms1-1_2 (J-)	ND	U	ND	U	ND	U	ND	U	ND	U
dms 2-1	ND	U	ND	U	ND	U	ND	U	ND	U

Blank cells mean not applicable or non-existent information.
J: Estimated value
U: Indicates that the compound was analyzed for but not detected
ND: Not detected

Table D-4. Soil Concentration Data for FTOHs (ppb) continued

Sample ID	16:2 FTOH		14:2 FTAcr		18:2 FTOH		16:2 FTAcr		20:2 FTOH		18:2 FTAcr		22:2 FTOH	
	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier	Final Soil Concentration (ppb)	Data Qualifier
a1-1	3.39	J	1.36	J	1.00	J	1.16	J	ND	U	ND	U	ND	U
a2-1	2.36	J	ND	U	1.02	J	ND	U	ND	U	ND	U	ND	U
b29 1-1	10.23		1.43	J	5.76	J	1.65	J	1.36	J	0.44	J	ND	U
b29 2-1	11.79		4.80		4.71	J	3.69		0.90	J	2.48	J	ND	U
b29dup 1-1	2.13		0.61	J	3.46	J	0.36	J	ND	U	ND	U	ND	U
b29 dup 2-1	5.35	J	0.60	J	2.23	J	ND	U	ND	U	ND	U	ND	U
c1-1	37.36		4.15		6.68		4.07		3.55	J	2.51	J	ND	U
c2-1	32.22		20.71		5.13		4.75		2.33	J	2.00	J	ND	U
d1-1	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
d2-1	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
dms 1-1_2 (J-)	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
dms 2-1	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U

Blank cells mean not applicable or non-existent information.
J: Estimated value
U: Indicates that the compound was analyzed for but not detected
ND: Not detected

Table D-5. Soil Concentration Data for PFAS (ppb)

Sample Name		PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUdA	PFDoA
a1	CW-A-SO01-072821	2.17	3.73	15.81	2.41	3.35	5.21	21.74	12.73	33.71
a2	CW-A-SO01-072821	2.19	3.91	16.34	2.42	2.97	4.05	15.39	11.05	30.35
b29 1	CW-B-SO01-072921	1.77	2.65	5.52	1.83	2.58	2.46	7.14	10.18	83.23
b29 2	CW-B-SO01-072921	1.79	2.99	6.03	1.94	2.47	2.50	7.04	9.99	84.73
b29 1 dup	CW-B-SO01-072921-Dup	1.80	2.83	4.86	1.99	2.62	2.64	7.25	11.23	89.31
b29 2 dup	CW-B-SO01-072921-Dup	1.97	2.73	4.53	2.02	2.72	2.60	7.34	11.21	88.92
c1*	CW-C-SO01-072921	3.23	8.60	46.21	15.90	70.26	33.94	167.66	92.95	266.82
c2*	CW-C-SO01-072921	3.49	9.26	47.62	15.79	67.05	34.99	171.82	102.32	281.41
d1	CW-D-SO01-072921	2.33	3.82	10.73	13.55	35.37	4.89	1.20	0.81	0.81
d2	CW-D-SO01-072921	2.16	3.43	9.17	12.25	31.99	4.32	1.12	0.80	0.74
dms 1	CW-D-SO01-072921-MSD	2.31	4.05	11.23	8.87	23.99	4.21	1.42	0.88	0.90
dms 2	CW-D-SO01-072921-MSD	2.22	3.82	10.30	9.16	24.68	3.91	1.32	0.84	0.92

LC/MS-MS summary data from USEPA ORD laboratory. All analytes detected and no data flags except for the ‘c’ samples, which are flagged as E.

* Concentrations are lower bound estimates and re-extraction is necessary due to probable saturation of MTBE during ion-pair clean-up step as defined in SOP. The c samples are flagged as E.

PFTrDA uses PFTrDA/mPFUdA for the calibration curve.
PFPeDA uses PFUdA/mPFUdA for the calibration curve.
PFHxDA uses PFHxDA/mPFTeDA for the calibration curve.
PFHpDA uses PFUda/mPFUdA for the calibration curve.
PFODA uses PFODA/mPFTeDA for the calibration curve.
PFNDA uses PFUda/mPFUdA for the calibration curve.
PFEA uses PFODA/mPFTeDA for the calibration curve.

Table D-6. Soil Concentration Data for PFAS (ppb), continued

Sample Name		PFTrDA	PFTeDA	PFPeDA	PFHxDA	PFHpDA	PFODA	PFNDA	PFEA
a1	CW-A-SO01-072821	11.55	8+8.76	3.93	8.00	1.51	3.37	0.78	0.91
a2	CW-A-SO01-072821	10.47	23.48	3.99	8.76	1.63	3.80	0.71	1.05
b29 1	CW-B-SO01-072921	43.10	109.72	18.86	43.42	4.31	12.87	1.04	1.14
b29 2	CW-B-SO01-072921	48.12	131.64	22.48	48.01	5.71	13.73	1.18	1.29
b29 1 dup	CW-B-SO01-072921-Dup	47.89	113.95	19.16	40.22	4.30	7.26	0.81	0.90
b29 2 dup	CW-B-SO01-072921-Dup	45.97	108.30	18.07	37.45	4.20	7.41	0.82	0.89
c1*	CW-C-SO01-072921	102.85	194.95	36.50	72.81	8.63	10.62	0.92	0.84
c2*	CW-C-SO01-072921	107.53	200.27	37.05	70.51	6.85	5.96	0.81	0.82
d1	CW-D-SO01-072921	0.84	0.89	0.73	0.83	0.69	0.83	0.65	0.74
d2	CW-D-SO01-072921	0.78	0.69	0.70	0.78	0.68	0.81	0.64	0.74
dms 1	CW-D-SO01-072921-MSD	0.84	0.88	0.75	0.94	0.72	0.90	0.66	0.75
dms 2	CW-D-SO01-072921-MSD	0.84	0.89	0.73	0.86	0.63	0.84	0.63	0.73

LC/MS-MS summary data from USEPA ORD laboratory. All analytes detected and no data flags except for the ‘c’ samples, which are flagged as E.

* Concentrations are lower bound estimates and re-extraction is necessary due to probable saturation of MTBE during ion-pair clean-up step as defined in SOP. The c samples are flagged as E.

PFTrDA uses PFTrDA/mPFUdA for the calibration curve.
PFPeDA uses PFUdA/mPFUdA for the calibration curve.
PFHxDA uses PFHxDA/mPFTeDA for the calibration curve.
PFHpDA uses PFUda/mPFUdA for the calibration curve.
PFODA uses PFODA/mPFTeDA for the calibration curve.
PFNDA uses PFUda/mPFUdA for the calibration curve.
PFEA uses PFODA/mPFTeDA for the calibration curve.

Appendix E: Bench Scale Limited Method Development of Filtration

The laboratory evaluated quartz microfiber filter material for PFAS cleanliness and analytical recovery as described in Eurofins Air Toxics Quote Q211131207R0 in support of the STREAMS III PWS Task 7. The filters were prepared by punching ¼" diameter disks from a Whatman Quartz Microfiber Filter QMA 101.6 mm circle. Filter disks were rinsed with methanol as part of the initial cleaning step. The rinsed disks were dried for several hours at ~80 deg C and stored covered with foil.

The filter blank and the recovery evaluations are detailed below. Two spike recovery tests were performed as part of the study. The initial test was conducted at a low concentration level of 1.0 ng, a concentration within 10 times the reporting limit of the low concentration PFAS method. A second follow-up recovery evaluation was conducted at a higher spike concentration of 10 ng. Based on screening concentrations measured previously in subslab samples at the project site, concentrations in a 100 mL sample are expected to range between <5 ng to potentially over 500 ng. As such, 10 ng represents the low end of the expected PFAS detections in the upcoming subslab samples.

Blank Evaluation: To evaluate filter cleanliness, the filter disk was inserted into the sampling inlet of a clean PFAS sorbent tube, positioning the filter flat against the front sorbent bed. A 2.0 µL aliquot of 0.5 ng/µL internal standard (6:2 FTOH-$^{13}C_2$) was injected onto the filter prior to analysis. The methanol introduced from the internal standard aliquot was removed by purging the installed filter with nitrogen. Three filters were evaluated, each filter inserted into a clean PFAS sorbent tube for analysis. Analysis was conducted by using the low concentration PFAS analytical method, which targeted a calibration range from 0.1 to 10 ng. Results are summarized in **Table E1**. No compounds were detected above the analytical reporting limit.

Table E1. Blank Filter Concentrations

Analyte	Blank 1	Blank 2	Blank 3
	tq112310.d	tq112311.d	tq112312.d
PFBA	<0.1 ng	<0.1 ng	<0.1 ng
PFPeA	<0.1 ng	<0.1 ng	<0.1 ng
PFHxA	<0.1 ng	<0.1 ng	<0.1 ng
PFHpA	<0.1 ng	<0.1 ng	<0.1 ng
PFOA	<0.1 ng	<0.1 ng	<0.1 ng
5:2 sFTOH	<0.1 ng	<0.1 ng	<0.1 ng
4:2 FTOH	<0.1 ng	<0.1 ng	<0.1 ng
7:2 sFTOH	<0.1 ng	<0.1 ng	<0.1 ng
6:2 FTOH	<0.2 ng	<0.2 ng	<0.2 ng
8:2 FTOH	<0.1 ng	<0.1 ng	<0.1 ng
10:2 FTOH	<0.1 ng	<0.1 ng	<0.1 ng
n-MeFOSA	<1.0 ng	<1.0 ng	<1.0 ng
n-EtFOSA	<1.0 ng	<1.0 ng	<1.0 ng

Spike Recovery Evaluation: To evaluate analytical recoveries from the filter, a filter disk was inserted into the sampling inlet of a clean PFAS tube, positioning the disk flat against the sorbent bed. The filter was spiked with 2.0 µL of 0.5 ng/µl of internal standard and 2.0 µL of 0.5 ng/µl of the PFAS calibration standard yielding a spiking concentration of 1.0 ng. The methanol introduced from the standards was removed by purging the filter with nitrogen. Three spiked filters were prepared for evaluation and were analyzed using the low concentration PFAS analytical method. Filter recoveries were calculated compared to the continuing calibration verification (CCV) analyzed at the beginning of the daily batch. The CCV was prepared on a PFAS tube using the same internal standard and spiking solutions and concentrations as the filter spikes. The recoveries for each spike and the average recoveries are summarized in **Table E2a**. Recoveries outside the project's CCV acceptance criteria are highlighted in gray with low recoveries observed for PFOA across all 3 filter spikes and low recoveries for the PFCAs in Filter Spike 1.

Table E2a. 1.0 ng Filter Spike Recoveries

Analyte	Filter Spike 1 (%R)	Filter Spike 2 (%R)	Filter Spike 3 (%R)	Average (%R)	CCV Acceptance Limits
	tq112313	tq112314	tq112315		
PFBA	51%	68%	72%	64%	60 – 140
PFPeA	53%	63%	70%	62%	60 – 140
PFHxA	43%	60%	64%	56%	60 – 140
PFHpA	46%	64%	66%	59%	60 – 140
PFOA	37%	54%	59%	50%	60 – 140
5:2 sFTOH	81%	94%	94%	90%	70 – 130
4:2 FTOH	75%	96%	93%	88%	70 – 130
7:2 sFTOH	77%	95%	95%	89%	70 – 130
6:2 FTOH	72%	94%	86%	84%	70 – 130
8:2 FTOH	88%	96%	104%	96%	70 – 130
10:2 FTOH	97%	98%	98%	98%	70 – 130
n-MeFOSA	113%	135%	126%	125%	50 – 150
n-EtFOSA	115%	135%	130%	127%	50 – 150

To further evaluate the filter spike recoveries observed at the 1.0 ng concentration, additional tests were performed, repeating the evaluation at a higher spike concentration of 10 ng and re-analyzing the desorbed filter sample to evaluate desorption efficiency. The three blank filters packed in PFAS tubes previously analyzed as part of the blank evaluation study were each spiked with 2.0 µL of 0.5 ng/µl of internal standard and 2.0 µL of 5.0 ng/µl of the PFAS calibration standard. The methanol introduced from the standards was removed by purging the filter with nitrogen. Spiked samples were analyzed using the low concentration analytical configuration and re-analyzed a second time without addition of internal standard to evaluate residual concentration on the spiked filter. All data files were processed using the external response factor of the daily continuing calibration standard spiked at the same concentration and with the same calibration standard as the spiked filters. Recovery results are summarized in **Table E2b**.

Table E2b. 10 ng Filter Spike Recoveries

Analyte	Filter Spike 1 (%R)	Filter Spike 2 (%R)	Filter Spike 3 (%R)	Average (%R)	CCV Acceptance Limits
	tq112412	tq112413	tq112414		
PFBA	91%	90%	83%	88%	60 – 140
PFPeA	100%	104%	94%	99%	60 – 140
PFHxA	89%	91%	75%	85%	60 – 140
PFHpA	90%	86%	75%	84%	60 – 140
PFOA	73%	77%	69%	73%	60 – 140
5:2 sFTOH	121%	111%	117%	116%	70 – 130
4:2 FTOH	120%	103%	116%	113%	70 – 130
7:2 sFTOH	114%	108%	106%	109%	70 – 130
6:2 FTOH	111%	106%	108%	108%	70 – 130
8:2 FTOH	98%	103%	105%	102%	70 – 130
10:2 FTOH	102%	100%	102%	101%	70 – 130
n-MeFOSA	141%	131%	136%	136%	50 – 150
n-EtFOSA	135%	126%	131%	131%	50 – 150

Recoveries for PFAS at the 10 ng concentration met the project CCV acceptance limits. Additionally, the second desorption of the filter demonstrated good desorption efficiency, with less than 5% of the initial measured mass remaining on the filter tube assembly after the desorption step.

Limitations to the evaluation: The tests did not clarify whether the apparent improved analytical recoveries at the 10 ng level were attributable to the higher spike concentration and/or due to the use of previously thermally conditioned filter disks, or another factor. As a mitigating step, the laboratory plans to thermally condition the filter disks as part of the filter preparation steps for the sample collection media. A set of these prepared filters will remain in the lab to use as batch QC (Lab Blank and Laboratory Control Samples (LCSs)) for the upcoming sample filter analysis.

Please note that the tests did not evaluate the potential adsorption of gas phase PFAS on the filter during sample collection. The effectiveness of the filter in retaining particulate-phase PFAS during sample collection was also not addressed. Additionally, no data was collected to determine the storage stability of PFAS on the filter.

Appendix F: QA/QC Data from Laboratory 2 Reports, December 2021 NJ Mobilization, Sampling Event 2

NOTE: Blank cells mean not applicable or non-existent information.

LabID	SampleID	Compound	RL	Units	AMT	Units	RL µg/m³	Units µg/m³	AMT µg/m³	Units µg/m³	Flag
2112214-01A	CW-1156-SG01-120921-A1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2112214-01A	CW-1156-SG01-120921-A1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2112214-01A	CW-1156-SG01-120921-A1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2112214-01A	CW-1156-SG01-120921-A1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2112214-01A	CW-1156-SG01-120921-A1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m³	ND	µg/m³	U
2112214-01A	CW-1156-SG01-120921-A1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	15	ng	50	µg/m³	150	µg/m³	

2112214-01A	CW-1156-SG01-120921-A1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	62	ng	50	µg/m^3	620	µg/m^3	
2112214-01A	CW-1156-SG01-120921-A1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	29	ng	50	µg/m^3	290	µg/m^3	
2112214-01A	CW-1156-SG01-120921-A1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	1800	ng	50	µg/m^3	18000	µg/m^3	E
2112214-01A	CW-1156-SG01-120921-A1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	1600	ng	50	µg/m^3	16000	µg/m^3	E
2112214-01A	CW-1156-SG01-120921-A1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	140	ng	50	µg/m^3	1400	µg/m^3	
2112214-01A	CW-1156-SG01-120921-A1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-01A	CW-1156-SG01-120921-A1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-02A	CW-1156-SG01-120921-B1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-02A	CW-1156-SG01-120921-B1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-02A	CW-1156-SG01-120921-B1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-02A	CW-1156-SG01-120921-B1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-02A	CW-1156-SG01-120921-B1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-02A	CW-1156-SG01-120921-B1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	12	ng	50	µg/m^3	120	µg/m^3	
2112214-02A	CW-1156-SG01-120921-B1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	51	ng	50	µg/m^3	510	µg/m^3	
2112214-02A	CW-1156-SG01-120921-B1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-02A	CW-1156-SG01-120921-B1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	90	ng	50	µg/m^3	900	µg/m^3	

2112214-02A	CW-1156-SG01-120921-B1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-02A	CW-1156-SG01-120921-B1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-02A	CW-1156-SG01-120921-B1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-02A	CW-1156-SG01-120921-B1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-03A	CW-1156-SG01-120921-B1F	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U,Q
2112214-03A	CW-1156-SG01-120921-B1F	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U,Q
2112214-03A	CW-1156-SG01-120921-B1F	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U,Q
2112214-03A	CW-1156-SG01-120921-B1F	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U,Q

2112214-03A	CW-1156-SG01-120921-B1F	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U,Q
2112214-03A	CW-1156-SG01-120921-B1F	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	8.7	ng	50	µg/m^3	87	µg/m^3	Q
2112214-03A	CW-1156-SG01-120921-B1F	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	34	ng	50	µg/m^3	340	µg/m^3	Q
2112214-03A	CW-1156-SG01-120921-B1F	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	22	ng	50	µg/m^3	220	µg/m^3	Q
2112214-03A	CW-1156-SG01-120921-B1F	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	990	ng	50	µg/m^3	9900	µg/m^3	E,Q
2112214-03A	CW-1156-SG01-120921-B1F	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	230	ng	50	µg/m^3	2300	µg/m^3	Q
2112214-03A	CW-1156-SG01-120921-B1F	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	14	ng	50	µg/m^3	140	µg/m^3	Q
2112214-03A	CW-1156-SG01-120921-B1F	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U,Q

2112214-03A	CW-1156-SG01-120921-B1F	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U,Q
2112214-04A	CW-1156-SG01-120921-A2T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-04A	CW-1156-SG01-120921-A2T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-04A	CW-1156-SG01-120921-A2T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-04A	CW-1156-SG01-120921-A2T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-04A	CW-1156-SG01-120921-A2T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-04A	CW-1156-SG01-120921-A2T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	14	ng	50	µg/m^3	140	µg/m^3	
2112214-04A	CW-1156-SG01-120921-A2T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	56	ng	50	µg/m^3	560	µg/m^3	

2112214-04A	CW-1156-SG01-120921-A2T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	28	ng	50	µg/m^3	280	µg/m^3	
2112214-04A	CW-1156-SG01-120921-A2T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	1600	ng	50	µg/m^3	16000	µg/m^3	E
2112214-04A	CW-1156-SG01-120921-A2T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	1500	ng	50	µg/m^3	15000	µg/m^3	E
2112214-04A	CW-1156-SG01-120921-A2T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	150	ng	50	µg/m^3	1500	µg/m^3	
2112214-04A	CW-1156-SG01-120921-A2T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-04A	CW-1156-SG01-120921-A2T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-05A	CW-1156-SG01-120921-B2T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-05A	CW-1156-SG01-120921-B2T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-05A	CW-1156-SG01-120921-B2T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-05A	CW-1156-SG01-120921-B2T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-05A	CW-1156-SG01-120921-B2T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-05A	CW-1156-SG01-120921-B2T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	13	ng	50	µg/m^3	130	µg/m^3	
2112214-05A	CW-1156-SG01-120921-B2T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	54	ng	50	µg/m^3	540	µg/m^3	
2112214-05A	CW-1156-SG01-120921-B2T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-05A	CW-1156-SG01-120921-B2T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	25	ng	50	µg/m^3	250	µg/m^3	
2112214-05A	CW-1156-SG01-120921-B2T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-05A	CW-1156-SG01-120921-B2T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-05A	CW-1156-SG01-120921-B2T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-05A	CW-1156-SG01-120921-B2T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-06A	CW-1156-SG01-120921-B2F	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-06A	CW-1156-SG01-120921-B2F	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-06A	CW-1156-SG01-120921-B2F	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-06A	CW-1156-SG01-120921-B2F	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-06A	CW-1156-SG01-120921-B2F	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-06A	CW-1156-SG01-120921-B2F	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-06A	CW-1156-SG01-120921-B2F	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	14	ng	50	µg/m^3	140	µg/m^3	
2112214-06A	CW-1156-SG01-120921-B2F	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	21	ng	50	µg/m^3	210	µg/m^3	
2112214-06A	CW-1156-SG01-120921-B2F	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	1300	ng	50	µg/m^3	13000	µg/m^3	E
2112214-06A	CW-1156-SG01-120921-B2F	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	1200	ng	50	µg/m^3	12000	µg/m^3	E
2112214-06A	CW-1156-SG01-120921-B2F	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	210	ng	50	µg/m^3	2100	µg/m^3	
2112214-06A	CW-1156-SG01-120921-B2F	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-06A	CW-1156-SG01-120921-B2F	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U

2112214-07A	CW-1156-SG01-120921-C1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-07A	CW-1156-SG01-120921-C1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-07A	CW-1156-SG01-120921-C1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-07A	CW-1156-SG01-120921-C1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-07A	CW-1156-SG01-120921-C1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-07A	CW-1156-SG01-120921-C1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-07A	CW-1156-SG01-120921-C1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	14	ng	200	µg/m^3	560	µg/m^3	
2112214-07A	CW-1156-SG01-120921-C1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	6.2	ng	200	µg/m^3	250	µg/m^3	

2112214-07A	CW-1156-SG01-120921-C1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	380	ng	200	μg/m^3	15000	μg/m^3	
2112214-07A	CW-1156-SG01-120921-C1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	260	ng	200	μg/m^3	10000	μg/m^3	
2112214-07A	CW-1156-SG01-120921-C1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	55	ng	200	μg/m^3	2200	μg/m^3	
2112214-07A	CW-1156-SG01-120921-C1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	200	μg/m^3	ND	μg/m^3	U,J
2112214-07A	CW-1156-SG01-120921-C1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	200	μg/m^3	ND	μg/m^3	U,J
2112214-08A	CW-1156-SG01-120921-D1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	200	μg/m^3	ND	μg/m^3	U
2112214-08A	CW-1156-SG01-120921-D1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	200	μg/m^3	ND	μg/m^3	U
2112214-08A	CW-1156-SG01-120921-D1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	200	μg/m^3	ND	μg/m^3	U

2112214-08A	CW-1156-SG01-120921-D1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U
2112214-08A	CW-1156-SG01-120921-D1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U
2112214-08A	CW-1156-SG01-120921-D1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U
2112214-08A	CW-1156-SG01-120921-D1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U
2112214-08A	CW-1156-SG01-120921-D1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U
2112214-08A	CW-1156-SG01-120921-D1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U
2112214-08A	CW-1156-SG01-120921-D1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U
2112214-08A	CW-1156-SG01-120921-D1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	200	$\mu g/m^3$	ND	$\mu g/m^3$	U

2112214-08A	CW-1156-SG01-120921-D1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-08A	CW-1156-SG01-120921-D1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-09A	CW-1156-SG01-120921-D1F	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-09A	CW-1156-SG01-120921-D1F	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-09A	CW-1156-SG01-120921-D1F	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-09A	CW-1156-SG01-120921-D1F	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-09A	CW-1156-SG01-120921-D1F	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-09A	CW-1156-SG01-120921-D1F	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U

2112214-09A	CW-1156-SG01-120921-D1F	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	11	ng	200	µg/m^3	440	µg/m^3	
2112214-09A	CW-1156-SG01-120921-D1F	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-09A	CW-1156-SG01-120921-D1F	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	21	ng	200	µg/m^3	840	µg/m^3	
2112214-09A	CW-1156-SG01-120921-D1F	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	20	ng	200	µg/m^3	800	µg/m^3	
2112214-09A	CW-1156-SG01-120921-D1F	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	9	ng	200	µg/m^3	360	µg/m^3	
2112214-09A	CW-1156-SG01-120921-D1F	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-09A	CW-1156-SG01-120921-D1F	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-11A	CW-1156-SG02-120921-A1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-11A	CW-1156-SG02-120921-A1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-11A	CW-1156-SG02-120921-A1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	18	ng	50	µg/m^3	180	µg/m^3	
2112214-11A	CW-1156-SG02-120921-A1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	5.2	ng	50	µg/m^3	52	µg/m^3	
2112214-11A	CW-1156-SG02-120921-A1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-11A	CW-1156-SG02-120921-A1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-11A	CW-1156-SG02-120921-A1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	70	ng	50	µg/m^3	700	µg/m^3	
2112214-11A	CW-1156-SG02-120921-A1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	20	ng	50	µg/m^3	200	µg/m^3	
2112214-11A	CW-1156-SG02-120921-A1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	110	ng	50	µg/m^3	1100	µg/m^3	

2112214-11A	CW-1156-SG02-120921-A1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	46	ng	50	µg/m^3	460	µg/m^3	
2112214-11A	CW-1156-SG02-120921-A1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	9.9	ng	50	µg/m^3	99	µg/m^3	
2112214-11A	CW-1156-SG02-120921-A1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-11A	CW-1156-SG02-120921-A1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-12A	CW-1156-SG02-120921-B1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-12A	CW-1156-SG02-120921-B1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	27	ng	50	µg/m^3	270	µg/m^3	
2112214-12A	CW-1156-SG02-120921-B1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-12A	CW-1156-SG02-120921-B1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U

2112214-12A	CW-1156-SG02-120921-B1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-13A	CW-1156-SG02-120921-B1F	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-13A	CW-1156-SG02-120921-B1F	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-13A	CW-1156-SG02-120921-B1F	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-13A	CW-1156-SG02-120921-B1F	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-13A	CW-1156-SG02-120921-B1F	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-13A	CW-1156-SG02-120921-B1F	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-13A	CW-1156-SG02-120921-B1F	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	27	ng	50	µg/m^3	270	µg/m^3	

2112214-13A	CW-1156-SG02-120921-B1F	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	15	ng	50	µg/m^3	150	µg/m^3	
2112214-13A	CW-1156-SG02-120921-B1F	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	86	ng	50	µg/m^3	860	µg/m^3	
2112214-13A	CW-1156-SG02-120921-B1F	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	66	ng	50	µg/m^3	660	µg/m^3	
2112214-13A	CW-1156-SG02-120921-B1F	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	23	ng	50	µg/m^3	230	µg/m^3	
2112214-13A	CW-1156-SG02-120921-B1F	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-13A	CW-1156-SG02-120921-B1F	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-14A	CW-1156-SG02-120921-A2T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-14A	CW-1156-SG02-120921-A2T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-14A	CW-1156-SG02-120921-A2T	Perfluorohexanoic acid (PFHxA)	5.0	ng	16	ng	50	µg/m^3	160	µg/m^3	I
2112214-14A	CW-1156-SG02-120921-A2T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-14A	CW-1156-SG02-120921-A2T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-14A	CW-1156-SG02-120921-A2T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-14A	CW-1156-SG02-120921-A2T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	70	ng	50	µg/m^3	700	µg/m^3	
2112214-14A	CW-1156-SG02-120921-A2T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	18	ng	50	µg/m^3	180	µg/m^3	
2112214-14A	CW-1156-SG02-120921-A2T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	96	ng	50	µg/m^3	960	µg/m^3	
2112214-14A	CW-1156-SG02-120921-A2T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	42	ng	50	µg/m^3	420	µg/m^3	

2112214-14A	CW-1156-SG02-120921-A2T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	14	ng	50	µg/m^3	140	µg/m^3	
2112214-14A	CW-1156-SG02-120921-A2T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-14A	CW-1156-SG02-120921-A2T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-15A	CW-1156-SG02-120921-B2T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U

2112214-15A	CW-1156-SG02-120921-B2T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	34	ng	50	µg/m^3	340	µg/m^3	
2112214-15A	CW-1156-SG02-120921-B2T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-15A	CW-1156-SG02-120921-B2T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-15A	CW-1156-SG02-120921-B2T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U

2112214-16A	CW-1156-SG02-120921-B2F	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-16A	CW-1156-SG02-120921-B2F	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-16A	CW-1156-SG02-120921-B2F	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-16A	CW-1156-SG02-120921-B2F	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-16A	CW-1156-SG02-120921-B2F	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-16A	CW-1156-SG02-120921-B2F	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	U
2112214-16A	CW-1156-SG02-120921-B2F	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	27	ng	50	µg/m^3	270	µg/m^3	
2112214-16A	CW-1156-SG02-120921-B2F	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	19	ng	50	µg/m^3	190	µg/m^3	

2112214-16A	CW-1156-SG02-120921-B2F	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	97	ng	50	µg/m^3	970	µg/m^3	
2112214-16A	CW-1156-SG02-120921-B2F	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	64	ng	50	µg/m^3	640	µg/m^3	
2112214-16A	CW-1156-SG02-120921-B2F	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	21	ng	50	µg/m^3	210	µg/m^3	
2112214-16A	CW-1156-SG02-120921-B2F	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-16A	CW-1156-SG02-120921-B2F	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	50	µg/m^3	ND	µg/m^3	J,U
2112214-17A	CW-1156-SG02-120921-C1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-17A	CW-1156-SG02-120921-C1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-17A	CW-1156-SG02-120921-C1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U

2112214-17A	CW-1156-SG02-120921-C1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-17A	CW-1156-SG02-120921-C1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-17A	CW-1156-SG02-120921-C1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-17A	CW-1156-SG02-120921-C1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	15	ng	200	µg/m^3	600	µg/m^3	
2112214-17A	CW-1156-SG02-120921-C1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-17A	CW-1156-SG02-120921-C1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	27	ng	200	µg/m^3	1100	µg/m^3	
2112214-17A	CW-1156-SG02-120921-C1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	14	ng	200	µg/m^3	560	µg/m^3	
2112214-17A	CW-1156-SG02-120921-C1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	6.6	ng	200	µg/m^3	260	µg/m^3	

2112214-17A	CW-1156-SG02-120921-C1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-17A	CW-1156-SG02-120921-C1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-18A	CW-1156-SG02-120921-D1T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U

2112214-18A	CW-1156-SG02-120921-D1T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-18A	CW-1156-SG02-120921-D1T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-18A	CW-1156-SG02-120921-D1T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-19A	CW-1156-SG02-120921-D1F	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U

2112214-19A	CW-1156-SG02-120921-D1F	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-19A	CW-1156-SG02-120921-D1F	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-19A	CW-1156-SG02-120921-D1F	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-19A	CW-1156-SG02-120921-D1F	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-19A	CW-1156-SG02-120921-D1F	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	U
2112214-19A	CW-1156-SG02-120921-D1F	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	9.1	ng	200	µg/m^3	360	µg/m^3	
2112214-19A	CW-1156-SG02-120921-D1F	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	6.3	ng	200	µg/m^3	250	µg/m^3	
2112214-19A	CW-1156-SG02-120921-D1F	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	360	ng	200	µg/m^3	14000	µg/m^3	

2112214-19A	CW-1156-SG02-120921-D1F	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	350	ng	200	µg/m^3	14000	µg/m^3	
2112214-19A	CW-1156-SG02-120921-D1F	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	76	ng	200	µg/m^3	3000	µg/m^3	
2112214-19A	CW-1156-SG02-120921-D1F	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-19A	CW-1156-SG02-120921-D1F	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng	200	µg/m^3	ND	µg/m^3	J,U
2112214-21A	CW-1156-Blank-120921-T	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng					U

2112214-21A	CW-1156-Blank-120921-T	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng					U
2112214-21A	CW-1156-Blank-120921-T	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng					J,U

2112214-21A	CW-1156-Blank-120921-T	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng					J,U
2112214-22A	CW-1156-Blank-120921-F	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng					U

2112214-22A	CW-1156-Blank-120921-F	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng					U
2112214-22A	CW-1156-Blank-120921-F	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng					J,U
2112214-22A	CW-1156-Blank-120921-F	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng					J,U
2112214-23A	Lab Blank (12/17/21)	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng					U

2112214-23A	Lab Blank (12/17/21)	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng					U
2112214-23A	Lab Blank (12/17/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng					J,U
2112214-23A	Lab Blank (12/17/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng					J,U
2112214-23B	Lab Blank (12/20/21)	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng					U

2112214-23B	Lab Blank (12/20/21)	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng					U
2112214-23B	Lab Blank (12/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng					J,U
2112214-23B	Lab Blank (12/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng					J,U

2112214-23C	Lab Blank (12/21/21)	Perfluorobutanoic acid (PFBA)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	Perfluoropentanoic acid (PFPeA)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	Perfluorohexanoic acid (PFHxA)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	Perfluoroheptanoic acid (PFHpA)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	Perfluorooctanoic acid (PFOA)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	2-Perfluorobutyl ethanol (4:2 FTOH)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	1-Perfluoropentyl ethanol (5:2s FTOH)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	2-Perfluorohexyl ethanol (6:2 FTOH)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	2-Perfluorooctyl ethanol (8:2 FTOH)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	2-Perfluorodecyl ethanol (10:2 FTOH)	5.0	ng	ND	ng					U
2112214-23C	Lab Blank (12/21/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	5.0	ng	ND	ng					J,U

2112214-23C	Lab Blank (12/21/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	5.0	ng	ND	ng					J,U
2112214-24A	CCV (12/17/21)	Perfluorobutanoic acid (PFBA)							86	%R	
2112214-24A	CCV (12/17/21)	Perfluoropentanoic acid (PFPeA)							88	%R	
2112214-24A	CCV (12/17/21)	Perfluorohexanoic acid (PFHxA)							87	%R	
2112214-24A	CCV (12/17/21)	Perfluoroheptanoic acid (PFHpA)							85	%R	
2112214-24A	CCV (12/17/21)	Perfluorooctanoic acid (PFOA)							88	%R	
2112214-24A	CCV (12/17/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							95	%R	
2112214-24A	CCV (12/17/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							96	%R	
2112214-24A	CCV (12/17/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							95	%R	
2112214-24A	CCV (12/17/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							96	%R	
2112214-24A	CCV (12/17/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							89	%R	
2112214-24A	CCV (12/17/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							94	%R	

2112214-24A	CCV (12/17/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							96	%R	
2112214-24A	CCV (12/17/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							94	%R	
2112214-24B	CCV (12/20/21)	Perfluorobutanoic acid (PFBA)							74	%R	
2112214-24B	CCV (12/20/21)	Perfluoropentanoic acid (PFPeA)							76	%R	
2112214-24B	CCV (12/20/21)	Perfluorohexanoic acid (PFHxA)							76	%R	
2112214-24B	CCV (12/20/21)	Perfluoroheptanoic acid (PFHpA)							77	%R	
2112214-24B	CCV (12/20/21)	Perfluorooctanoic acid (PFOA)							90	%R	
2112214-24B	CCV (12/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							96	%R	
2112214-24B	CCV (12/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							93	%R	
2112214-24B	CCV (12/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							91	%R	
2112214-24B	CCV (12/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							94	%R	

2112214-24B	CCV (12/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							101	%R	
2112214-24B	CCV (12/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							95	%R	
2112214-24B	CCV (12/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							92	%R	
2112214-24B	CCV (12/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							90	%R	
2112214-24C	CCV (12/21/21)	Perfluorobutanoic acid (PFBA)							78	%R	
2112214-24C	CCV (12/21/21)	Perfluoropentanoic acid (PFPeA)							80	%R	
2112214-24C	CCV (12/21/21)	Perfluorohexanoic acid (PFHxA)							94	%R	
2112214-24C	CCV (12/21/21)	Perfluoroheptanoic acid (PFHpA)							108	%R	
2112214-24C	CCV (12/21/21)	Perfluorooctanoic acid (PFOA)							109	%R	
2112214-24C	CCV (12/21/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							100	%R	
2112214-24C	CCV (12/21/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							104	%R	

2112214-24C	CCV (12/21/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							105	%R	
2112214-24C	CCV (12/21/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							107	%R	
2112214-24C	CCV (12/21/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							102	%R	
2112214-24C	CCV (12/21/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							103	%R	
2112214-24C	CCV (12/21/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							81	%R	
2112214-24C	CCV (12/21/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							87	%R	
2112214-25A	LCS (12/17/21)	Perfluorobutanoic acid (PFBA)							107	%R	
2112214-25A	LCS (12/17/21)	Perfluoropentanoic acid (PFPeA)							126	%R	
2112214-25A	LCS (12/17/21)	Perfluorohexanoic acid (PFHxA)							121	%R	
2112214-25A	LCS (12/17/21)	Perfluoroheptanoic acid (PFHpA)							117	%R	
2112214-25A	LCS (12/17/21)	Perfluorooctanoic acid (PFOA)							86	%R	

2112214-25A	LCS (12/17/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							108	%R	
2112214-25A	LCS (12/17/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							115	%R	
2112214-25A	LCS (12/17/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							109	%R	
2112214-25A	LCS (12/17/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							107	%R	
2112214-25A	LCS (12/17/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							100	%R	
2112214-25A	LCS (12/17/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							102	%R	
2112214-25A	LCS (12/17/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							69	%R	
2112214-25A	LCS (12/17/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							83	%R	
2112214-25AA	LCSD (12/17/21)	Perfluorobutanoic acid (PFBA)							130	%R	
2112214-25AA	LCSD (12/17/21)	Perfluoropentanoic acid (PFPeA)							155	%R	Q
2112214-25AA	LCSD (12/17/21)	Perfluorohexanoic acid (PFHxA)							141	%R	Q

2112214-25AA	LCSD (12/17/21)	Perfluoroheptanoic acid (PFHpA)							135	%R	
2112214-25AA	LCSD (12/17/21)	Perfluorooctanoic acid (PFOA)							102	%R	
2112214-25AA	LCSD (12/17/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							105	%R	
2112214-25AA	LCSD (12/17/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							110	%R	
2112214-25AA	LCSD (12/17/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							110	%R	
2112214-25AA	LCSD (12/17/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							111	%R	
2112214-25AA	LCSD (12/17/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							96	%R	
2112214-25AA	LCSD (12/17/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							110	%R	
2112214-25AA	LCSD (12/17/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							96	%R	
2112214-25AA	LCSD (12/17/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							106	%R	
2112214-25B	LCS (12/20/21)	Perfluorobutanoic acid (PFBA)							89	%R	

2112214-25B	LCS (12/20/21)	Perfluoropentanoic acid (PFPeA)							112	%R	
2112214-25B	LCS (12/20/21)	Perfluorohexanoic acid (PFHxA)							118	%R	
2112214-25B	LCS (12/20/21)	Perfluoroheptanoic acid (PFHpA)							117	%R	
2112214-25B	LCS (12/20/21)	Perfluorooctanoic acid (PFOA)							86	%R	
2112214-25B	LCS (12/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							92	%R	
2112214-25B	LCS (12/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							95	%R	
2112214-25B	LCS (12/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							91	%R	
2112214-25B	LCS (12/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							99	%R	
2112214-25B	LCS (12/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							81	%R	
2112214-25B	LCS (12/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							96	%R	
2112214-25B	LCS (12/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							78	%R	

2112214-25B	LCS (12/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							85	%R	
2112214-25BB	LCSD (12/20/21)	Perfluorobutanoic acid (PFBA)							91	%R	
2112214-25BB	LCSD (12/20/21)	Perfluoropentanoic acid (PFPeA)							116	%R	
2112214-25BB	LCSD (12/20/21)	Perfluorohexanoic acid (PFHxA)							125	%R	
2112214-25BB	LCSD (12/20/21)	Perfluoroheptanoic acid (PFHpA)							122	%R	
2112214-25BB	LCSD (12/20/21)	Perfluorooctanoic acid (PFOA)							90	%R	
2112214-25BB	LCSD (12/20/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							95	%R	
2112214-25BB	LCSD (12/20/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							99	%R	
2112214-25BB	LCSD (12/20/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							101	%R	
2112214-25BB	LCSD (12/20/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							100	%R	
2112214-25BB	LCSD (12/20/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							88	%R	
2112214-25BB	LCSD (12/20/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							96	%R	

2112214-25BB	LCSD (12/20/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							68	%R	
2112214-25BB	LCSD (12/20/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							82	%R	
2112214-25C	LCS (12/21/21)	Perfluorobutanoic acid (PFBA)							87	%R	
2112214-25C	LCS (12/21/21)	Perfluoropentanoic acid (PFPeA)							112	%R	
2112214-25C	LCS (12/21/21)	Perfluorohexanoic acid (PFHxA)							119	%R	
2112214-25C	LCS (12/21/21)	Perfluoroheptanoic acid (PFHpA)							122	%R	
2112214-25C	LCS (12/21/21)	Perfluorooctanoic acid (PFOA)							89	%R	
2112214-25C	LCS (12/21/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							99	%R	
2112214-25C	LCS (12/21/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							99	%R	
2112214-25C	LCS (12/21/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							98	%R	
2112214-25C	LCS (12/21/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							104	%R	

2112214-25C	LCS (12/21/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							92	%R	
2112214-25C	LCS (12/21/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							108	%R	
2112214-25C	LCS (12/21/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							86	%R	
2112214-25C	LCS (12/21/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							91	%R	
2112214-25CC	LCSD (12/21/21)	Perfluorobutanoic acid (PFBA)							101	%R	
2112214-25CC	LCSD (12/21/21)	Perfluoropentanoic acid (PFPeA)							124	%R	
2112214-25CC	LCSD (12/21/21)	Perfluorohexanoic acid (PFHxA)							125	%R	
2112214-25CC	LCSD (12/21/21)	Perfluoroheptanoic acid (PFHpA)							119	%R	
2112214-25CC	LCSD (12/21/21)	Perfluorooctanoic acid (PFOA)							95	%R	
2112214-25CC	LCSD (12/21/21)	2-Perfluorobutyl ethanol (4:2 FTOH)							106	%R	
2112214-25CC	LCSD (12/21/21)	1-Perfluoropentyl ethanol (5:2s FTOH)							111	%R	

2112214-25CC	LCSD (12/21/21)	1-Perfluoroheptyl ethanol (7:2s FTOH)							116	%R	
2112214-25CC	LCSD (12/21/21)	2-Perfluorohexyl ethanol (6:2 FTOH)							120	%R	
2112214-25CC	LCSD (12/21/21)	2-Perfluorooctyl ethanol (8:2 FTOH)							107	%R	
2112214-25CC	LCSD (12/21/21)	2-Perfluorodecyl ethanol (10:2 FTOH)							113	%R	
2112214-25CC	LCSD (12/21/21)	n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)							82	%R	
2112214-25CC	LCSD (12/21/21)	n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)							94	%R	

%R = percent recovery
E: Results exceeded calibration range
I: Matrix interference affecting qualifier ion(s) used for compound identification
J: Estimated value
Q: Sample held beyond the accepted holding time
U: Indicates that the compound was analyzed for but not detected
NA: Not analyzed
nd: Not detected

Appendix G: Laboratory 1 Reports Including QA/QC Data, GA Site, August 2021 Sampling

Table G-1. GA Landfill Groundwater Data.

Analyte	Unit	FCL-B2 8/19/21 2:25 PM	FCL-Blank 8/19/21 10:15 AM	FCL-GWC4 8/19/21 11:15 AM	FCL-GWC5A 8/19/21 3:45 PM
10:2 FTOH-2-Perfluorodecyl ethanol	µg/L	<1.0	<1.0	<1.0	<1.0
11Cl-PF3OUdS	µg/L	<0.0017	<0.0018	<0.0017	<0.0017
4:2 FTOH-2-Perfluorobutyl ethanol	µg/L	<1.0	<1.0	<1.0	<1.0
6:2 FTOH-2-Perfluorohexyl ethanoic acid	µg/L	<1.0	<1.0	<1.0	<1.0
7:2 FTOH-1-Perfluoroheptyl ethanol	µg/L	<1.0	<1.0	<1.0	<1.0
8:2 FTOH-2-Perfluorooctyl ethanol	µg/L	<1.0	<1.0	<1.0	<1.0
9Cl-PF3ONS	µg/L	<0.0017	<0.0018	<0.0017	<0.0017
DONA	µg/L	<0.0017	<0.0018	<0.0017	<0.0017
HFPODA	µg/L	<0.0025	<0.0027	<0.0025	<0.0026
NEtFOSAA	µg/L	<0.0025	<0.0027	<0.0025	<0.0026
NMeFOSAA	µg/L	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorobutanesulfonic acid	µg/L	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorobutanoic acid	µg/L	0.0082	<0.0045	<0.0042	<0.0043
Perfluorodecanoic acid	µg/L	<0.0017	<0.0018	<0.0017	<0.0017
Perfluorododecanoic acid	µg/L	<0.0017	<0.0018	<0.0017	<0.0017
Perfluoroheptanoic acid	µg/L	0.0028	<0.0018	<0.0017	<0.0017
Perfluorohexanesulfonic acid	µg/L	0.0029	<0.0018	<0.0017	<0.0017
Perfluorohexanoic acid	µg/L	0.017	<0.0018	0.0039	<0.0017

Table G-2. GA Landfill Soil Gas Data.

NOTE: First row headers are sample number, date collected, and time collected.

Compound	Units	FCL-B2 8/19/21 1:15 PM	FCL-FB 8/19/21 9:38 AM	FCL-GWC4 8/19/21 9:52 AM	FCL-GWC5A 8/19/21 2:57 PM	FCL-MM7A 8/19/21 2:02 PM	FCL-MV2 8/19/21 3:30 PM	FCL-V7-5 8/19/21 12:15 PM
1-Perfluoroheptyl ethanol (7:2s FTOH)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
1-Perfluoropentyl ethanol (5:2s FTOH)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
2-Perfluorobutyl ethanol (4:2 FTOH)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
2-Perfluorodecyl ethanol (10:2 FTOH)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
2-Perfluorohexyl ethanol (6:2 FTOH)	µg/m^3	<0.2 U	2.2	0.20	<0.2 U	0.48	<0.2 U,Q	<0.2 U
2-Perfluorooctyl ethanol (8:2 FTOH)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	0.11	<0.1 U,Q	<0.1 U
n-Ethylperfluoro-1-octanesulfonamide (n-EtFOSA)	µg/m^3	<1.0 J,U	<10.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U,Q	<1.0 J,U
n-Methylperfluoro-1-octanesulfonamide (n-MeFOSA)	µg/m^3	<1.0 J,U	<10.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U	<1.0 J,U,Q	<1.0 J,U
Perfluorobutanoic acid (PFBA)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluoroheptanoic acid (PFHpA)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluorohexanoic acid (PFHxA)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluorooctanoic acid (PFOA)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U
Perfluoropentanoic acid (PFPeA)	µg/m^3	<0.1 U	<1.0 U	<0.1 U	<0.1 U	<0.1 U	<0.1 U,Q	<0.1 U

J:	Estimated value
Q:	Sample held beyond the accepted holding time
U:	Indicates that the compound was analyzed for but not detected