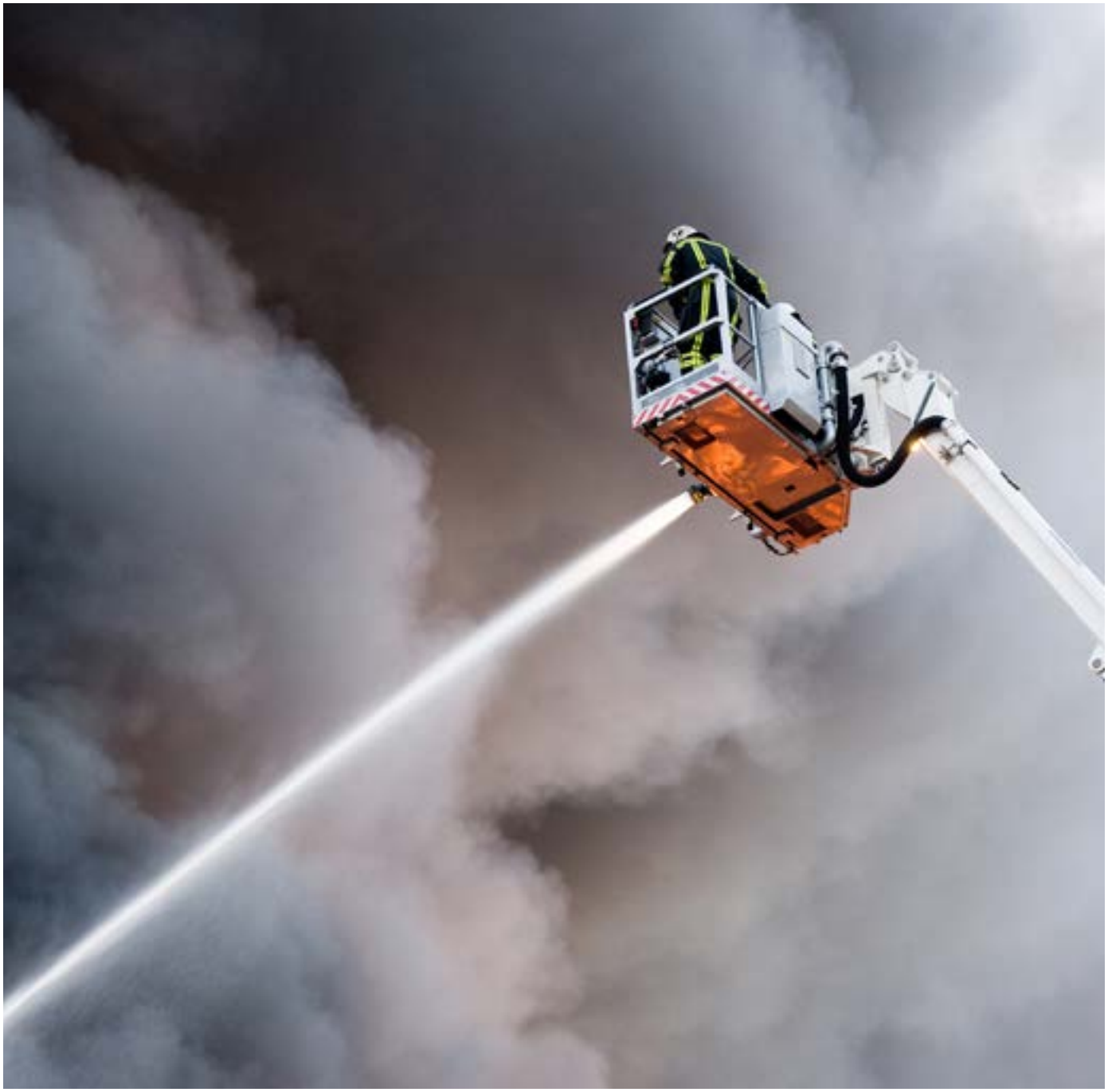


PFAS USER GUIDE

SGS

ANALYSES OF PER- AND POLYFLUORO ALKYL SUBSTANCES (PFAS) BY LC-MS/MS

WHAT ARE PFAS COMPOUNDS?

Per- and Polyfluoroalkyl Substances (PFAS) are classified as contaminants of emerging concern (CECs) based on increasing environmental and health concerns and consequent developing regulatory standards. Comprising a class of over 3,000 identified fluorinated compounds; they are used in the manufacture of many products such as PTFE (polytetrafluorethylene), textile coatings, firefighting foams, semi-conductors, paper and packaging coating additives, cleaning products, pesticides and metal plating process agents. The C-F bond is the strongest known in organic chemistry, making PFAS persistent in the environment. Longer chain PFAS are bioaccumulative as well. Key PFAS classes of concern include perfluoroalkyl carboxylic acids (PFCAs) such as PFOA, and perfluoroalkyl sulfonic acids (PFSAs) such as PFOS. Many PFAS will transform in the environment or via biological processes to form PFCAs or PFSAs.

There are no federal drinking water standards established for PFAS substances. However, in 2016, the EPA released drinking water health advisories of 70 parts per trillion for the sum of PFOS and PFOA to protect Americans from adverse health effects caused over a lifetime of exposure. Other countries, and select U.S. states have implemented regulations for a broader group of PFAS and the development of regulatory guidance is on-going.

BENEFITS OF SERVICE

As an emerging contaminant requiring evolving analytical methods, it is important that you get the highest degree of positive identification and accurate quantification. Analytical methods must be rugged and use defined best practices updated to reflect current understanding. SGS provides you industry leading testing experience over 16 years and more than 80,000 processed PFAS samples. SGS has multiple facilities in North America with broad accreditation scope including DoD, NELAP, and ISO17025.

We support your PFAS needs by:

- ANALYSIS of PFAS compounds of concern with the widest range of PFAS analytes and matrices available commercially
- INSTRUMENTAL CAPACITY to address growing market demands for volume and turn-around-time with our network of 12 LC/MS/MS instruments available for PFAS analysis
- TOP (Total Oxidizable Precursor) analysis - providing you comprehensive information on unknown precursors at your site
- METHOD DEVELOPMENT - adapting to changing analytical needs. PFAS analytical methodologies and regulations are in a state of rapid transition. SGS AXYS is at the forefront of these changes, through collaboration with leading technical and regulatory groups. As the PFAS analytical requirements change, SGS helps you meet your evolving PFAS data needs.

SGS has a wide variety of analytical options to support many and varied PFAS studies. Your SGS representative can assist you to determine the right service for your needs.

TOTAL OXIDIZIABLE PRECURSORS (TOPS)

TOP is an analytical procedure for transforming PFAS Precursors in a sample to measurable perfluorinated carboxylic acids (C4-C14), and is used to estimate potential PFCA contributions from unknown precursors. TOP uses persulfate-mediated hydroxyl radical oxidation to convert precursors to terminal PFCAs. The analysis may be applied with pre- and post-conversion measurements. The measured increase in PFCAs in the post-conversion analysis compared to pre-conversion values, represents a measure of the potential precursors in the sample. This data may be useful to clients concerned with studying overall PFAS in specific environments/sites, and to provide comprehensive assessments of remediation success.

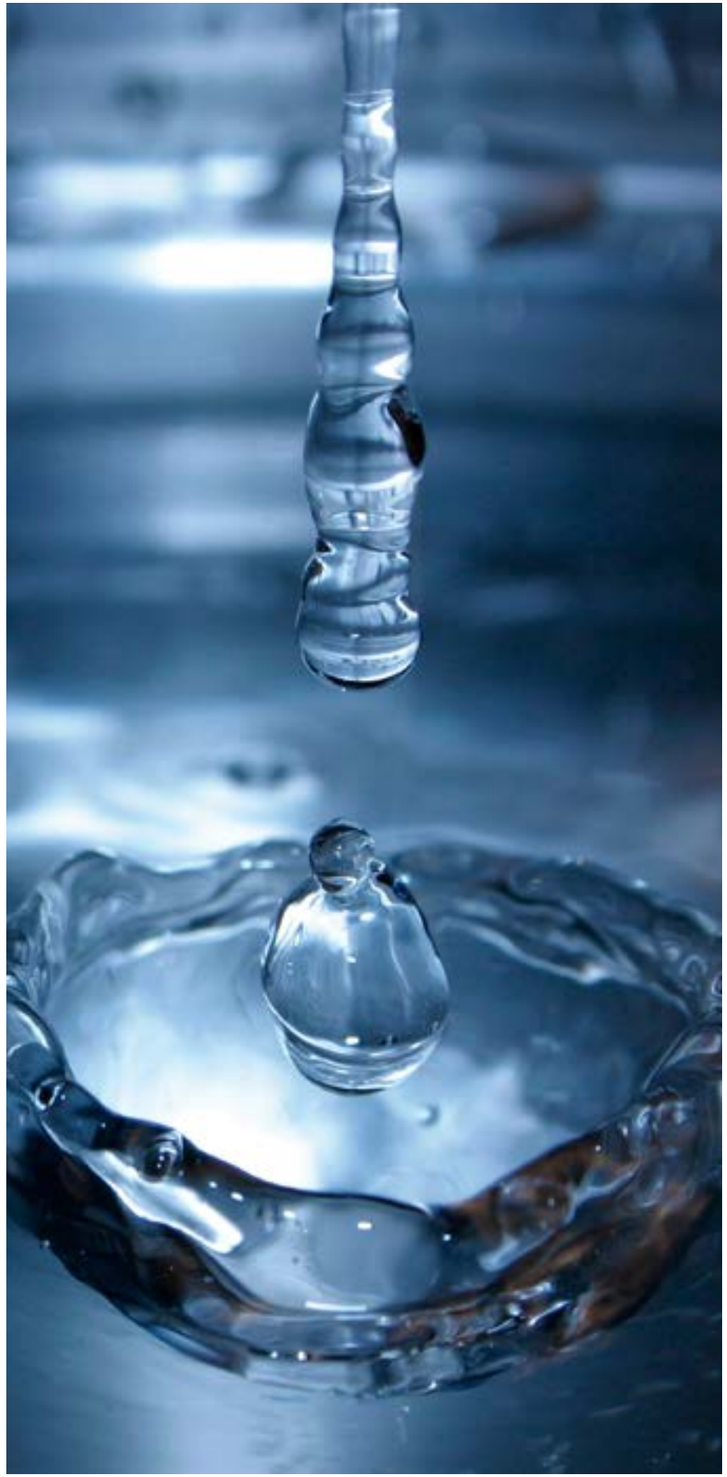
CONTINUED COMPETITIVE ADVANTAGE

Our unrivalled analytical experience, capabilities and capacity offer you the best choice for your PFAS testing needs.

Consequently, SGS is the first choice for many government agencies, consultants and EHS managers. Our continuous improvement and quality control practices ensure comprehensive, current and defensible data.

Our PFAS Analyses include:

- A wide range of matrices to analyze 24 - 33 PFAS compounds in water, soil, sediments, biosolids and tissues/ biofluids.
- Specific analyte lists applicable to air, biological tissue and serum are available
- Specialized tests for precursors such as PAPs, diPAPs, FTCAs, FTUCAs etc, and for isomer speciation.
- Use of isotope dilution/internal standard methods in all matrices except prescriptive EPA 537 drinking water analysis
- Best in class reporting limits for low level PFAS work
- 8 dedicated LC/MS/MS instruments specifically for PFAS analysis in our network
- Technical expertise with more than 30 years of analytical experience and over 80,000 samples processed for PFAS
- Multiple accreditations including DoD, ELAP/TNI and ISO17025
- Demonstrated analytical proficiency demonstrated through regular PE studies and worldwide inter-calibration studies
- The most experienced technical assistance available for SGS clients



PFAS ANALYTES

ANALYTE	ACRONYM	CAS #	REPORT LISTS*										CERTS	
			PFOA PFOS GENX	UCMR3 List	EPA 537 List	EPA 537.1 List	NH Short List	NH Long List	TCEQ List	NY List	MI List	QSM 5.1 "List"	DOD ELAP	FL NELAC
PERFLUOROALKYL CARBOXYLIC ACIDS														
Perfluorobutanoic acid	PFBA	375-22-4					X	X	X	X	X	X	X	X
Perfluoropentanoic acid	PFPeA	2706-90-3					X	X	X	X	X	X	X	X
Perfluorohexanoic acid	PFHxA	307-24-4			X	X	X	X	X	X	X	X	X	X
Perfluoroheptanoic acid	PFHpA	375-85-9		X	X	X	X	X	X	X	X	X	X	X
Perfluorooctanoic acid	PFOA	335-67-1	X	X	X	X	X	X	X	X	X	X	X	X
Perfluorononanoic acid	PFNA	375-95-1		X	X	X	X	X	X	X	X	X	X	X
Perfluorodecanoic acid	PFDA	335-76-2			X	X		X	X	X	X	X	X	X
Perfluoroundecanoic acid	PFUnDA or PFUnA	2058-94-8			X	X		X	X	X	X	X	X	X
Perfluorododecanoic acid	PFDoDA or PFDoA	307-55-1			X	X		X	X	X	X	X	X	X
Perfluorotridecanoic acid	PFTrDA	72629-94-8			X	X		X	X	X	X	X	X	X
Perfluorotetradecanoic acid	PFTeDA	376-06-7			X	X		X	X	X	X	X	X	X
PERFLUOROALKYL SULFONIC ACIDS														
Perfluorobutanesulfonic acid	PFBS	375-73-5		X	X	X	X	X	X	X	X	X	X	X
Perfluoropentanesulfonic acid	PFPeS	2706-91-4									X	X	X	X
Perfluorohexanesulfonic acid	PFHxS	355-46-4		X	X	X	X	X	X	X	X	X	X	X
Perfluoroheptanesulfonic acid	PFHpS	375-92-8						X		X	X	X	X	X
Perfluorooctanesulfonic acid	PFOS	1763-23-1	X	X	X	X	X	X	X	X	X	X	X	X
Perfluorononanesulfonic acid	PFNS	474511-07-4									X	X	X	X
Perfluorodecanesulfonic acid	PFDS	335-77-3						X	X	X	X	X	X	X
PERFLUOROOCTANE SULFONAMIDES														
Perfluorooctane sulfonamide	FOSA or PFOSA	754-91-6						X	X	X	X	X	X	X
N-Methyl perfluorooctane sulfonamide	N-MeFOSA	31506-32-8						X*					X	X
N-Ethyl perfluorooctane sulfonamide	N-EtFOSA	4151-50-2						X*					X	X
PERFLUOROOCTANE SULFONAMIDO ACETIC ACIDS														
N-Methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9			X	X				X	X	X	X	X
N-Ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6			X	X				X	X	X	X	X
PERFLUOROOCTANE SULFONAMIDO ETHANOLS														
N-Methyl perfluorooctane sulfonamidoethanol	N-MeFOSE	24448-09-7						X*					X	X
N-Ethyl perfluorooctane sulfonamidoethanol	N-EtFOSE	1691-99-2						X*					X	X
FLUOROTELOMER SULFONATES														
4:2 Fluorotelomer sulfonate	4:2 FTS	757124-72-4									X	X	X	X
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2						X		X	X	X	X	X
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4						X		X	X	X	X	X
PERFLUOROETHER CARBOXYLIC/SULFONIC ACIDS (PFECA/PFESA)														
Tetrafluoro-2-(heptafluoropropoxy)-propanoic acid (GenX)	HFPO-DA	13252-13-6	X			X		X						
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4				X								
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (F-53B Major)	9Cl-PF3ONS	756426-58-1				X								
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B Minor)	11Cl-PF3OUdS	763051-92-9				X								

Updated February 2019 | Custom report lists are available | *Available at SGS Axys & Wilmington labs

Please contact the laboratory for DL, LOD and LOQ

SAMPLING, SHIPPING & HANDLING

MATRIX	CONTAINER	PRESERVATIVE	MATRIX CODE ON COC	METHOD	NOTES
Soil, sediment	1x4 oz. HDPE	none	SO/SED	537 performance-based	
Groundwater, surface water, water	2x125 ml HDPE	none	GW/SW/WW	537 performance-based	
Groundwater, surface water, water needing lower RLs	2x250 ml HDPE	none	GW/SW/WW	537 performance-based	
Effluent	2x125 ml HDPE	TRIZMA	WW or EF	537 performance-based	Finished samples may need TRIZMA. TRIZMA is a buffer and removes free chlorine.
Drinking water	2x250 ml HDPE or PP	TRIZMA	DW	537	
Drinking water not for compliance	2x250 ml HDPE	TRIZMA	WW	537 performance-based	Matrix code DW triggers the lab to use method 537 so samples need to be logged as WW.
Air					contact Orlando lab for specifics
Tissue					contact SGS AXYS for specifics

SAMPLING GUIDELINES

When sampling for PFAS, use best practices prior to and during sampling to avoid residual PFAS on sampling equipment, cross contamination issues, and sample heterogeneity in high surfactant situations.Your SGS project manager can provide more information.

Using new nitrile gloves, collect the sample for PFAS first, prior to collecting samples for any other parameters into any other containers. This avoids contact with any other type of sample containers, bottles or package materials.

Do not place the sample bottle cap on any other surface when collecting the sample.

Avoid all contact with the inside of the sample bottle or its cap.

When the sample is collected and capped, place the sample bottle(s) in an individual sealed plastic bag (e.g. Ziploc) separate from all other sample parameter bottles. To facilitate whole container aqueous analysis, it may be necessary to provide samples of different bottle sizes.

DO NOT USE ITEMS	DO USE ITEMS
FIELD EQUIPMENT ITEMS	
No Teflon™ containing materials	High-density polyethylene (HDPE) and polypropylene (PP) materials
Do not store samples in containers made of LDPE materials	Acetate liners
No Teflon™ tubing	Silicon tubing
No waterproof field books	Loose paper (non-waterproof)
No plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
No Post-It Notes	Sharpies®, pens
No chemical (blue) ice packs	Regular ice
FIELD CLOTHING AND PPE ITEMS	**FIELD CLOTHING AND PPE ITEMS**
No new clothing or water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of synthetic or natural fibers (preferably cotton)
No clothing laundered using fabric softener	No fabric softener
No boots containing Gore-Tex™	Boots made with polyurethane and polyvinyl chloride (PVC)
No Tyvek®	Cotton Clothing
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	Sunscreens – All Organic Natural Sunscreen, that are “free” or “natural”. Check the label
	Insect Repellents – Natural preparations, DEET (check the label)
SAMPLE CONTAINERS ITEMS	**SAMPLE CONTAINERS ITEMS**
No LDPE or glass containers	HDPE or polypropylene
No Teflon™-lined caps	Lined or unlined HDPE or polypropylene caps
RAIN GEAR ITEMS	**RAIN GEAR ITEMS**
No waterproof or resistant rain gear	Tent that is only touched or moved prior to & following sampling activities
EQUIPMENT DECONTAMINATION ITEMS	**EQUIPMENT DECONTAMINATION ITEMS**
No Decon 90	Alconox® and/or Liquinox®
No water from an on-site well	Potable water from municipal drinking water supply
FOOD ITEMS	**FOOD ITEMS**
No food and drink, with exceptions noted on the right	Bottled water and hydration drinks (i.e. Gatorade® and Powerade®) to be brought and consumed only in the staging area

SHIPPING

Please include a fully completed chain-of-custody with each shipment. All sample documentation must be received for the samples to be accepted for analysis.

Samples are accepted Monday through Friday from 8 am – 5 pm. Samples are accepted Saturday delivery by Federal Express only. Other arrangements may be made as necessary.

ACCREDITATIONS SUMMARY

STATE	POTABLE WATER (SDWA)	NON-POTABLE WATER (CWA)	SOLID AND CHEMICAL MATERIALS (RCRA)	TISSUE	SERUM PLASMA
Alabama	O* W*	O* W* S*	O* S*		
Alaska	O W	O W	O		
Arizona	O	O* W* S*	O* S*		
Arkansas	O* W*	O* W* S*	O* S*		
California	O	O* W* S*	O* S*		
Colorado	O* W*	O* W* S*	O* S*		
Connecticut	O* W*	O* W* S*	O* S*		
Delaware		O* W* S*	O* S*		
DoD ELAP/ISO 17025	O W	O S	O S		
DoD QSM 5.1.1., Table b-15	NA	O S	O S		
Florida	O W	O S	O S	S	
Georgia	O* W*	O* W* S*	O* S*		
Hawaii	O* W*	O* W* S*	O* S*		
Idaho		O* W* S*	O*		
Illinois	O* W*	O* W* S*	O* S*		
Indiana	O* W*	O* W* S*	O* S*		
Iowa	O* W*	O* W* S*	O* S*		
Kansas	O	O* W* S*	O*		
Kentucky	O* W*	O* W* S*	O* S*		
Louisiana	O W	O	O		
Maine	W	W* S*			
Maryland	O* W*	O* W* S*	O* S*		
Massachusetts	O* W*	O* W* S*	O* S*		
Michigan	O* W*	O* W* S*	O* S*		
Minnesota	W	W S	S	S	
Mississippi	O* W*	O* W* S*	O* S*		
Missouri		O* W* S*	O* S*		
Montana	W	O* W* S*	O* S*		
Nebraska	O	O* W* S*	O*		
Nevada	O	O	O		
New Hampshire	O W	O W	O		
New Jersey	O W	O W S	O S	S	
New Mexico	O* W*	O* W* S*	O* S*		
New York	O W	O* W* S*	O* S*		
North Carolina	O* W*	O* W* S*	O* S*		
North Dakota	O W	O* W* S*	O* S*		
Ohio	W*				
Oklahoma	O* W*	O* W* S*	O* S*		
Oregon	O W	O	O		
Pennsylvania	O W	O* S*	O* S*		
Rhode Island	O*	O*	O* S*		
South Carolina	O* W*	O* W* S*	O* S*		
South Dakota	O* W*	O* W* S*	O* S*		
Tennessee		O* W* S*	O* S*		
Texas	O* W*	O* W* S*	O* S*		
Utah	O	O	O		
Vermont	O W	O* W* S*	O* S*		
Virginia	O* W*	O* W* S*	O* S*		
Washington	O W	O S	O S		
West Virginia		O* S*	O* S*		
Wisconsin	W*	W* S*			
Wyoming		O* W* S*	O* S*		
ISO/IEC 17025		S**	S	S	S

Updated March 2019

O Accreditation for Orlando, FL laboratory

S Accreditation for SGS Axys, Sidney, BC laboratory

W Accreditation for Wilmington, NC laboratory

* Accreditation not required under this state program, o is either not needed or is covered under another program (different matrix, NELAP, etc.). SGS is fully qualified to perform work for this program.

** The ISO 17025 accreditation granted by Canada does not distinguish between potable and non-potable water. In some Canada jurisdictions labs are required to have separate licensing; in addition to accreditation. SGS AXYS does not hold any accreditation, licensing, or recognition specific for drinking water.

NOTE SGS AXYS Analytical Services Ltd. is now certified in Total Oxidizable Precursors (TOP) in Canada. This is a new test that includes a measurement of sample PFAS content plus the potential of the sample to form PFAS from the presence of PFAS 'precursor' compounds.

GLOSSARY OF TERMS

AFFF	Aqueous film forming foams
ASTM	American Society for Testing and Materials
CWA	Clean Water Act
CoC	Contaminant of concern
CoPC	Contaminant of potential concern
DoD	Department of Defense
DW	Drinking water
EPA	Environmental Protection Agency
FFTA	Firefighting training area
FRBs	Field Reagent Blanks
FTS	Fluorotelomer sulfonate
GC/MS	Gas chromatography/mass spectroscopy
GW	Ground Water
HAs	Health advisories
HDPE	High-density polyethylene
HPLC	High performance liquid chromatography
HRMS	High resolution mass spectrometry
ID	Isotope Dilution
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LC-MS/MS	Liquid chromatography tandem mass spectrometry
LDPE	Low-density polyethylene
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
MS	Matrix spike
MSD	Matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
ng/l	nanogram/liter
NPDES	National Pollution Discharge Elimination System
PAH	Polynuclear aromatic hydrocarbon
PE	Polyethylene
PFAS	Perfluoroalkyl and polyfluoroalkyl substance(s)
PFCs	Perluorinated compounds
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PHA	Provisional health advisory
PP	Polypropylene
PPE	Personal protective equipment
ppm	parts per million
ppt	parts per trillion
PTFE	Polytetrafluoroethylene
QA/QC	Quality Assurance/Quality Control
QSM	Quality systems manual
RCRA	Resource Conservation and Recovery Act
RL	Reporting limit
SDWA	Safe Drinking Water Act
SPE	Solid phase extraction
SW	Solid waste
TOP	Total Oxidizable Precursor
ug/l	microgram per liter

PFAS FREE DRILLING

SGS's North American Drilling Division has over 30 years of experience with more than 6,500 completed projects within the United States and the U.S. Virgin Islands. Our expansive, diverse fleet of drills ranges from the smallest Geoprobe 420M up to full size Sonic, Air Rotary, Mud Rotary, Dual Rotary and Hollow-Stem rigs.

We are setting standards of excellence in the drilling industry by proudly offering certified PFAS-Free Drilling. All drilling lubricants, consumables, down-hole rod/augers and bits as well as our on-site water supply well have been tested and are certified PFAS-free by SGS. In addition, our staff has practical field experience with PFAS investigation/characterization jobs. We are well versed in preparation requirements to prevent interference from our activities on your project.

These measures are incomparable in the industry and ensure reliably sampled, representative and defensible test results.

NORTH AMERICA PFAS BY FACILITY

ORLANDO, FL USA LABORATORY

- Full Service Regulatory Analysis
- PFAS in Drinking Water by EPA 537 rev. 1.1
- PFAS in Groundwater, NPG and Solids by isotope dilution (ID)
- DoD QSM 5.1 / NELAP / ISO 17025 accredited
- State accreditations for DW, NPW, and Solids where available (see table)

WILMINGTON, NC, USA LABORTAORY

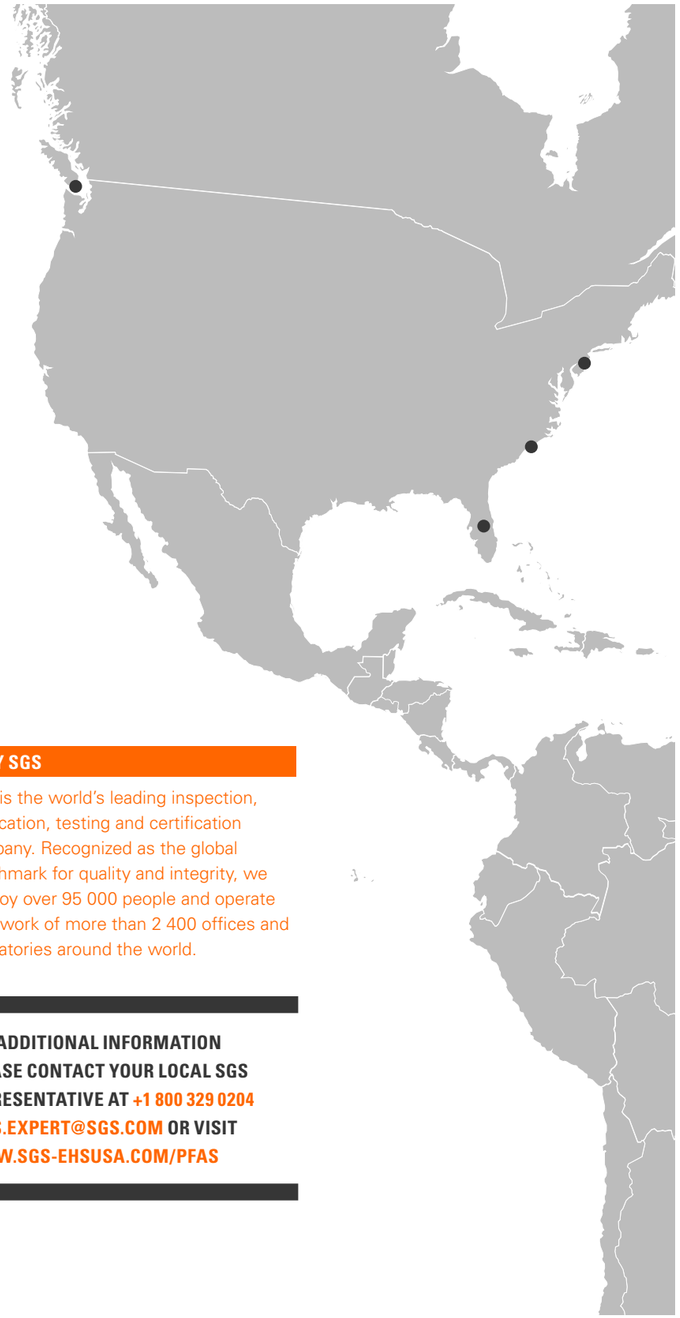
- HRMS Specialty (Dioxin/Furans, PCB Congeners, HRMS PAHs, HRMS Pesticides)
- Source Evaluation, Contaminated-Sites and NPDES analyses
- PFAS in Drinking Water, Water and Solids by internal standard approaches
- DoD QSM 5.1 / NELAP / ISO 17025 accredited

SGS AXYS, SIDNEY, BC, CANADA LABORATORY

- HRMS, LC-MS/MS, GC-MS trace snd ultra-trace, all matrices excluding DW
- PFAS in Water, Solids, Tissue, Serum, Method Development (multiple target analyte methods)
- DoD QSM 5.1 / NELAP / ISO 17025 accredited
- Also offers other PFAS analysis (such as polyfluorinated phosphorous compounds, extended precursor list)
- TOP (aqueous, solids)
- AFFF products and manufacturing intermediates

WEST CREEK, NJ, USA DRILLING

- United States, Virgin Islands
- Sampling for PFAS in Drinking Water, Water and Solids
- Certified PFAS Free Drilling



WHY SGS

SGS is the world's leading inspection, verification, testing and certification company. Recognized as the global benchmark for quality and integrity, we employ over 95 000 people and operate a network of more than 2 400 offices and laboratories around the world.

FOR ADDITIONAL INFORMATION PLEASE CONTACT YOUR LOCAL SGS REPRESENTATIVE AT +1 800 329 0204 PFAS.EXPERT@SGS.COM OR VISIT WWW.SGS-EHSUSA.COM/PFAS

WWW.SGS.COM

WHEN YOU NEED TO BE SURE

SGS