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PFAS SOLUTION GUIDE

SOLID PHASE EXTRACTION | QuEChERS | LC-MS/MS

INNOVATION THROUGH CHEMISTRY

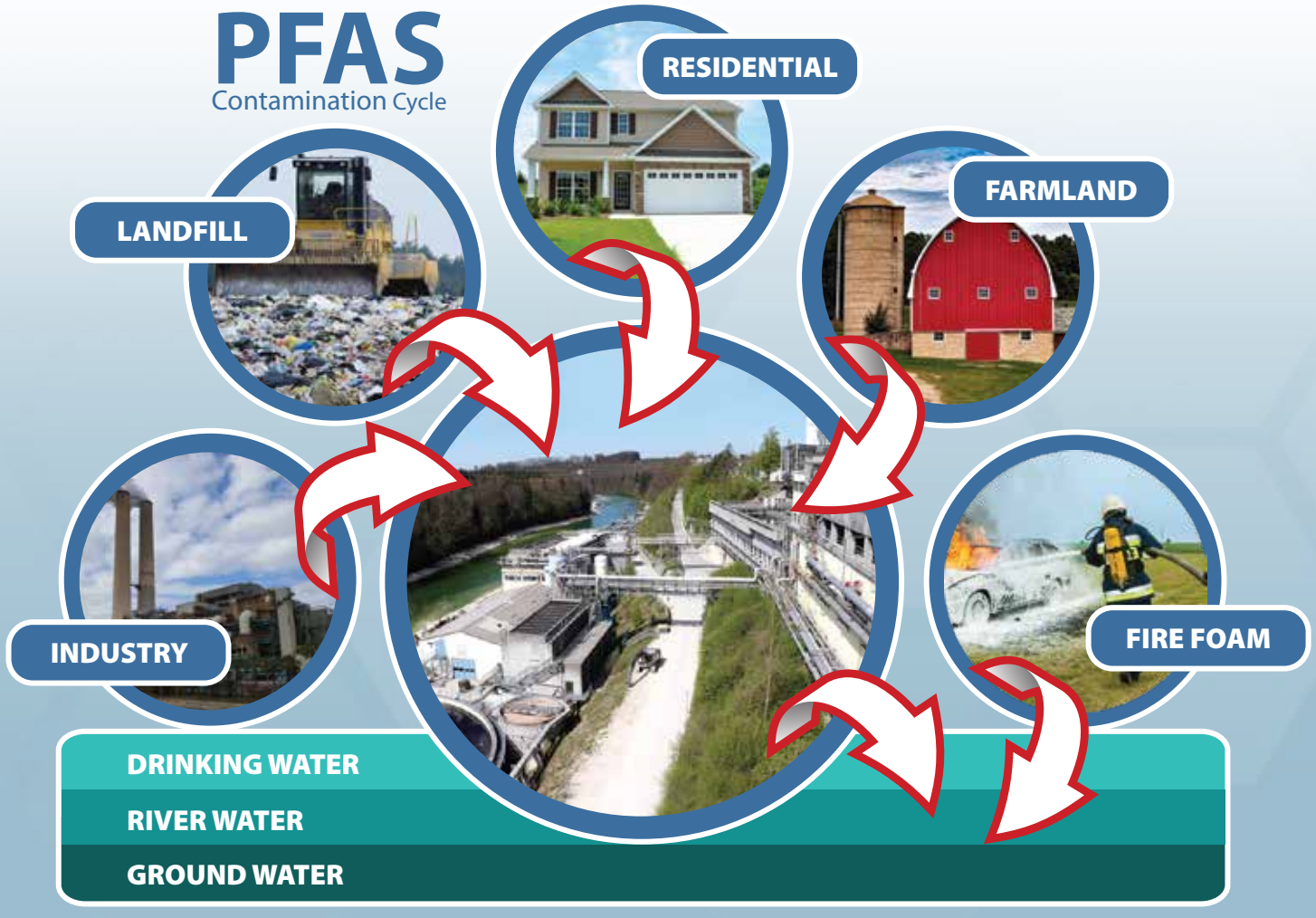
Navigating the PFAS Landscape

Per - and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that includes PFOA, PFOS, GenX, and many other chemicals. PFAS have been manufactured and used in a variety of industries around the globe, including in the United States since the 1940s. PFOA and PFOS have been the most extensively produced and studied of these chemicals. Both chemicals are very persistent in the environment and in the human body – meaning they don't break down and they can accumulate over time. There is evidence that exposure to PFAS can lead to adverse human health effects.

Per- and polyfluoroalkyl substances (PFASs) are a diverse group of synthetic organofluorine compounds that have been widely used in industrial applications and consumer products such as non-stick cookware, food packaging, fire-fighting foams, carpeting, apparels and metal plating. PFASs are persistent in the environment and are extremely resistant to degradation due to heat, acids or bases. They are also bioaccumulative in wildlife and humans and are known to cause reproductive and developmental toxicity in laboratory animals and wildlife.

The United States Environmental Protection Agency (USEPA) has issued drinking water health advisories for two PFASs, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) at 70 ng/L [1]. Several US states also have public health guidelines for PFASs ranging from 20–7,000 ng/L in drinking water.

As the research surrounding these problematic, lifelong chemicals becomes more expansive, the need for sensitive and specific extraction methods becomes more vital for accurate detection and quantitation. UCT is the 35+ years premier environmental analysis provider, featuring an extensive range of turnkey solutions, ranging from sample prep columns, to QuEChERS configurations, to processing stations all the way to analytical columns.



Sample Prep/Consumable Solutions

Enviro-Clean® WAX

UCT's polymeric weak-anion exchange (WAX) SPE cartridges feature enhanced cleanliness for minimal background in addition to unrivaled exchange capacities. Available in 100, 150, 200, and 500 mg bed sizes, these robust cartridges can be used for sample analysis in drinking water, ground water, surface water, and waste water. The use of this phase can be assessed in UCT's new US EPA Method 533 application solution in addition to an internally developed method for the sensitive quantification of 26 PFASs in drinking water, including the 14 covered in the US EPA Method 537.

Enviro-Clean® HL DVB

In addition to UCT's weak-anion exchange polymeric sorbent, we also offer our ENVIRO-CLEAN® HL DVB extraction cartridge manufactured from an extremely clean, and highly cross-linked divinylbenzene based sorbent. It has been successfully used to clean up water samples for testing a wide range of analytes to include acidic, neutral (both polar & non-polar), and basic compounds. This highly retentive, reverse phase sorbent has been used successfully in US EPA Method 537 and US EPA Method 537.1.

Enviro-Clean® WAX
200mg and 500mg / 6mL

Enviro-Clean®Free-Flowing Dual Phase Cartridges

Avoid time intensive dSPE and cumbersome dual stacked cartridges to meet the additional DOD B-15 method-required carbon purification for PFAS testing. Through the use of UCT's Enviro-Clean dual phase WAX+ Graphitized Carbon Black (GCB) cartridge, clean-up can be targeted in one step minimizing loss of long chain PFAS compounds. Cartridges are available in 2 varying configurations, 200mg of WAX + 50mg of GCB and 500 mg of WAX + 50mg GCB. This sample clean-up approach is quickly becoming the "go-to" method for non-potable water and soil in advance of an official EPA published method.

EPA Method	Part Number	Description	UoM
533	ECWAX116-P	Enviro-Clean WAX - PE Frits 100mg 6ml	30/Pkg
533	ECWAX(150)6-P	Enviro-Clean WAX - PE Frits 150mg 6ml	30/Pkg
533	ECWAX126-P	Enviro-Clean WAX - PE Frits 200mg 6ml	30/Pkg
533	ECWAX156-P	Enviro-Clean WAX - PE Frits 500mg 6ml	30/Pkg
537 & 537.1	ECHLD116-P	Enviro-Clean HL DVB - PE Frits 100mg 6ml	30/Pkg
537 & 537.1	ECHLD(150)6-P	Enviro-Clean HL DVB - PE Frits 150mg 6ml	30/Pkg
537 & 537.1	ECHLD126-P	Enviro-Clean HL DVB - PE Frits 200mg 6ml	30/Pkg
537 & 537.1	ECHLD156-P	Enviro-Clean HL DVB - PE Frits 500mg 6ml	30/Pkg
DoD QSM 5.3	ECWAXCB206-B	PFAS Analysis-Dual Phase Cartridge-200mg ECWAX+50mg Graphitized Carbon Black-PE Frits	30/Pkg
DoD QSM 5.3	ECWAXCB506-B	PFAS Analysis-Dual Phase Cartridge-500mg ECWAX+50mg Graphitized Carbon Black-PE Frits	30/Pkg

Enviro-Clean® WAX for EPA Method 533

Deionized Water (n=6)

Analyte	Fortified conc = 10 ng/L		Fortified conc = 80 ng/L	
	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)
PFBA	115.89	9.22	108.04	10.71
PFMPA	102.20	4.71	100.47	1.24
PFPeA	100.93	5.10	100.70	2.33
PFBS	107.67	5.92	108.84	2.09
PFMBA	103.33	5.45	103.18	0.45
PFEESA	101.27	5.28	103.70	1.90
NFDHA	98.07	5.46	95.73	2.29
4:2FTS	107.27	5.89	105.98	1.90
PFHxA	100.47	5.73	102.22	2.34
PFPeS	107.40	5.97	112.27	2.69
HFPO-DA	106.07	7.09	105.08	2.50
PFHPA	106.60	5.01	107.54	1.96
PFHxS	104.13	5.32	106.32	1.35
ADONA	99.87	5.16	99.94	1.76
6:2FTS	127.00	13.24	102.90	1.54
PFOA	106.47	5.74	106.16	1.91
PFHpS	101.07	5.84	99.50	3.68
PFOS	101.73	4.96	100.48	2.05
PFNA	99.93	5.61	99.12	2.60
9Cl-PF3ONS	105.07	5.10	103.32	5.22
PFDA	106.47	4.84	106.89	2.38
8:2FTS	108.93	4.42	108.40	1.94
PFUnA	110.00	5.21	108.53	2.46
11Cl-PF3OUdS	101.07	5.28	97.37	10.74
PFDoA	109.13	4.85	107.22	1.99

Enviro-Clean® WAX
200mg and 500mg / 6mL
Selectra® C18 HPLC

Enviro-Clean® WAX for Diverse 26 PFAS Compound List

	Deionized Water (n=4)				Tap Water (n=4)			
	Fortified conc = 10 ppt (0.01 µg/L)		Fortified conc = 10 ppt (0.01 µg/L)		Fortified conc = 10 ppt (0.01 µg/L)		Fortified conc = 10 ppt (0.01 µg/L)	
Analyte	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)
PFBA	121	10.6	123	7.5	105	16.6	107	11.9
PFPeA	112	2.9	110	5.6	102	14.5	92	9.8
PFHxA	103	5.8	103	6.5	109	7.6	105	7.9
PFHpA	101	5.9	105	4.9	99	5.1	99	6.1
PFOA	99	6.9	98	5.0	114	9.3	99	8.7
PFNA	104	5.4	108	8.1	100	9.8	94	10.7
PFDA	104	6.3	98	3.4	107	1.9	96	5.6
PFUdA	101	7.5	87	4.3	95	5.3	89	6.5
PFDoA	97	6.2	99	3.3	104	9.4	93	4.1
PFTrDA	105	5.7	102	5.7	100	12.6	93	7.8
PFTeDA	95	2.1	100	6.2	98	13.9	92	7.2
PFBS	108	5.2	110	5.0	99	8.3	93	5.1
PFPeS	99	8.3	100	4.1	96	9.6	93	5.7
PFHxS	91	12.6	98	5.9	105	14.4	100	7.8
PFHpS	91	8.3	90	4.7	86	8.9	84	6.4
PFOS	91	14.5	90	2.8	90	10.6	87	2.2
PFNS	96	5.9	97	5.2	84	6.7	86	5.5
PFDS	97	3.9	93	3.4	94	10.1	84	6.7
FOSA	90	4.4	96	7.1	82	6.3	84	12.6
N-MeFOSAA	105	6.5	96	10.8	90	7.7	97	9.0
N-EtFOSAA	100	8.6	87	19.8	99	6.1	101	3.8
FOSAA*	64	13.5	58	0.9	30	33.6	30	23.7
PFHxPA	102	10.4	106	7.3	87	10.2	91	8.9
4:2 FTS	111	5.4	108	5.7	83	6.1	85	6.2
6:2 FTS**	158	65.1	211	66.0	214	107.9	77	5.4
8:2 FTS	113	4.5	105	9.9	102	6.8	84	5.3

* Low Recovery of FOSAA due to potential loss during evaporation.

** High Recovery of 6:2 FTS due to potential exogenous contamination.

Sample Processing

Due to the wide prevalence of Teflon™ usage in standard commercially available manifolds, UCT has designed a tailor-made kit to mitigate this secondary exposure. UCT's complete PFAS glass block processing station and accessories provide all facets needed for an efficient extraction. All components are hand-selected to minimize potential for any secondary background contamination. End-users can extract samples with confidence and avoid unnecessary quantitative and qualitative rework.

A complete PFAS Vacuum Manifold System consists of a glass block, Corian® manifold lid, a cover gasket, vacuum gauge and assembly, PE clean-thru tips, PE stopcocks, adjustable collection rack, bulkhead luer fittings, plugs and a glass block safety tray. The Vacuum Manifold System is available in either 16 or 24 positions.

Part Number	Description
VMF016GL-PFAS	Complete 16 Position Vacuum Manifold System for PFAS Analysis
VMF024GL-PFAS	Complete 24 Position Vacuum Manifold System for PFAS Analysis

UCT PFAS GLASS BLOCK
Vacuum Manifold System

Additional Glassblock Manifold Accessories for PFAS Testing

Part Number	Description
VMFSTFR06-PFC	Large Volume LLDPE Sample Transfer Tubes (6 ct) – For Analysis of Perfluorinated Compounds
VMFSTFR12-PFC	Large Volume LLDPE Sample Transfer Tubes (12 ct) – For Analysis of Perfluorinated Compounds
VMF02116-PFAS	16 pack of Polyethylene (PE) Stopcocks
VMF02024-PFAS	24 pack of Polyethylene (PE) Stopcocks
ECUCTTRAP20	20L Manifold Trap
ECUCTTRAP20-ADPT	3/8" X ¼" PVDF Adaptor + 1 FT, ¼" hose
ECROCKER400	Rocker 400 Vacuum Pump 110 Volt

PFAS Food Safety Testing Solutions

Since 2012, the FDA has been refining the analytical method to test specific food groups for PFAS, as well as focusing assessment efforts on foods grown or produced in areas associated with environmental PFAS contamination. In 2019, the FDA expanded the methods used in earlier testing and made available the first single-lab validated scientific method for testing 16 different types of PFAS in a highly diverse sample of foods (fruits and vegetables, bread, milk, cheese, other dairy, meat) utilizing a UCT QuEChERS approach. This method is being used to continue testing foods from the general food supply and in the FDA's work supporting states in assessing the safety of human and animal food from specific areas potentially affected by environmental contamination.

For additional FDA method information visit: fda.gov/media/131510/download

UCT QuEChERS Products Featured in the FDA Validated Method

Part Number	Description	UoM
ECMSSCFS-MP	Mylar Pouch - 6000 mg $MgSO_4$ and 1500 mg NaCl	50/Pkg
ECMPSCB-MP	QuEChERS dSPE Mylar Pouch - 900 mg $MgSO_4$, 300 mg PSA, 150 mg GCB	50/Pkg
ECMPSCB15-CT	QuEChERS dSPE 15mL Prefilled CT's - 900 mg $MgSO_4$, 300 mg PSA, 150 mg GCB	50/Pkg

Access UCT's Full Application Note Here: unitedchem.com/wp-content/uploads/2020/04/PFAS-FDA-Method_Final.pdf

FDA Targeted PFAS List

Acronym	Name
PFBA	Perfluorobutanoic acid
PFPeA	Perfluoropentanoic acid
PFHxA	Perfluorohexanoic acid
PFHpA	Perfluoroheptanoic acid
PFOA	Perfluorooctanoic Acid
PFNA	Perfluorononanoic acid
PFDA	Perfluorodecanoic acid
PFBS	Perfluorobutanesulfonic acid
PFPeS	Perfluoropentanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFHpS	Perfluoroheptanesulfonic acid
PFOS	Perfluorooctanesulfonic acid
NaDONA	Sodium dodecafluoro-3H-4, 8-dioxanonanoate
HFPO-DA	2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoic acid (GenX)
9Cl-PF3ONS	Potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate
11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid

QuEChERS
Extraction Kit

Separations/Analytical Columns

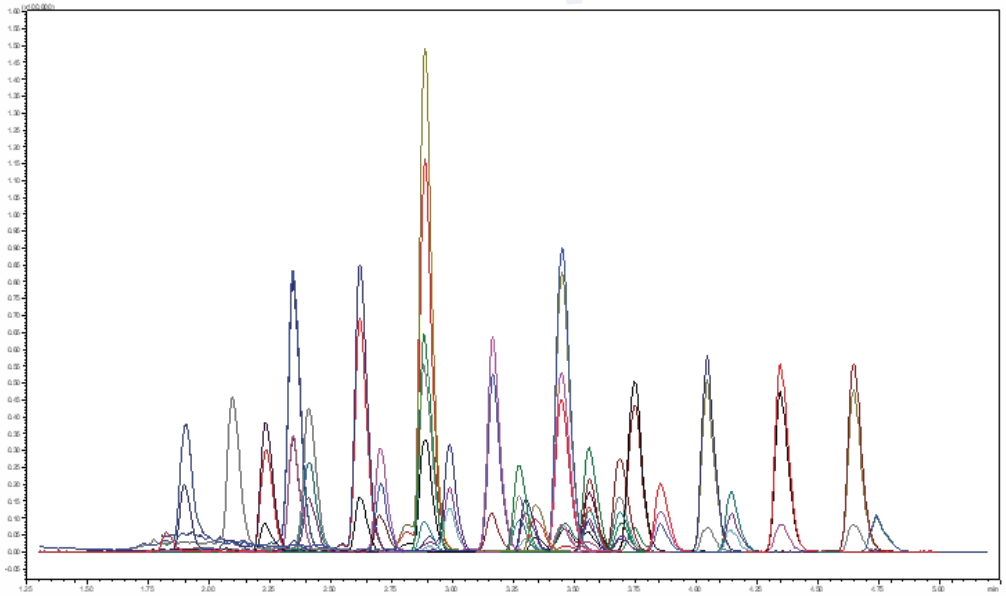
UCT provides robust & cost-effective Selectra® C18 column solutions that maximize resolution and sensitivity for PFAS analysis. We also offer corresponding delay columns to capture any unwanted background contamination in mobile phase, solvent lines, and online degassers. End-users can separate PFAS contamination peaks from the true PFAS levels being identified within their samples. Request samples today!

Part Number	Description
SLC-18100ID21-18UM	Selectra® C18 Column 100 x 2.1 mm, 1.8µm
SLC-18100ID21-3UM	Selectra® C18 Column 100 x 2.1 mm, 3µm
SLC-18100ID21-5UM	Selectra® C18 Column 100 x 2.1 mm, 5µm
SLC-1850ID46-5UM	Selectra® C18 Delay Column 100 x 4.6 mm, 5µm
SLGRDHLDR	Selectra® Standard Guard Cartridge Holder
SLGRDHLDR-HPOPT	Selectra® UHPLC Guard Cartridge Holder (For use w/ 1.8 µm columns and guard column)
SLC-18GDC20-18UMOPT	Selectra® C18 Guard Column 10 x 2.1 mm, 1.8µm
SLC-18GDC20-3UM	Selectra® C18 Guard Column 10 x 2.1 mm, 3µm
SLC-18GDC20-5UM	Selectra® C18 Guard Column 10 x 2.1 mm, 5µm

QuEChERS EXTRACTION KIT
Featuring Selectra® C18 HPLC Column

Chromatogram for 26 PFAS Compounds

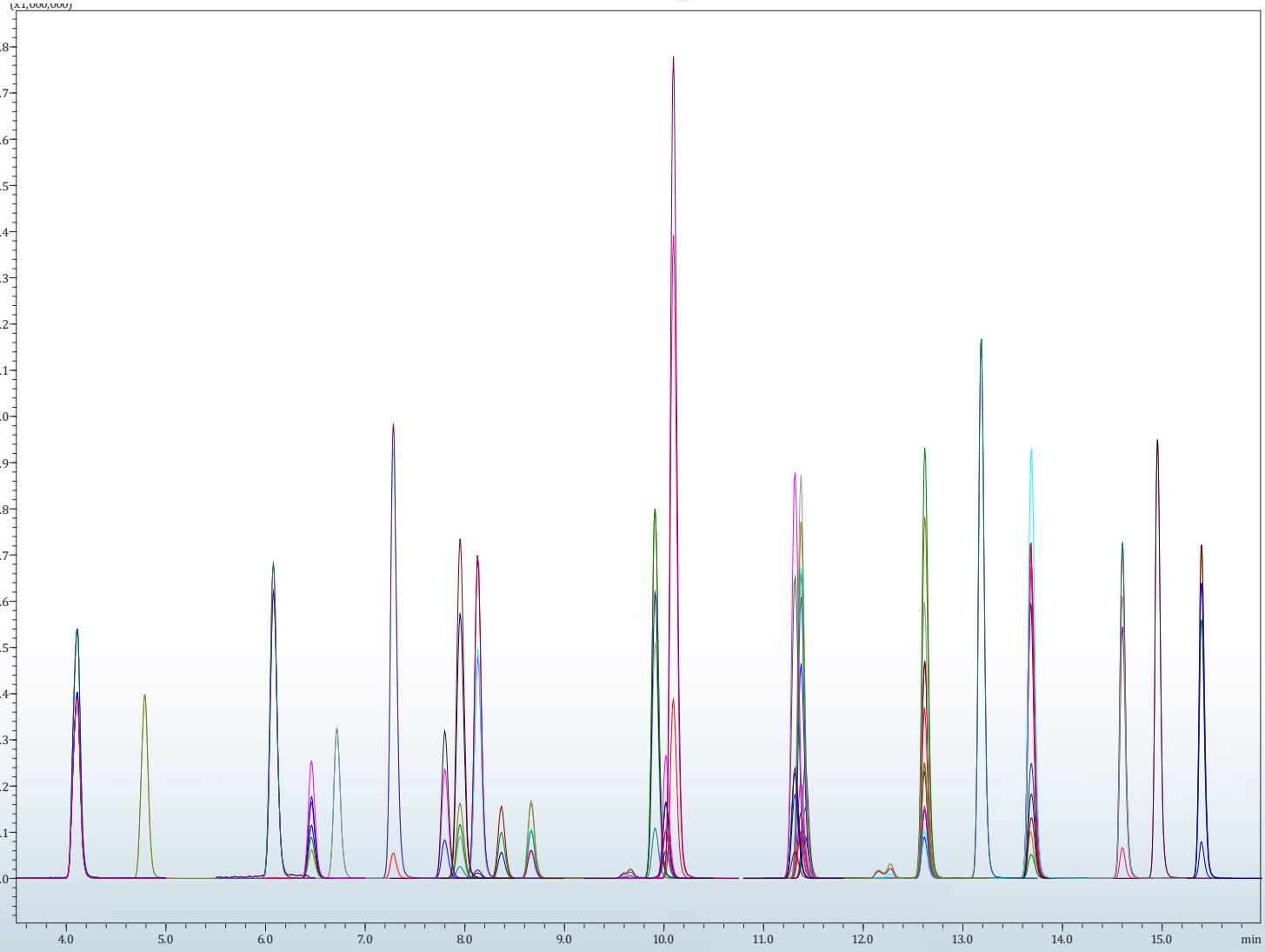
PFASs fortified at 10 ppt (0.01 µg/L) in tap water. Using Selectra® C18 100 X 2.1mm, 3µm HPLC Column



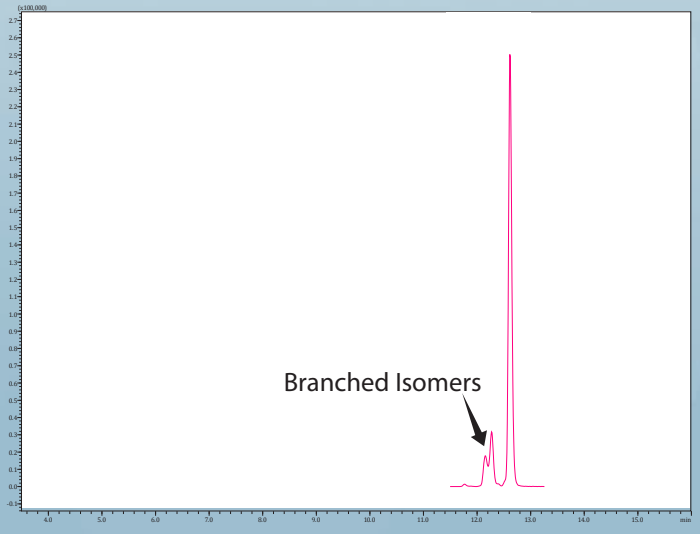
Analyte	RT (min)	Calibration Curve Range (µg/L)	R^2
PFBA	1.89	0.5 - 10	0.9867
PFPeA	2.08	0.5 - 10	0.9995
PFHxPA	1.80	0.5 - 10	0.9960
PFBS	2.40	0.5 - 10	0.9998
4:2 FTS	2.23	0.5 - 10	0.9990
PFHxA	2.33	0.5 - 10	0.9994
PFPeS	2.69	0.5 - 10	0.9976
PFHpA	2.61	0.5 - 10	0.9981
PFHxS	2.97	0.5 - 10	0.9992
PFOA	2.88	0.5 - 10	0.9974
6:2 FTS	2.76	0.5 - 10	0.9952
PFHpS	3.30	0.5 - 10	0.9991
PFNA	3.18	0.5 - 10	0.9968
PFOS	3.58	0.5 - 10	0.9995
PFNS	3.96	0.5 - 10	0.9989
PFDA	3.46	0.5 - 10	0.9998
8:2 FTS	3.33	0.5 - 10	0.9992
FOSAA	3.36	0.5 - 10	0.9937
PFDS	4.16	0.5 - 10	0.9978
PFUdA	3.76	0.5 - 10	0.9994
N-MeFOSAA	3.57	0.5 - 10	0.9947
N-EtFOSAA	3.72	0.5 - 10	0.9962
PFDoA	4.07	0.5 - 10	0.9979
PFTrDA	4.37	0.5 - 10	0.9981
FOSA	4.77	0.5 - 10	0.9999
PFTeDA	4.66	0.5 - 10	0.9999

Chromatogram for EPA Method 533

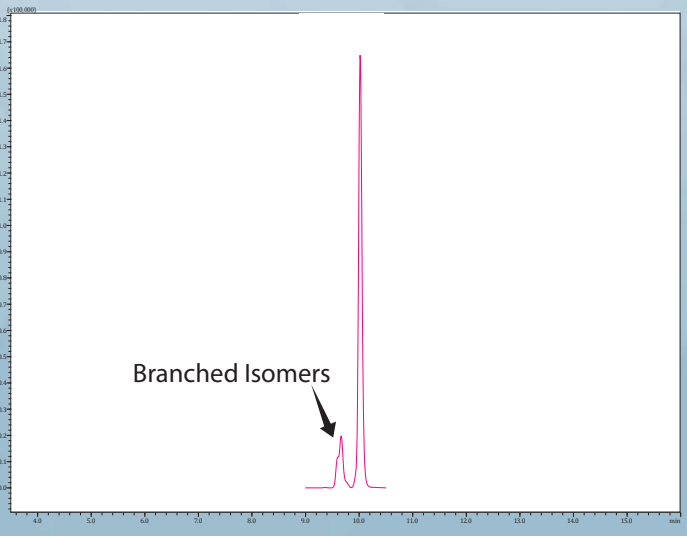
PFASs fortified at 10µg/L in D.I. H_2O



PFOS Baseline Separation (Branched vs Linear Isomers)



PFHxS Baseline Separation (Branched vs Linear Isomers)



Analyte	RT (min)	Calibration Curve Range (µg/L)	R^2
PFBA	4.11	0.5 - 25	0.9984
PFMPA	4.79	0.5 - 25	0.9977
PFPeA	6.09	0.5 - 25	0.9987
PFBS	6.47	0.5 - 25	0.9989
PFMBA	6.72	0.5 - 25	0.9985
PFEESA	7.29	0.5 - 25	0.9987
NFDHA	7.80	0.5 - 25	0.9970
4:2FTS	7.96	0.5 - 25	0.9987
PFHxA	8.14	0.5 - 25	0.9971
PFPeS	8.37	0.5 - 25	0.9986
HFPO-DA	8.67	0.5 - 25	0.9986
PFHPA	9.90	0.5 - 25	0.9987
PFHxS	10.01	0.5 - 25	0.9979
ADONA	10.09	0.5 - 25	0.9982
6:2FTS	11.31	0.5 - 25	0.9978
PFOA	11.37	0.5 - 25	0.9976
PFHpS	11.42	0.5 - 25	0.9967
PFOS	12.61	0.5 - 25	0.9979
PFNA	12.62	0.5 - 25	0.9978
9Cl-PF3ONS	13.19	0.5 - 25	0.9980
PFDA	13.68	0.5 - 25	0.9988
8:2FTS	13.68	0.5 - 25	0.9979
PFUnA	14.61	0.5 - 25	0.9984
11Cl-PF3OUdS	14.96	0.5 - 25	0.9977
PFDoA	15.40	0.5 - 25	0.9980

Isotope Performance Standards

	RT (min)	Calibration Curve Range (µg/L)
13C3-PFBA	4.11	0.5 - 25
13C2-PFOA	11.36	0.5 - 25
13C4-PFOS	12.61	0.5 - 25

Isotope Dilution Standards

13C4-PFBA	4.11	0.5 - 25
13C5-PFPeA	6.09	0.5 - 25
13C3-PFBS	6.47	0.5 - 25
13C2-4:2FTS	7.96	0.5 - 25
13C5-PFHxA	8.13	0.5 - 25
13C3-HFPO-DA	8.67	0.5 - 25
13C4-PFHPA	9.90	0.5 - 25
13C3-PFHxS	10.01	0.5 - 25
13C2-6:2FTS	11.31	0.5 - 25
13C8-PFOA	11.36	0.5 - 25
13C8-PFOS	12.61	0.5 - 25
13C9-PFNA	12.62	0.5 - 25
13C6-PFDA	13.68	0.5 - 25
13C2-8:2FTS	13.68	0.5 - 25
13C7-PFUnA	14.61	0.5 - 25
13C2-PFDoA	15.40	0.5 - 25

Enviro-Clean® WAX
200mg and 500mg / 6mL
Selectra® C18 HPLC

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