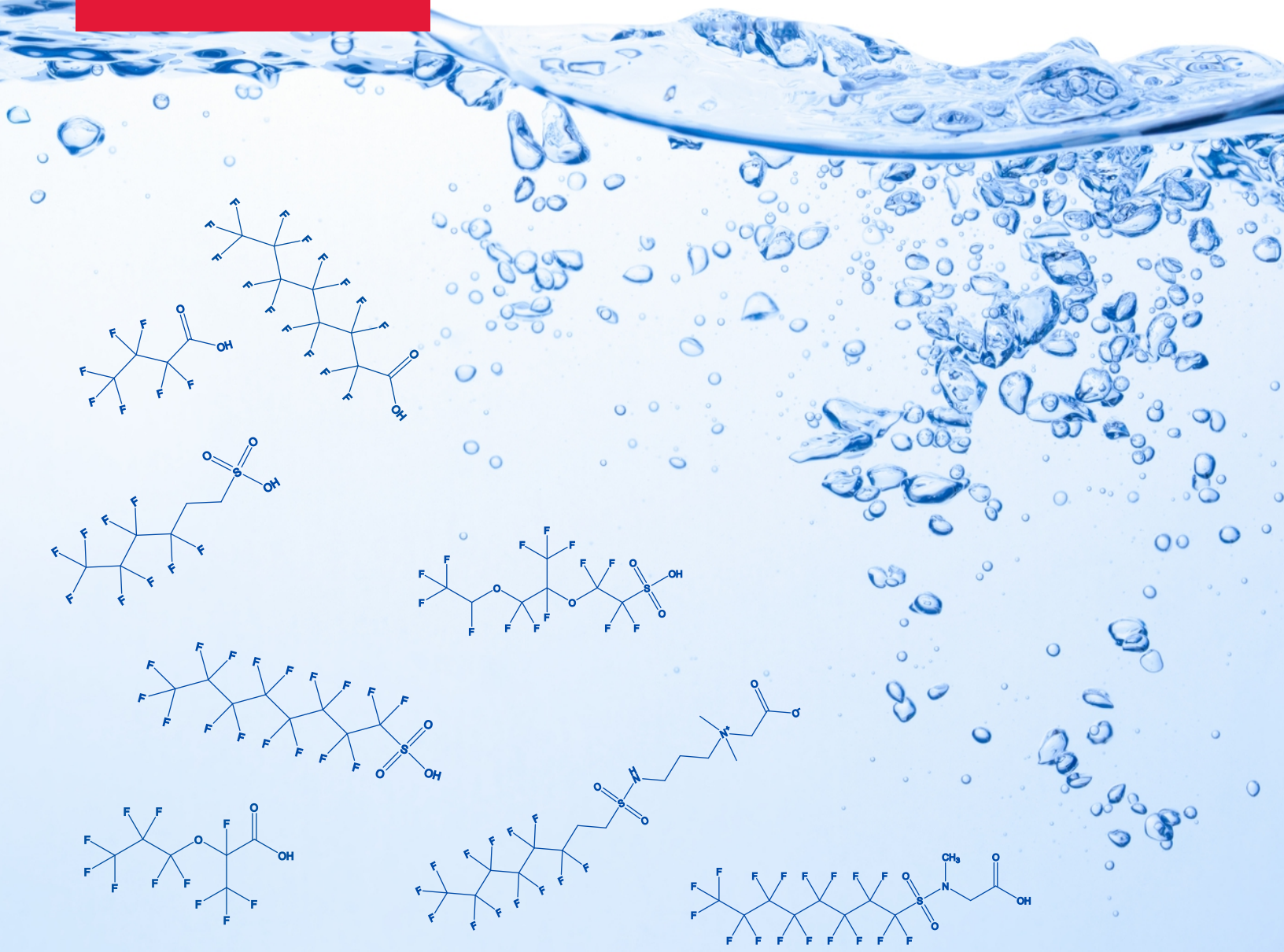
METRIC

Molecular Education, Technology and Research Innovation Center

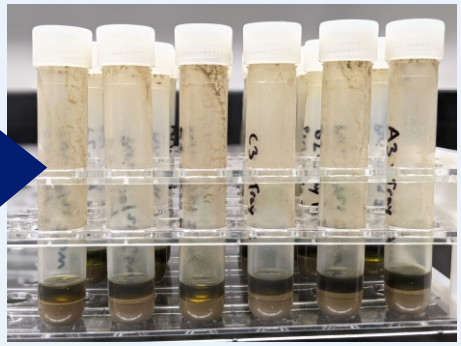
POLY & PER-FLUORINATED COMPOUND MEASUREMENTS

Partner with METRIC at North Carolina State University to fulfill your PFAS measurement needs. We have the capabilities to detect and quantify numerous PFAS compounds from different matrices, including several compounds produced by Chemours©.



Our Method's Reporting Limits

Our current method reporting limits in water can be found in the table on the right. Though these numbers are not directly applicable to other sample matrices, they do help inform on the levels we are capable of reaching in other samples.



Sample Preparation Capabilities and Process

At METRIC, we are able to process many different environmental sample types, including but not limited to the list shown below.

In addition, our sample preparation process includes direct injection of drinking water samples for high throughput analysis or sample cleanup of complicated matrices via solid-phase extraction prior to LC-MS analysis. Our sample clean-up method has been adapted from the EPA method (MDAB-077.0) with minor alterations to improve efficiency. In addition to cleaning up samples, we can also concentrate low levels of PFAS in order to provide quantifiable detection of low abundance compounds.

Sample Types

- Serum
- Periphyton
- Wastewater
- Landfill Leachate
- Stonefly
- Caddisfly
- Mayfly
- Mayfly Nymph
- Zebrafish
- Zebrafish Larvae
- Drinking Water
- Seafoam

Class	Compound	Minimum Reporting Limit (ng/L)
FTS		
	4:2 FTS	5
	6:2 FTS	10
	8:2 FTS	5
	10:2 FTS	5
PFSAm		
	NEtFOSAA	10
	NMeFOSAA	10
	FOSA	2
	MeFOSA	2
	FHxSA	2
	FBSA	2
PFSA		
	PFBS	5
	PFPeS	2
	PFHxS	5
	PFHpS	2
	PFOS	10
	PFNS	2
	PFDS	5
PFCA		
	PFBA	50
	PFPeA	10
	PFHxA	2
	PFHpA	2
	PFOA	2
	PFNA	5
	PFDA	2
	PFUdA	5
	PFDoDA	5
	PFTrDA	5
	PFTeDA	10
	PFHxDA	50
	PFODA	100
PFECA		
	Gen-X[§]	2
	PFMOAA	5
	NaDONA	2
	PEPA	50
	PFO3OA	50
	PFO4DA	50
	PFO5DoDA	100
Zwitter		
	N-AP-FHxSA	5
	N-CMAmP-6:2FOSA	10
	N-TAmP-FHxSA	5
PFESA		
	PS Acid[†]	5
	Nafion by-product 2	2
	F53B Minor[‡]	2
	F53B Major[††]	2

[§]GenX- decarboxylated form of GenX is measured
[†]PS Acid alternative name is Nafion by-product 1
[‡]F53B Minor alternative name is 11Cl-PF3OUdS
[††]F53B Major alternative name is 9Cl-PF3ONS

NOTE: *The reported limits are raw concentrations with no preconcentration of the samples prior to analysis.*

Analyte List

The following tables include the list of analytes included in our method with the chemical name & CAS number. Compounds are denoted with an X if they have a corresponding chemically matched heavy labeled ^{13}C or ^{2}H internal standard. Please see our following paper for information regarding matching surrogate heavy labeled standards: Enders, Jeffrey R., et al., Anal. Bioanal. Chem. 2021 Jul 21: 1-8.

Analytical Standards

Abbreviation	Analyte	CAS #	CCL*	Matching Heavy Labeled Standard
Perfluoroalkyl carboxylic acids (PFCA)				
PFBA	Perfluorobutanoic acid	375-22-4	4	X
PFPeA	Perfluoropentanoic acid	2706-90-3	5	X
PFHxA	Perfluorohexanoic acid	307-24-4	6	X
PFHpA	Perfluoroheptanoic acid	375-85-9	7	X
PFOA	Perfluorooctanoic acid	335-67-1	8	X
PFNA	Perfluorononanoic acid	375-95-1	9	X
PFDA	Perfluorodecanoic acid	335-76-2	10	X
PFUnDA	Perfluoroundecanoic acid	2058-94-8	11	X
PFDoDA	Perfluorododecanoic acid	307-55-1	12	X
PFTrDA	Perfluorotridecanoic acid	72629-94-8	13	
PFTeDA	Perfluorotetradecanoic acid	376-06-7	14	X
PFHxDA	Perfluorohexadecanoic acid	67905-19-5	16	X
PFODA	Perfluorooctadecanoic acid	16517-11-6	18	
Perfluoroalkyl sulfonic acids (PFSA)				
PFBS	Perfluorobutanesulfonic acid	375-73-5	4	X
PFPeS	Perfluoropentanesulfonic acid	2706-91-4	5	
PFHxS	Perfluorohexanesulfonic acid	355-46-4	6	X
PFHpS	Perfluoroheptanesulfonic acid	375-92-8	7	
PFOS	Perfluorooctanesulfonic acid	1763-23-1	8	X
PFNS	Perfluorononanesulfonic acid	68259-12-1	9	
PFDS	Perfluorodecanesulfonic acid	2806-15-7	10	
Perfluoroether carboxylic acids (PFECA)				
PFMOAA	Perfluoro-2-methoxyacetic acid	674-13-5	4	
PEPA	Perfluoro-2-ethoxypropanoic acid	267239-61-2	5	
PFO3OA	Perfluoro-3,5,7-trioxaoctanoic acid	39492-89-2	5	
Gen-X	Perfluoro-2-propoxypropanoic acid	13252-13-6	6	X
PFO4DA	Perfluoro-3,5,7,9-butaoxadecanoic acid	39492-90-5	6	
PFO5DoDA	Perfluoro-3,5,7,9,11-pentaoxadodecanoic acid	39492-91-6	7	
Nadona	4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	9	
Perfluoroether sulfonic acids (PFESA)				
PS Acid	Perfluoro-3,6-dioxa-4-methyl-7-octene-1-sulfonic acid	29311-67-9	8	
Nafion by-product 2	Perfluoro-2-{[perfluoro-3-(perfluoroethoxy)-2-propanyl]oxy}ethanesulfonic acid	749836-20-2	9	
F53B Major	9-chlorohexadecafluoro-3-oxanonane-1-sulfonate	73606-19-6	10	
Perfluoroalkyl sulfonamides (PFSAm)				
FBSA	Perfluorobutane sulfonamide	30334-69-1	4	
FHxSA	Perfluorohexane sulfonamide	41997-13-1	6	
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid	2355-31-9	8	X
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid	2991-50-6	8	X
FOSA	Perfluorooctane sulfonamide	754-91-6	8	X
MeFOSA	N-Methylperfluorooctanesulfonamide	31506-32-8	8	X
F53B Minor	11-chloroeicosafluoro-3-oxaundecane-1-sulfonate	83329-89-9	12	

***Abbreviations**: Carbon Chain Length (CCL)

Analytical Standards Continued

Abbreviation	Analyte	CAS #	CCL*	Matching Heavy Labeled Standard
Fluorotelomer sulfonic acids (FTS)				
4:2 FTS	4:2 Fluorotelomer sulfonic acid	757124-72-4	6	X
6:2 FTS	6:2 Fluorotelomer sulfonic acid	27619-97-2	8	X
8:2 FTS	8:2 Fluorotelomer sulfonic acid	39108-34-4	10	X
10:2 FTS	10:2 Fluorotelomer sulfonic acid	120226-60-0	12	X
Zwitterions				
N-AP-FHxSA	N-(3-dimethylaminopropan-1-yl)perfluoro-1-hexane-sulfonamide	50598-28-2	6	
N-TAmP-FHxSA	N-[3-(perfluoro-1-hexanesulfonamido)propan-1-yl]-N,N,N-trimethylammonium	38850-51-0	6	
N-CMAmP-62FOSA (62 FTAB)	6:2 Fluorotelomer sulfonamide betaine	34455-29-3	8	

***Abbreviations**: Carbon Chain Length (CCL)

Heavy Labeled Standards

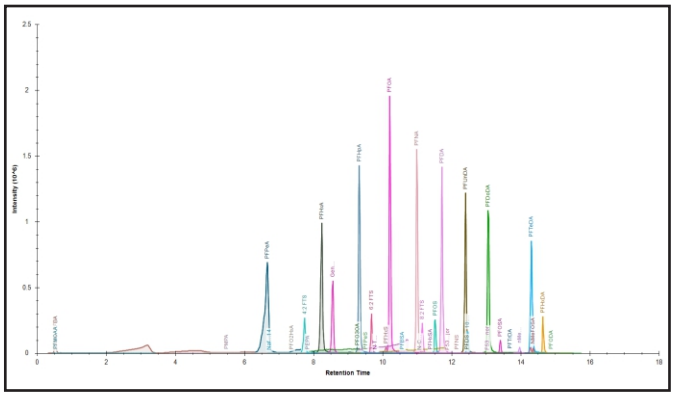
Abbreviation	Analyte	CAS #	Heavy Labels		CCL*
Perfluoroalkyl carboxylic acids (PFCA)			^{13}C*	^{2}H*	
PFBA	Perfluoro-n-[$^{13}C_3$]butanoic acid	375-22-4	3	0	4
PFPeA	Perfluoro-n-[$^{13}C_5$]pentanoic acid	2706-90-3	5	0	5
PFHxA	Perfluoro-n-[$^{13}C_6$]hexanoic acid	307-24-4	6	0	6
PFHpA	Perfluoro-n-[$^{13}C_7$]heptanoic acid	375-85-9	7	0	7
PFOA	Perfluoro-n-[$^{13}C_8$]octanoic acid	335-67-1	8	0	8
PFNA	Perfluoro-n-[$^{13}C_9$]nonanoic acid	375-95-1	9	0	9
PFDA	Perfluoro-n-[$^{13}C_9$]decanoic acid	335-76-2	9	0	10
PFUnDA	Perfluoro-n-[$^{13}C_9$]undecanoic acid	2058-94-8	9	0	11
PFDoDA	Perfluoro-n-[$^{13}C_{12}$]dodecanoic acid	307-55-1	12	0	12
PFTeDA	Perfluoro-n-[$^{13}C_3$]tetradecanoic acid	376-06-7	3	0	14
PFHxDA	Perfluoro-n-[1,2-$^{13}C_2$]hexadecanoic acid	67905-19-6	2	0	16
Perfluoroalkyl sulfonic acids (PFSA)					
PFBS	Perfluoro-n-[$^{13}C_4$]butanesulfonic acid	375-73-5	4	0	4
PFHxS	Perfluoro-n-[$^{13}C_6$]hexanesulfonic acid	355-46-4	6	0	6
PFOS	Sodium perfluoro-1-[$^{13}C_8$]octanesulfonate	1763-23-1	8	0	8
Perfluoroether carboxylic acids (PFECA)					
Gen-X	Perfluoro-n-[1,2,3-$^{13}C_3$]-2-propoxypropanoic acid	13252-13-6	3	0	6
Perfluoroalkyl sulfonamides (PFSAm)					
NMeFOSAA	N-ethyl-$^{2}H_3$-perfluoro-1-octanesulfonamidoacetic acid	2355-31-9	0	3	8
NEtFOSAA	N-ethyl-$^{2}H_5$-perfluoro-1-octanesulfonamidoacetic acid	2991-50-6	0	5	8
MeFOSA	N-Methyl-$^{2}H_3$-perfluorooctanesulfonamide	31506-32-8	0	3	8
FOSA	Perfluoro-n-[$^{13}C_8$]octanesulfonamide	754-91-6	8	0	8
Fluorotelomer sulfonic acids (FTS)					
4:2 FTS	1H,1H,2H,2H-Perfluorohexane sulfonate-Na salt (1,2-$^{13}C_2$/$^{2}H_4$)	757124-72-4	2	4	6
6:2 FTS	1H,1H,2H,2H-Perfluorooctane sulfonate-Na salt (1,2-$^{13}C_2$/$^{2}H_4$)	27619-97-2	2	4	8
8:2 FTS	1H,1H,2H,2H-Perfluorodecane sulfonate-Na salt (1,2-$^{13}C_2$/$^{2}H_4$)	39108-34-4	2	4	10
10:2 FTS	1H,1H,2H,2H-Perfluorododecane sulfonate-Na salt (1,2-$^{13}C_2$/$^{2}H_4$)	120226-60-0	2	4	12

***Abbreviations**: Carbon Chain Length (CCL), Heavy Carbon (^{13}C), Deuterium (^{2}H)

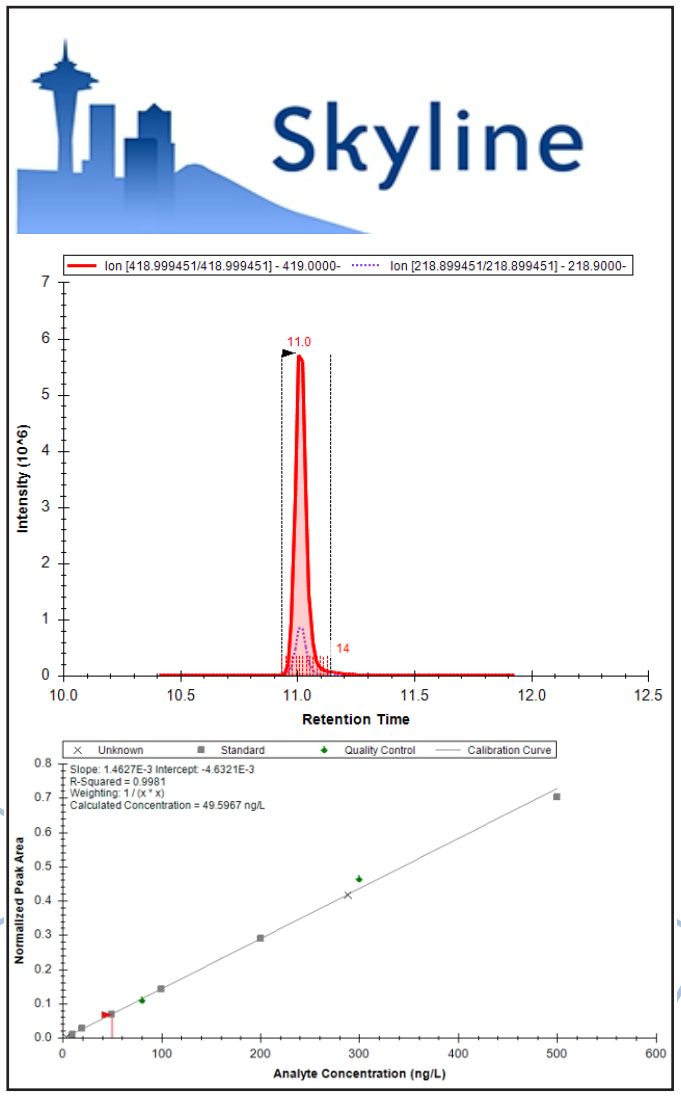
Notes: The decarboxylated form of GenX is used in the analytical method, which has 2 heavy carbons instead of the 3 in the intact form.

LC-MS Method

Our analytical method utilizes a 20 minute chromatographic gradient and relies on a 1290 Agilent LC system coupled to a 6495c Agilent QQQ. We achieve excellent chromotography by using a Kinetex F5 100 Å analytical column (2.1×100 mm; Phenomenex, Torrance, CA). The method was validated in neat solvents (i.e., water and methanol), roughly in accordance with guidance detailed in EPA Method 537.1. The minimum reporting limit (MRL) was determined as is detailed in this same method. This method was adapted from our paper, [Enders, Jeffrey R., et al. Rapid Communications in Mass Spectrometry, 2022 Mar 11:e9295](#).



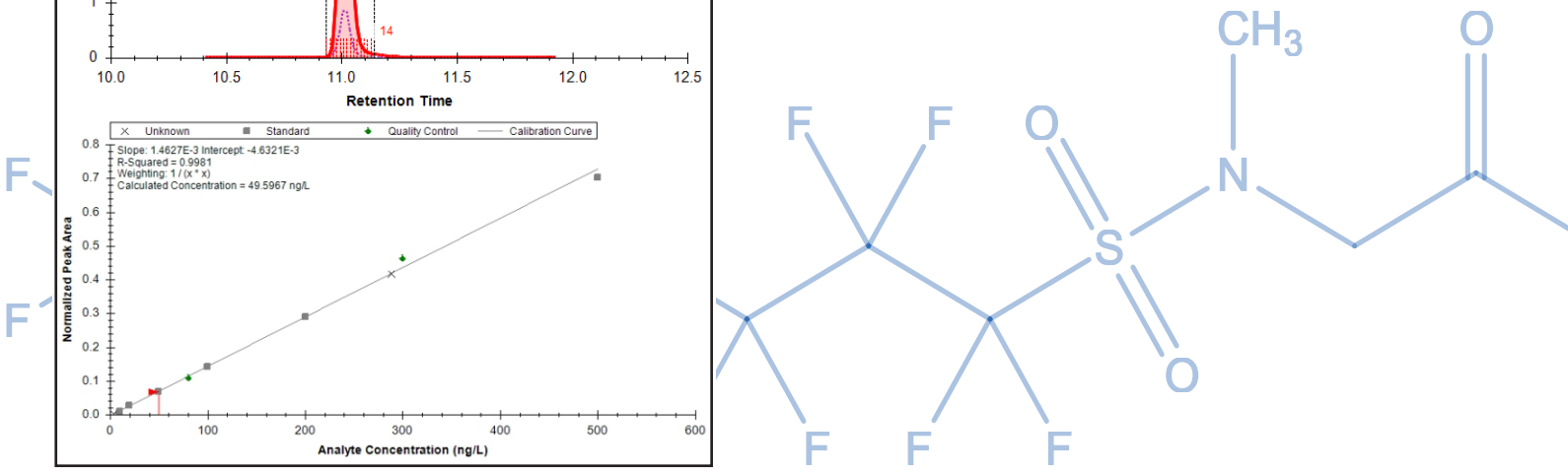
In addition to our validated analytical method, we also employ quality control checks suggested in the DoD Quality Systems Manual version 5.3. This includes but is not limited to method blanks, instrument blanks, and continuing calibration verification.



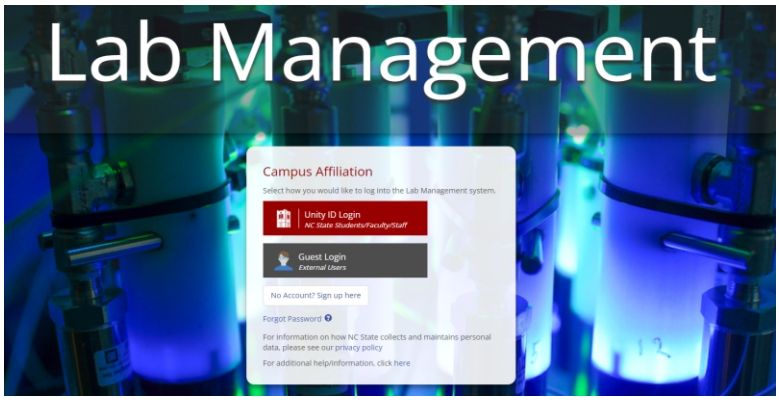
Data Analysis Method

We utilize the open-source software platform, Skyline. This software is a freely-available Windows client application that can analyze multiple types of mass spectrometry data, including Multiple Reaction Monitoring (MRM) data that is produced from a QQQ experiment. By using open-source software, we can directly share raw data with clients which empowers them to have a more active role in the data analysis process.

We can also provide training and expertise to clients that are interested in learning this software and type of data analysis.



How to Submit Your Samples



Interested in submitting samples to METRIC for analysis?

Please use go to https://labs.ncsu.edu/ to access our project management portal. Once there, if you are affiliated with North Carolina State University select the red button and use your Unity ID login information. If you are not affiliated with NCSU, create an account and use the guest login option. Once the consultation form has been submitted, a METRIC scientist will reach out to you to schedule a meeting to discuss your project goals and needs. Following the consultation meeting, you will be provided with an estimated quote to complete your project and a potential timeline for analysis. After that, you must set up a financial agreement with METRIC before samples can be accepted and the project started.

Interested In PFAS Compounds Not In Our panel?

Additional PFAS panels can be developed at our current method development rate. Method validation is available but incurs an additional cost. Please submit a consultation request in order to receive a quote with the current rates.

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https://research.ncsu.edu/metric/


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