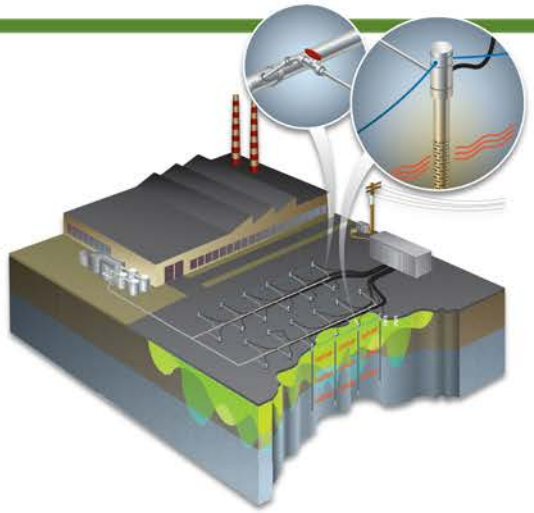
Defense Air Base

PFAS Soil Treatment



Report on Bench Test Thermal Remediation of PFAS Compounds

DATE
June 29, 2020

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The Netherlands
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Introduction

A defense base in the Netherlands contains soil impacted with per and polyfluoroalkyl substances (PFAS) at its fire brigade training center. The consultant for the base is evaluating options to remediate PFAS and has requested that parties demonstrate their abilities through bench testing using soil samples from the site. Approximately two cubic meters of soil was excavated near a former sprinkler system for use in the testing. A sample was subjected to sieve and moisture analysis and analysis of PFAS and soil organics by SYNLAB Analytics & Services B.V. The sieve analysis showed that the soil consisted of a fine to medium sand with 90 percent of particle sizes falling into the range of 0.1 to 1 millimeters. The moisture content of the sand was 5.2 percent and organic matter was less than 0.5 percent. Several PFAS were identified by analysis with the most prominent being perfluorooctanoic sulfonic acid (PFOS) at a concentration of 1,400 µg/kg.

HMVT/TRS collected 13.5 liters of soil for testing on May 8th. The samples were shipped to TRS and arrived on May 12, 2020 by Federal Express. A photograph of the soil is shown in **Figure 1** below.

Figure 1: Sand from the Site

The soil samples were subjected to testing between May 16 and June 7, 2020. Control samples and treated samples were sent to Battelle's accredited PFAS laboratory for PFAS analysis and to Pace Analytical for analyses of soil organics. This report includes a description of the following:

- Description of Process
- Maturity of the Technology
- Bench Test Method and Procedure
- Results of Testing
- Scale-up Cost Projections
- Water Usage

Description of Process

It has been demonstrated that low temperature thermal desorption can remove greater than 99.99 percent of PFAS from soil when performed at a temperature that degrades the organic material in the soil (Crownover et al., 2019). Greater than 99.99 percent removal of PFAS has been achieved by heating and holding the soil at a temperature of 400°C for 7 to 14 days. The carbon to fluoride chemical bond in PFAS generally requires temperatures in excess of 400°C to breakdown (Madorsky et al., 1953; Marhevka, 1982; Muhammad, 2017). The PFAS removal mechanism from soil occurs primarily by volatilization. PFAS vapors are captured and treated using carbon, scrubbers or thermal destruction.

Maturity of the Technology

TRS has been developing this thermal remediation technique for PFAS removal since 2014. Our initial testing began with development of vapor-liquid equilibrium relationships for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) to understand how these most prominent PFAS compounds would volatilize as moisture was boiled from soil during treatment. The test involved the preparation of a 1-liter solution of distilled water with a starting concentration of 120 µg/L PFOA and 300 µg/L PFOS. The solution was placed into a 2-liter Erlenmeyer flask and slowly boiled. The steam produced from the boil-down was passed through an ice pack condenser and the condensate was collected for analysis at different intervals during the boil-down. The test results showed a vapor-liquid equilibrium constant in the range of 0.0005 to 0.00062 for PFOA and a vapor-liquid equilibrium constant in the range of 0.002 to 0.0047 for PFOS. In other words, if the entire volume of water were to be boiled down, only about 0.05% of the PFOA and 0.4% of the PFOS would be removed from the system during boiling. This confirmed that a very large percentage of the PFAS would remain adsorbed to the soil as moisture is boiled from the soil.

In subsequent testing, soils impacted with PFAS were subjected to temperatures in the range of 220 to 400 ˚C. The testing showed that little to no PFAS removal occurred from the soils at a temperature of 220˚C, despite that many of the PFAS had boiling point temperatures less than 220°C. This indicated that the PFAS may be experiencing some chemisorption to the soil rather than simple physical desorption. When the soil was heated to 350°C to 400°C, greater than 99 percent of the PFAS was removed from the soil. It was noted that the efficient removal of PFAS coincided with the change in coloration of the soil. Based on these findings, TRS surmised that efficient removal of PFAS from the soil is directly related to the destruction of soil organics to which there may be chemisorptive bonds.

A field demonstration was performed involving construction of a 6-foot by 6-foot containment cell constructed of concrete block. The cell was filled with 11,000 pounds of soil for the test. When the cell was completed, TRS installed steel casings through the top of the cell and heaters were installed into each casing. Heating of the cell was performed at an average power of approximately 3.3 kW over a period of 79 heating days, during which the soil temperature was increased to 400˚C. When the soils were removed from the cell, a distinct change in coloration of the soil was noted, thus indicating destruction of organic material from the soil during heating. The proof of concept field demonstration thus showed that the TRS heaters are fully capable of heating soils to the temperatures required for destruction of organic material and thermal desorption of PFAS from soils.

In the bench-scale testing already completed by TRS, nearly complete removal of PFAS from soils has already been demonstrated. Ten PFAS were originally identified in the soil being tested at concentrations described in **Table 1** below, with PFOS being the compound of highest concentration. In heating the samples to 400 ˚C, all PFAS were removed to below detection limits with the exception of a possible detection of perfluorobutanoic acid at a concentration below the reporting limit. The results of the testing showed that very high removal efficiencies in excess of 99.9 percent can be achieved which demonstrate that TRS's heating technology can clearly meet the targeted treatment values, as summarized below in **Table 1**.

Table 1: Prior Bench Test Results

Compound	Abbreviation	Untreated (ug/kg)	400 C (ug/kg)	% removed at 400 C
Perfluorobutanoic acid	PFBA	91	0.049 J	>99.999%
Perfluoropentanoic acid	PFPeA	100	<0.077	>99.999%
Perfluorobutanesulfonic acid	PFBS	41	<0.025	>99.999%
Perfluorohexanoic acid	PFHxA	200	<0.042	>99.999%
Perfluoroheptanoic acid	PFHpA	27	<0.029	>99.998%
Perfluorohexanesulfonice acid	PFHxS	1600	<0.031	>99.999%
Perfluorooctanoic acid	PFOA	64	<0.086	>99.865%
Perfluorononanoic acid	PFNA	16	<0.036	>99.997%
Perfluorooctanesulfonic acid	PFOS	21000	<0.2	>99.999%
Perfluorodecanesulfonic acid	PFDS	48	<0.039	>99.999%

Bench Test Method and Procedure

Soil from the site was separated into 250-gram (g) samples for testing. One sample was reserved as a control group to compare against the baseline PFAS concentrations reported by SYNLAB Analytics & Services B.V . A second sample was reserved for the heating test. The sample for heating was placed inside a 1-liter galvanized steel container. The container lid was modified with brass compression fittings sized to secure 3.2-millimeter diameter copper tubing to the container to allow vapors to pass through the soil during heating as shown in **Figures 2 and 3**. The container was placed inside a temperature-controlled oven where the temperature was maintained at 400^{o}C for 14 days as shown in **Figure 4**. Vapors from inside the container were removed by a vacuum pump with a moisture knock-out vessel as shown in **Figure 5.**

Figure 3: Soil Heating Container

Figure 4: Air Inlet Tubing

Figure 5: Temperature Regulating Oven

Figure 6: Vacuum Pump and Moisture Knock-Out

A second test was conducted with the soil held at a temperature of 350^{o}C for a period of seven days to evaluate if the process could be performed at lower temperature and for less time for potential savings in cost. For this test, a cylinder of coconut shell, granular activated carbon was placed in-line between the oven and the vacuum pump to evaluate if the granular carbon was effective in adsorbing the PFAS. A photograph of the carbon trap is shown in **Figure 6**.

Figure 7: Activated Carbon Filter

When the heating tests were completed, the soils were cooled and then transferred into sample jars for analyses. Three 4-ounce samples of soil were collected from the control group, the 350°C test and the 400°C test for analysis of total organic carbon (TOC) by ASTM 2974 – Method C. One sample of soil was collected from the control group, the 350°C test and the 400°C test for analysis of PFAS compounds. The samples for TOC analyses were shipped to Pace Analytical Laboratories in Lebanon, Tennessee. A copy of the chain-of-custody is included in **Appendix A**. The samples for PFAS analyses were shipped to Battelle Laboratories in Norwell, Massachussetts which is an ELAP/NELAP accredited laboratory for PFAS analyses. The samples were shipped inside "PFAS-free" sample containers for analysis by Method 537. A copy of the chain-of-custory is included in **Appendix A**. Both sets of samples were shipped on June 9, 2020 by Federal Express for next day delivery.

Results of Testing

The soil was notably different in appearance after thermal treatment. An example of the difference in coloration of the samples before and after heating is shown in **Figure 7**. The change in coloration is due in large part to the combustion of organic material in the soil, which plays a role in the adsorption of PFAS to the soil.

Figure 7: Soil before and after thermal treatment

Analytical data from the PFAS testing are attached in **Appendix B**. Analytical data from the TOC testing are attached in **Appendix C**. The data show the control sample contained 1,499.06 ng/g of total PFAS detected and 0.324% fractional organic matter (fractional organic carbon of 0.00190 g C/g soil) prior to heating. The PFAS consisted of slightly more than 96% PFOS with the remaining PFAS consisting primarily of other sulfonated PFAS. Because the PFAS was predominantly PFOS, the evaluation of treatment effectiveness will be focused on this compound which had an initial concentration of 1,441.55 ng/g.

In the sample heated to 350°C for seven days of heating, the concentration of PFOS was reduced from 1,441.55 ng/g to less than the limits of detection, which were 1.92 ng/g and 2.19 ng/g in samples tested in duplicate. One sample indicated the presence of PFOS below the limits of detection at an estimated concentration of 0.98 ng/g. This would represent greater than a 99.9% reduction of PFOS in the soil. The organic carbon content of the soil was reduced by approximately 80% from an average 0.324% to an average of 0.0643% from the heating.

PFOS in the sample heated at 400°C for 14 days was reduced from 1,441.55 ng/g to less than the 2.03 ng/g limit of detection, again representing a 99.9% reduction in PFOS. The organic content of the soil was reduced by approximately 87% from an average of 0.324% to an average of 0.0411%. The efficiency of treatment at 350°C for 7 days appeared to be just as effective as treatment at 400°C for 14 days.

A variety of smaller chain PFAS were adsorbed onto the activated carbon during heating, thus indicating that a fraction of the PFOS may have undergone degradation reactions during heating. If PFOS were to undergo a desulfonation reaction, its desulfonation product would most likely be 1H-perfluorooctane.

This compound would be adsorbed to the activated carbon but would likely not be detected in the analyses since it is not part of the standard PFAS analyte list.

Scale-up Cost Projections

The primary factors that impact the cost of full-scale thermal treatment of PFAS include:

- The volume of soil being treated
- If the treatment occurs in-situ or ex-situ, and
- The moisture content of the soil prior to treatment

There is capital cost associated with setting up equipment to heat the soil and a treatment process to recover and treat the PFAS vapors that makes it more economical on a cost per cubic meter basis to treat larger volumes of soil. Soil volumes less than 10,000 cubic meters become increasingly more expensive to treat because the price largely reflects capital costs. For large volumes of soil, the price becomes less expensive because the capital cost becomes a less substantial portion of the total cost of treatment.

Another important factor is whether the soil needs to be treated in-situ or ex-situ. For in-situ treatment, the soil does not need to be excavated, transported and compacted prior to treatment and special cells do not need to be constructed to hold the soils. Furthermore, in-situ treatment does not require removal and movement of the soils after treatment. However, soils cannot be treated in-situ if the contamination is spread across only a very thin layer of soil near the surface or if the soils lie below the water table.

A large portion of the energy required to heat the soils is used to boil off the moisture from the soil. For example, a clay soil that contain 20 to 30 percent moisture wil require more energy to heat than a sand that only contains 4 to 6 percent moisture.

These factors will cause variability in anticipated pricing for treatment of PFAS from soils by thermal treatment, the largest variable being the volume of soil being treated. When models are run to evaluate the overall pricing for treatment using different scenarios for the above parameters, the models predict the pricing shown in **Figure 8**. The values in **Figure 8** are shown in U.S. dollars.

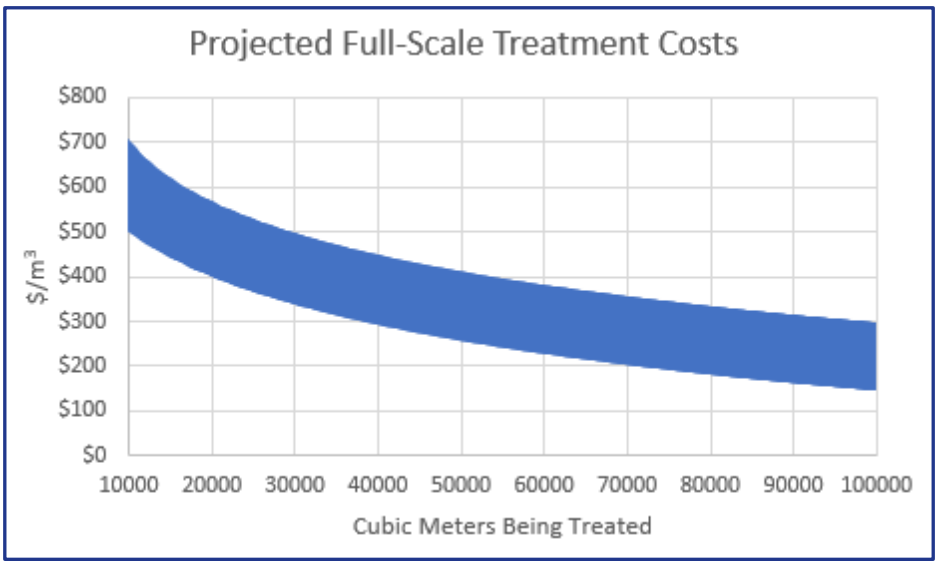

Figure 8: Treatment Costs vs Volume Treated

Water Usage

Unlike soil washing systems, thermal treatment of PFAS does not require that water be used in any portion of the process. The PFAS are heated to the point of volatilization, the vaporized PFAS are collected in the hot gases and are conveyed to a vapor treatment system. The vapor treatment system may consist of granular activated carbon, in which case no water is required to operate the vapor treatment. Other vapor treatment systems may require water for treatment of the vapors. For example, a thermal oxidation system may be used to convert the PFAS into hydrofluoric acid, followed by a sodium hydroxide scrubber to neutralize the hydrofluoric acid and convert it into sodium fluoride salt. This type of vapor treatment system might use between 5 to 10 liters per minute of makeup water.

Conclusions

The results of this testing showed that greater than a 99.9 percent reduction can be achieved for PFOS in soils at this site by heating and holding the soil at a temperature of 350^{o}C for a period of seven days.

References

Crownover, E.C. et al., *Perfluoroalkyl and polyfluoroalkyl substances thermal desorption evaluation*, Remediation, Vol. 29, pp 77-81 (2019).

Madorsky, S.L, *Thermal Degradation of Tetrfluoroethylene and Hydrofluoroethylene Polymers in a Vacuum*, Journal of Research of the National Bureau of Standards, Vol. 51, No. 6, pp. 327-333 (1953).

Marhevka, J.S. et al., *Generation of Perfluoroisobutylene Reference Sample and Determination by Gas Chromatography with Electron Capture and Flame Ionization Detection*, Analytical Chemistry, Vol. 54, pp 2607-2610 (December 1982).

Muhammad, S. et al., *PTFE-coated non-stick cookware and toxidity concerns: a perspective*, Environ. Sci. Pollut. Res., Vol. 24., pp 23436-23440 (2017).

APPENDIX A

BATTELLE LABORATORY RESULTS

TRS Group - PFAS in Solids
Project No 100105456-0063
PFAS by DoD QSM 5.3 Table B-15

SOLID

Batch 20-0645

Package DP-20-0559

Submitted to:
TRS Group
P.O. Box 737
Longview, WA 98632 USA

Submitted by:
Battelle Norwell Operations
141 Longwater Drive Suite 202
Norwell, MA 02061

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TRS Group - PFAS in Solids
Project No 100105456-0063
PFAS by DoD QSM 5.3 Table B-15

SOLID

Batch 20-0645

Package DP-20-0559

Submitted to:
TRS Group
P.O. Box 737
Longview, WA 98632 USA

NELAP Accreditation Number: E87856 (Florida Department of Health)
DoD-ELAP Accreditation Number: 91667

Submitted by:
Battelle Norwell Operations
141 Longwater Drive Suite 202
Norwell, MA 02061

Analyst Approval: Digitally signed by Denise Schumitz Date: 2020.06.16 14:15:05 -04'00'

QC Chemist Approval: Digitally signed by Ellyn M. Fitch Date: 2020.06.17 10:45:14 -04'00'

Project Manager Approval: Digitally signed by Jonathan Thorn Date: 2020.06.17 13:39:39 -04'00'

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TRS Group - PFAS in Solids
Project No 100105456-0063
PFAS by DoD QSM 5.3 Table B-15

SOLID

Batch 20-0645

Package DP-20-0559

1	***Work Plan*** Laboratory Work Plan, Addendums To Work Plan, Memos From Project Manager, Special Instructions, Chain-of-Custody Reports.	1
2	***Tables*** Analytical Data Tables, Qualifier Definitions.	17
3	***Miscellaneous Documentation*** Case Narrative, Miscellaneous Documentation Form, Quality Control Summary, Example Calculations, Internal Standard Recovery Report, Retention Time Window Report.	35
4	***Sample Preparation Records*** Sample Preparation Records, Dilution Worksheets, Standard Preparation Records, Certificates Of Analysis, GPC Check Report.	N/A
5	***Analytical Calibrations*** Analytical Sequence, Analytical Method, Tune Report, Initial Calibration, Pesticide Degradation Report, RF Summary, Calibration Verifications, Independent Calibration Verification Check.	N/A
6	***Analytical Data*** Raw Data Quantification Reports.	N/A
7	***Chromatograms*** Sample And Standard Chromatograms.	N/A
8	***Unused Data***	N/A

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Master Signature Page

Name (Printed)	Signature	Initials	Date
Jonathan Thorn		JRT	1/9/2020
Robert Lizotte, Jr.		BL	1.9.2020
Elyn M Fitch		EMF	1/9/2020
Carla Devine		CRD	1/9/2020
Denise Schumitz		DS	1/9/2020
Lauren Griffith		LMG	1.9.2020
Carrie P McCarthy		CPM	1/9/2020
Rich Restuccia		RR	1/9/2020
Sam Guimaraes		SAG	1/9/2020
Jordan Tower		JT	1/9/2020
Christie Usher		CU	1/9/2020
Kevin McInerney		KM	1/14/2020
Matt Schumitz		MDS	1/14/2020
Weidong Li		W.L	1/14/2020
Kayla Lamarre		KAL	1/14/2020
MUNAZ MUNTASIR		MM	01/14/2020
Kristen Nichols		KN	01/14/2020
Kelsey Harnden		KH	01/30/2020
Kevin Bailey		KB	1/30/2020
Stephanie Schultz		SAS	1/30/2020

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Master Signature Page

Name (Printed)	Signature	Initials	Date
Chimieo Brown		CB	01/30/20
Ryan Kelly		RK	01/30/20
KAREN HYPPOLITE		K.H.	01/31/20
Gail DeRuzzo		GD	01/31/2020
Tracy Stenner			1/31/2020
Ashley Wellington		AW	1131/2020
Daniel Cooney		DAC	1/31/2020
Peter Demers		PD	1/31/2020
Zachary Willenberg			2/3/2020

Sample Summary

Client: TRS Group
SDG: 20-0645
Project/Site: PFAS in Solids
CTO: N/A

Lab Sample ID	Client Sample ID	Matrix	Collection Date	Receipt Date
CZ158PB-FS	Procedural Blank	SEDIMENT	6/11/2020	6/11/2020
CZ159LCS-FS	180507-02: Ottawa Sand	SEDIMENT	6/11/2020	6/11/2020
H6078-FS	Control	SOLID	5/31/2020	6/10/2020
H6079-FS	350 C	SOLID	6/7/2020	6/10/2020
H6079DUP-FS	350 C	SOLID	6/7/2020	6/10/2020
H6080-FS	400 C	SOLID	5/31/2020	6/10/2020
H6081-FS	Carbon	SOLID	6/7/2020	6/10/2020

Work Plan

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WORK/QUALITY ASSURANCE PROJECT PLAN

1.0 GENERAL PROJECT INFORMATION

Project Title:	TRS Group - PFAS in Solids
Project Number:	100105456-0063
Client:	TRS Group P.O. Box 737 Longview, WA 98632 USA
Client Contact Information:	Emily Crownover Lead Engineer (360) 846-8963(V) NA ecrownover@thermalrs.com
Effective Date of QAPP:	6/10/2020
Version Number:	100105456-0063(S)-01
Project Manager:	Thorn, Jonathan
Laboratory Task Manager:	Thorn, Jonathan
Deliverable Due Date:	7/8/2020

2.0 SCOPE OF WORK

Overview:	Analysis of solid samples for PFAS
Matrix:	Soil/Sediment

2.1 TECHNICAL APPROACH

2.1.1 Sample Receipt, Storage, and Handling

The list of samples for this project plan are presented in Attachment 1.

Storage Directions:	Store refrigerated.
Sub_Sampling:	None
Procedures:	NA
Contact:	NA
Comment:	None.
Archiving:	Store excess samples for six months after delivery of final results. Notify client prior to disposal of samples.
Disposal:	Dispose of samples in appropriate waste stream.

2.1.2 Sample Preparation

None

Samples Expected:	Samples Per Batch:	Batches Expected:
4	20	1

Batch quality control samples are defined in Table 1.

Target samples are presented in Attachment 1.

Table 1: Quality Control Samples

Type:	*Description:*	*Count:*	*Rgt:*	*Reference:*	*Comment:*
PB	Laboratory control reagent blank.	1 per batch	--	NA	
LCS	Laboratory Control Sample	1 per batch	Yes	180507-02: Ottawa Sand Lot:1DJ0861	
QADU	Duplicate extraction and anlysis of a field sample.	1 per batch	--	NA	

2.1.3 Extraction/Preparation

2.1.3.1 Extraction

SOP No.-Rev: **5-370-10**

SOP Title: *Extraction of Poly and Perfluoroalkyl Substances from Environmental Matrices*

Sample Size: 2 g

SIS and LCS/MS Compounds: Defined in Table 2.

Deviations: None

Comments: None

Table 2: SIS and LCS/MS Spiking Level

Standard Type	Standard Contents		Spike Amount (ng)	Volume (uL)	Comment
PFAS - DoD High Level Labelled Extracted Internal Standards (SIS)	KZ76	SIS	~ 11.3 - 12.5 ng	125 uL	NA
PFAS - DoD Second Source LCS/MS	KZ79	LCS/MS	~ 50 ng	500 uL	NA

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Standard Type	Standard Contents	Spike Amount (ng)	Volume (uL)	Comment
Solution				

2.1.3.2 Cleanup

None.

RIS spiking levels are presented in Table 3.

Extract PIV (uL): 1000

Table 3: RIS Spiking Level

Standard Type	Standard Contents	Spike Amount (ng)	Volume (uL)	Comment
PFAS - DoD Internal Standard Spiking Solution	KZ78 RIS	~ 1.25 ng	125 uL	NA

2.1.4 Instrumental Analysis

The list of analytes along with data quality criteria are presented in Attachment 2.

1) SOP_No-Rev: **5-369-08**

SOP_Title: *Analysis of Perfluoroalkyl Substances in Environmental Samples by Liquid Chromatography and Tandem Mass Spectrometry (LC-MS/MS)*

Deviations: None

Comments: None

2.2. DELIVERABLES

Deliverables Due:	7/8/2020
LIMS Reports:	*No*
Histograms:	*No*
Excel Tables:	*No*
EICs:	*No*
Chromatograms:	*No*
EDDs:	*No*
Comments:	• Level 2 data package and Excel tables.

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3.0 QUALITY

The Method Quality Objectives are defined in Attachment 3.

4.0 ORGANIZATION AND COMMUNICATION

4.1 ORGANIZATION

The project team is defined in Table 4. Supervisors may make substitutions with Project Manager concurrence.

Table 4: Project Team and Roles

Staff Member	Role	Comment
Jonathan R. Thorn	Project Manager	NA
Ryan P. Kelly	Sample Preparation	NA
Stephanie A. Schultz	LC-MS/MS Analysis	NA
Matt D. Schumitz	Sample Custody	NA
Ellyn M. Fitch	Quality Control Officer	NA

4.2 COMMUNICATION

A kick-off meeting will be held to discuss project scope and goals.

5.0 SCHEDULE

The project schedule is presented in Table 5.

Table 5. Schedule of Laboratory Activities

Activity:	Start Date:	End Date:	TAT (days):	Comment:
Sample Receipt	06/10/2020	06/10/2020	0	NA
Sample Preparation	06/10/2020	06/17/2020	7	NA
Instrument Analysis	06/17/2020	06/26/2020	9	NA
Quality Control Review	06/26/2020	07/03/2020	7	NA

6.0 BUDGET

The labor budget for the analytical task is presented in Table 6.

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Table 6. Labor Budget (Laboratory Analytical Task)

Labor Activity:	Hours/ Batch:	Batches:	Total Hours:	Comment:
Sample Receipt	4	1	4	Based on set of 20 samples
Sample Preparation	9	1	9	NA
Instrument Analysis	14	1	14	NA
Quality Control Review	4	1	4	NA

7.0 STAFF DEVELOPMENT

None anticipated.

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Attachment 1: Target Samples

Shipment: **SHP-200610-02**

Status: Pending

Description: Soesterberg

Range: H6078-H6081

Comment: NA

No:	BDO Id:	Client Sample ID:	Collection Date:	Matrix:	Storage Facility: Location: No:	Comments:
1	H6078	Control	05/31/2020 1:30 pm	SOLID	F0117 (NA)	
2	H6079	350 C	06/07/2020 3:00 pm	SOLID	F0117 (NA)	
3	H6080	400 C	05/31/2020 1:30 pm	SOLID	F0117 (NA)	
4	H6081	Carbon	06/07/2020 3:00 pm	SOLID	F0117 (NA)	

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Attachment 2: Test Codes

Project Test Code Name:	Master_369B
SOP Reference:	5-369 - Analysis of Perfluoroalkyl Substances in Environmental Samples by Liquid Chromatography and Tandem Mass Spectrometry (LC-MS/MS)
Description:	PFAS by DoD QSM 5.3 Table B-15
Matrix:	S - Solid Samples, like soil or sediment, prepared and anlyzed under the same class of detection limits.
Detection Limit Study:	5-369
Instrument:	LC-MS/MS
MQO Criteria	Universal_LC
Standard Report:	Standard Result Report

Method Specific Reporting				Holding Times (days)		Data Flags	
Result Units:	ng/g	***Unit Conversion:***	(none)	***Sample:***	14	***DL_Flag:***	U
Weight Basis:	DRY	***Result Format:***	Fixed Digits	***Frozen:***	14	***RL_Flag:***	J
Standard Basis:	SIS	***# of Figures/Digits:***	2	***Extract:***	28	***PB_Flag:***	B
Oil Weight Basis:	No	***Oil Weight Source:***	Oil Weight			***DIL_Flag:***	D
U-Value Substition:	U-Flag=MD	***Histograms:***	No			***HT_Flag:***	T
ECD_Reporting:	No						

No:	Analyte:	Report Name:	Type	RIS	SIS	Hidden:	Graph:
1	Perfluoro-n-butanoic Acid	PFBA	T		13C4-PFBA	No	No
2	Perfluoro-n-pentanoic acid	PFPeA	T		13C5-PFPeA	No	No
3	Perfluoro-n-hexanoic acid	PFHxA	T		13C5-PFHxA	No	No
4	Perfluoro-n-heptanoic Acid	PFHpA	T		13C4-PFHpA	No	No
5	Perfluoro-n-octanoic Acid	PFOA	T		13C8-PFOA	No	No
6	Perfluorononanoic Acid	PFNA	T		13C9-PFNA	No	No
7	Perfluoro-n-decanoic Acid	PFDA	T		13C6-PFDA	No	No
8	Perfluoro-n-undecanoic acid	PFUnA	T		13C7-PFUnA	No	No
9	Perfluoro-n-dodecanoic acid	PFDoA	T		13C2-PFDoA	No	No
10	Perfluoro-n-tridecanoic acid	PFTrDA	T		13C2-PFTeDA	No	No
11	Perfluoro-n-tetradecanoic acid	PFTeDA	T		13C2-PFTeDA	No	No
12	N-methylperfluoro-1-octanesulfonamidoacetic acid	NMeFOSAA	T		d3-MeFOSAA	No	No
13	N-ethylperfluoro-octanesulfonamidoacetic acid	NEtFOSAA	T		d5-EtFOSAA	No	No
14	Perfluoro-1-octanesulfonamide	PFOSA	T		13C8-FOSA	No	No
15	Perfluoro-1-butanesulfonate	PFBS	T		13C3-PFBS	No	No
16	perfluoro-1-pentanesulfonate	PFPeS	T		13C3-PFHxS	No	No
17	Perfluoro-1-hexanesulfonate	PFHxS	T		13C3-PFHxS	No	No
18	Perfluoro-1-heptanesulfonate	PFHpS	T		13C3-PFHxS	No	No

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It can be done

WORK/QUALITY ASSURANCE PROJECT PLAN

Attachment 2: Test Codes

Project Test Code Name: Master_369B

No:	Analyte:	Report Name:	Type	RIS	SIS	Hidden:	Graph:
19	Perfluoro-1-octanesulfonate	PFOS	T		13C8-PFOS	No	No
20	Perfluoro-1-nonanesulfonate	PFNS	T		13C8-PFOS	No	No
21	Perfluoro-1-decanesulfonate	PFDS	T		13C8-PFOS	No	No
22	1H,1H,2H,2H-Perfluorohexane sulfonate	4:2FTS	T		13C2-4:2FTS	No	No
23	1H,1H,2H,2H-Perfluorooctane sulfonate	6:2FTS	T		13C2-6:2FTS	No	No
24	1H,1H,2H,2H-Perfluorodecane sulfonate	8:2FTS	T		13C2-8:2FTS	No	No
25	Hexafluoropropylene oxide dimer acid	HFPO-DA	T		13C3-HFPO-DA	No	No
26	Adona	Adona	T		13C3-HFPO-DA	No	No
27	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	T		13C3-HFPO-DA	No	No
28	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	T		13C3-HFPO-DA	No	No
1	13C4-PFBA	13C4-PFBA	SIS	13C3-PFBA		No	No
2	13C5-PFPeA	13C5-PFPeA	SIS	13C3-PFBA		No	No
3	13C5-PFHxA	13C5-PFHxA	SIS	13C2-PFOA		No	No
4	13C4-PFHpA	13C4-PFHpA	SIS	13C2-PFOA		No	No
5	13C8-PFOA	13C8-PFOA	SIS	13C2-PFOA		No	No
6	13C9-PFNA	13C9-PFNA	SIS	13C2-PFOA		No	No
7	13C6-PFDA	13C6-PFDA	SIS	13C2-PFDA		No	No
8	13C7-PFUnA	13C7-PFUnA	SIS	13C2-PFDA		No	No
9	13C2-PFDoA	13C2-PFDoA	SIS	13C2-PFDA		No	No
10	13C2-PFTeDA	13C2-PFTeDA	SIS	13C2-PFDA		No	No
11	d3-MeFOSAA	d3-MeFOSAA	SIS	13C4-PFOS		No	No
12	d5-EtFOSAA	d5-EtFOSAA	SIS	13C4-PFOS		No	No
13	13C8-FOSA	13C8-FOSA	SIS	13C4-PFOS		No	No
14	13C3-PFBS	13C3-PFBS	SIS	13C4-PFOS		No	No
15	13C3-PFHxS	13C3-PFHxS	SIS	13C4-PFOS		No	No
16	13C8-PFOS	13C8-PFOS	SIS	13C4-PFOS		No	No
17	13C2-4:2FTS	13C2-4:2FTS	SIS	13C4-PFOS		No	No
18	13C2-6:2FTS	13C2-6:2FTS	SIS	13C4-PFOS		No	No
19	13C2-8:2FTS	13C2-8:2FTS	SIS	13C4-PFOS		No	No
20	13C3-HFPO-DA	13C3-HFPO-DA	SIS	13C2-PFOA		No	No

Total Analytes: 48

Subtract Peaks:

None

Sum Peaks:

None

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WORK/QUALITY ASSURANCE PROJECT PLAN

Attachment 2: Test Codes

Project Test Code Name: Master_369B

ICAL Acceptance Criteria:

Curve Fit:	Limit Mean(%):	Mean Qual:	Limit Ind.:	Ind. Qual:	Min Points:	Points Qual:	Comments:
Linear	NA	NA	0.99	N	5	N	y = Bx + C
Quadratic	NA	NA	0.99	N	6	N	y = Ax^2 + Bx + C

Continuing Calibration Verification Criteria:

CCV Name: 5-369

Frequency Hrs:		Mean PD(%):		Individual PD(%):		RIS/SIS RT Window (min):		Area Limit Low(%):	Area Limit High(%):		Comment:
12	(N)	30	(N)	30	(N)	0.04	(N)	-50	100	(N)	NA

Independent Calibration Verification:

ICC Name: 5-369

Mean PD Limit(%):		Ind. PD Limit(%):		RIS/SIS Window Limit (Secs):		Area Limit High(%):	Area Limit Low(%):		Comment:
30	(N)	30	(N)	0.04	(N)	-50	100	(N)	NA

Mass Discrimination Criteria:

None

Degredation Check Criteria:

None

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WORK/QUALITY ASSURANCE PROJECT PLAN

Attachment 3: Method Quality Objectives

MQO Application:	***Universal_LC***		
MQO:	**Acceptance Criteria:**	**Qual:**	**Corrective Action:**
Procedural Blank	Samples must be greater than five times the blank concentration (>5xPB).	B	Review with Project Manager; re-analyze or justify results in project records.
PB Measurement Quality Objective	Organic results in the Procedural Blank are less than 1/2 times the LOQ (<1/2xLOQ)	N	Review with Project Manager; re-analyze or justify results in project records.
Laboratory Control Sample	Recovery values 70-130%.	N	Review with project manager; re-analyze or justify reporting the results in project records.
Matrix Spike / Matrix Spike Duplicate Recovery	Organics 70-130%. Analyte concentration in MS/MSD must be greater than five times reported background concentration.	N	Review with Project Manager; re-analyze or justify reporting results in the project records.
	Organics Results in the Target is less than 5 times the Original	n	
Matrix Spike/Spike Duplicate Precision	Organics results less than 30% Relative Percent Difference (RPD). Analyte concentration in MS/MSD must be greater than five times reported background concentration.	N	Review with Project Manager; re-analyze or justify reporting results in the project records.
	Organics Results in the Target is less than 5 times the Original	n	
Standard Reference Material Accuracy	Organics Percent Difference less than 30% from a range of certified values on average. Analyte concentration must be greater than five times the Method Detection Limit (>5xMDL).	N	Review with Project Manager; re-analyze or justify reporting results in the project records.
	Organics Results in the Target is less than 5 times the MDL	n	
Analytical Duplicate Precision	Organics results less than 30% Relative Percent Difference (RPD). Analyte concentration must be > 5x MDL.	N	Review with Project Manager; re-analyze or justify reporting results in the project records.
	Organics Results in the Original is less than 5 times the MDL	n	

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WORK/QUALITY ASSURANCE PROJECT PLAN

Attachment 3: Method Quality Objectives

MQO Application:	***Universal_LC***		
MQO:	**Acceptance Criteria:**	**Qual:**	**Corrective Action:**
Analytical Triplicate Precision	Organics results less than 30% Relative Standard Deviation (RSD). Analyte concentration must be > 5x MDL.	N	Review with Project Manager; re-analyze or justify reporting results in the project records.
	Organics Results in the Original is less than 5 times the MDL	n	
Surrogate Compound Recovery	Recovery results between 50% and 150%.	N	Review with Project Manager; re-analyze or justify reporting results in the project records.
Control Oil	RPD < 30% for at least 90% of analytes	N	Results examined by project manager, task leader, or subcontractor lab manager. Reextraction, reanalysis, or justification documented.
Instrument Calibration	5-369-8: R-squared greater than or equal to 0.990		Results examined by project manager, task leader, or subcontractor lab manager. Reextraction, reanalysis, or justification documented.
Independent Calibration Check Solution	5-369-8: Individual PD less than or equal to 30%. Mean Percent Difference less than or equal to 30%.	N	Review with Project Manager; re-analyze or justify in project records.
Continuing Calibration Verification	5-369-8: Individual PD less than or equal to 30%. Mean Percent Difference less than or equal to 30%.	N	Review with Project Manager; re-analyze or justify in project records.

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ShpNo SHP-200610-02

Battelle Project No:

Sample Receipt Form

Approved: ☐ Authorized ☐

Project Number: 31.50E.2340P **Client:** TRS Group

Received by: Schumitz, Matt **Date/Time Received:** Wednesday, June 10, 2020 10:30 AM

No. of Shipping Containers: 1

SHIPMENT

Method of Delivery: Commercial Carrier **Tracking Number:** Fed Ex

COC Forms: ✔ **Shipped with samples** ☐ **No Forms**

Cooler(s)/Box(es)

Cntr	Type	Tracking No.	Seal	Seal	Container	Therm.	Temp C	Smps
1 of 1	Cooler	1790 3036 2337	Custody Seals	Intact	Intact	Therm_1	2.1	4

Samples

Sample Labels:
- ✔ Sample labels agree with COC forms
- ☐ Discrepancies (see Sample Custody Corrective Action Form)

Container Seals:
- ☐ Tape ☐ Custody Seals ☐ Other Seals (See sample Log)
- ✔ Seals intact for each shipping container
- ☐ Seals broken (See sample log for impacted samples)

Condition of Samples:
- ✔ Sample containers intact
- ☐ Sample containers broken/leaking (See Custody Corrective Action Form)

Temperature upon receipt (°C): 2.1 Temperature Blank used ✔ Yes ☐ No

(Note: If temperature upon receipt differs from required conditions, see sample log comment field)

Samples Acidified: ☐ Yes ☐ No ✔ Unknown

Initial pH 5-9?: ☐ Yes ☐ No ✔ NA

If no, individual sample adjustments on the Auxiliary Sample Receipt Form

Total Residual Chlorine Present?: ☐ Yes ☐ No ✔ NA

If yes, individual sample adjustments on the Auxiliary Sample Receipt Form

Head Space <1% in samples for water VOC analysis: ☐ Yes ☐ No ✔ NA

Individual sample deviations noted on sample log

Samples Containers:

Samples returned in PC-grade jars: ☐ Yes ☐ No ✔ Unknown /Lot No.: Unknown

Storage Location: Custody: Freezer - F0117 (NA) **BDO IDs Assigned:** H6078 - H6081

Samples logged in by: Schumitz, Matt **Date/Time:** 06/10/2020 10:30 AM

Approved By: **Approved On:**

Authorized By: **Authorized On:**

BATTELLE

It can be done

ShpNo SHP-200610-02

Battelle Project No:

Sample Receipt Form Details

Approved: ☐ Authorized ☐

Project Number: 31.50E.2340P **Client:** TRS Group

Received by: Schumitz, Matt **Date/Time Received:** Wednesday, June 10, 2020 10:30 AM

No. of Shipping Containers: 1

BDO Id:	Client Sample ID:	Collection Date:	Login Date:	Ctrs:	Matrix:	Temp:	pH:	TRC:	VOC:	Stored In:	Loc:	No:	Comments:
H6078	Control	05/31/20 13:30	06/10/20 10:48	1	SOLID	2.1	NA	NA	NA	F0117 (NA)			
H6079	350 C	06/07/20 15:00	06/10/20 10:48	1	SOLID	2.1	NA	NA	NA	F0117 (NA)			
H6080	400 C	05/31/20 13:30	06/10/20 10:48	1	SOLID	2.1	NA	NA	NA	F0117 (NA)			
H6081	Carbon	06/07/20 15:00	06/10/20 10:48	1	SOLID	2.1	NA	NA	NA	F0117 (NA)			

Total Samples: 4

Data Tables

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	Control
Battelle ID	H6078-FS
Sample Type	SA
Collection Date	05/31/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS
% Moisture	0.59
Matrix	SOLID
Sample Size	1.99
Size Unit-Basis	g

Analyte	CAS No.	Result (ng/g_Dry)	Extract ID	DF	Analysis Date	DL	LOD	LOQ
PFBA	375-22-4	2.01 U	H6078-FS(3)	10.000	6/15/2020	0.73	2.01	5.03
PFPeA	2706-90-3	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.45	1.01	5.03
PFHxA	307-24-4	0.85 J	H6078-FS(3)	10.000	6/15/2020	0.71	2.01	5.03
PFHpA	375-85-9	1.51 U	H6078-FS(3)	10.000	6/15/2020	0.51	1.51	5.03
PFOA	335-67-1	1.58 J	H6078-FS(3)	10.000	6/15/2020	0.61	2.01	5.03
PFNA	375-95-1	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.49	1.01	5.03
PFDA	335-76-2	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.46	1.01	5.03
PFUnA	2058-94-8	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.46	1.01	5.03
PFDoA	307-55-1	2.01 U	H6078-FS(3)	10.000	6/15/2020	0.61	2.01	5.03
PFTrDA	72629-94-8	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.28	1.01	5.03
PFTeDA	376-06-7	2.51 U	H6078-FS(3)	10.000	6/15/2020	1.09	2.51	5.03
NMeFOSAA	2355-31-9	5.50	H6078-FS(3)	10.000	6/15/2020	1.03	2.51	5.03
NEtFOSAA	2991-50-6	1.25 J	H6078-FS(3)	10.000	6/15/2020	0.75	2.01	5.03
PFOSA	754-91-6	11.64	H6078-FS(3)	10.000	6/15/2020	0.42	1.01	5.03
PFBS	375-73-5	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.35	1.01	5.03
PFPeS	2706-91-4	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.44	1.01	5.03
PFHxS	355-46-4	11.32	H6078-FS(3)	10.000	6/15/2020	0.81	2.01	5.03
PFHpS	375-92-8	2.06 J	H6078-FS(3)	10.000	6/15/2020	0.78	2.01	5.03
PFOS	1763-23-1	1441.55 D	H6078-FS-D(7)	625.000	6/16/2020	43.34	125.63	314.07
PFNS	68259-12-1	16.41	H6078-FS(3)	10.000	6/15/2020	0.56	2.01	5.03
PFDS	335-77-3	6.04	H6078-FS(3)	10.000	6/15/2020	0.24	0.50	5.03
4:2FTS	757124-72-4	2.51 U	H6078-FS(3)	10.000	6/15/2020	1.21	2.51	5.03
6:2FTS	27619-97-2	0.86 J	H6078-FS(3)	10.000	6/15/2020	0.80	2.01	5.03
8:2FTS	39108-34-4	3.02 U	H6078-FS(3)	10.000	6/15/2020	1.45	3.02	5.03
HFPO-DA	13252-13-6	2.01 U	H6078-FS(3)	10.000	6/15/2020	0.64	2.01	5.03
Adona	919005-14-4	2.01 U	H6078-FS(3)	10.000	6/15/2020	0.83	2.01	5.03
11Cl-PF3OUdS	763051-92-9	1.51 U	H6078-FS(3)	10.000	6/15/2020	0.52	1.51	5.03
9Cl-PF3ONS	756426-58-1	1.01 U	H6078-FS(3)	10.000	6/15/2020	0.48	1.01	5.03

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	Control
Battelle ID	H6078-FS
Sample Type	SA
Collection Date	05/31/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS

Surrogate Recoveries (%)	**Recovery**		**Extract ID**	**Analysis Date**
13C4-PFBA	95		H6078-FS(3)	6/15/2020
13C5-PFPeA	100		H6078-FS(3)	6/15/2020
13C5-PFHxA	107		H6078-FS(3)	6/15/2020
13C4-PFHpA	118		H6078-FS(3)	6/15/2020
13C8-PFOA	104		H6078-FS(3)	6/15/2020
13C9-PFNA	77		H6078-FS(3)	6/15/2020
13C6-PFDA	105		H6078-FS(3)	6/15/2020
13C7-PFUnA	108		H6078-FS(3)	6/15/2020
13C2-PFDoA	112		H6078-FS(3)	6/15/2020
13C2-PFTeDA	113		H6078-FS(3)	6/15/2020
13C8-FOSA	113	D	H6078-FS-D(7)	6/16/2020
d3-MeFOSAA	127	D	H6078-FS-D(7)	6/16/2020
d5-EtFOSAA	126	D	H6078-FS-D(7)	6/16/2020
13C3-PFBS	119	D	H6078-FS-D(7)	6/16/2020
13C3-PFHxS	114	D	H6078-FS-D(7)	6/16/2020
13C8-PFOS	111	D	H6078-FS-D(7)	6/16/2020
13C2-4:2FTS	108	D	H6078-FS-D(7)	6/16/2020
13C2-6:2FTS	110	D	H6078-FS-D(7)	6/16/2020
13C2-8:2FTS	115	D	H6078-FS-D(7)	6/16/2020
13C3-HFPO-DA	103		H6078-FS(3)	6/15/2020

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	350 C
Battelle ID	H6079-FS
Sample Type	SA
Collection Date	06/07/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS
% Moisture	0.53
Matrix	SOLID
Sample Size	1.83
Size Unit-Basis	g

Analyte	CAS No.	Result (ng/g_Dry)	Extract ID	DF	Analysis Date	DL	LOD	LOQ
PFBA	375-22-4	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.80	2.19	5.46
PFPeA	2706-90-3	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.49	1.09	5.46
PFHxA	307-24-4	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.78	2.19	5.46
PFHpA	375-85-9	1.64 U	H6079-FS(3)	10.000	6/15/2020	0.56	1.64	5.46
PFOA	335-67-1	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.67	2.19	5.46
PFNA	375-95-1	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.54	1.09	5.46
PFDA	335-76-2	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.50	1.09	5.46
PFUnA	2058-94-8	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.50	1.09	5.46
PFDoA	307-55-1	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.67	2.19	5.46
PFTrDA	72629-94-8	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.31	1.09	5.46
PFTeDA	376-06-7	2.73 U	H6079-FS(3)	10.000	6/15/2020	1.18	2.73	5.46
NMeFOSAA	2355-31-9	2.73 U	H6079-FS(3)	10.000	6/15/2020	1.11	2.73	5.46
NEtFOSAA	2991-50-6	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.82	2.19	5.46
PFOSA	754-91-6	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.46	1.09	5.46
PFBS	375-73-5	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.38	1.09	5.46
PFPeS	2706-91-4	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.48	1.09	5.46
PFHxS	355-46-4	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.89	2.19	5.46
PFHpS	375-92-8	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.85	2.19	5.46
PFOS	1763-23-1	0.98 J	H6079-FS(3)	10.000	6/15/2020	0.75	2.19	5.46
PFNS	68259-12-1	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.61	2.19	5.46
PFDS	335-77-3	0.55 U	H6079-FS(3)	10.000	6/15/2020	0.26	0.55	5.46
4:2FTS	757124-72-4	2.73 U	H6079-FS(3)	10.000	6/15/2020	1.31	2.73	5.46
6:2FTS	27619-97-2	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.87	2.19	5.46
8:2FTS	39108-34-4	3.28 U	H6079-FS(3)	10.000	6/15/2020	1.57	3.28	5.46
HFPO-DA	13252-13-6	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.70	2.19	5.46
Adona	919005-14-4	2.19 U	H6079-FS(3)	10.000	6/15/2020	0.91	2.19	5.46
11Cl-PF3OUdS	763051-92-9	1.64 U	H6079-FS(3)	10.000	6/15/2020	0.57	1.64	5.46
9Cl-PF3ONS	756426-58-1	1.09 U	H6079-FS(3)	10.000	6/15/2020	0.52	1.09	5.46

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	350 C
Battelle ID	H6079-FS
Sample Type	SA
Collection Date	06/07/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS

Surrogate Recoveries (%)	**Recovery**	**Extract ID**	**Analysis Date**
13C4-PFBA	83	H6079-FS(3)	6/15/2020
13C5-PFPeA	85	H6079-FS(3)	6/15/2020
13C5-PFHxA	104	H6079-FS(3)	6/15/2020
13C4-PFHpA	108	H6079-FS(3)	6/15/2020
13C8-PFOA	103	H6079-FS(3)	6/15/2020
13C9-PFNA	102	H6079-FS(3)	6/15/2020
13C6-PFDA	95	H6079-FS(3)	6/15/2020
13C7-PFUnA	97	H6079-FS(3)	6/15/2020
13C2-PFDoA	103	H6079-FS(3)	6/15/2020
13C2-PFTeDA	115	H6079-FS(3)	6/15/2020
13C8-FOSA	82	H6079-FS(3)	6/15/2020
d3-MeFOSAA	83	H6079-FS(3)	6/15/2020
d5-EtFOSAA	95	H6079-FS(3)	6/15/2020
13C3-PFBS	113	H6079-FS(3)	6/15/2020
13C3-PFHxS	113	H6079-FS(3)	6/15/2020
13C8-PFOS	111	H6079-FS(3)	6/15/2020
13C2-4:2FTS	110	H6079-FS(3)	6/15/2020
13C2-6:2FTS	108	H6079-FS(3)	6/15/2020
13C2-8:2FTS	107	H6079-FS(3)	6/15/2020
13C3-HFPO-DA	98	H6079-FS(3)	6/15/2020

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	350 C
Battelle ID	H6079DUP-FS
Sample Type	QADU
Collection Date	06/07/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS
% Moisture	0.00
Matrix	SOLID
Sample Size	2.08
Size Unit-Basis	g

Analyte	CAS No.	Result (ng/g_Dry)	Extract ID	DF	Analysis Date	DL	LOD	LOQ
PFBA	375-22-4	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.70	1.92	4.81
PFPeA	2706-90-3	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.43	0.96	4.81
PFHxA	307-24-4	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.68	1.92	4.81
PFHpA	375-85-9	1.44 U	H6079DUP-FS(3)	10.000	6/15/2020	0.49	1.44	4.81
PFOA	335-67-1	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.59	1.92	4.81
PFNA	375-95-1	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.47	0.96	4.81
PFDA	335-76-2	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.44	0.96	4.81
PFUnA	2058-94-8	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.44	0.96	4.81
PFDoA	307-55-1	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.59	1.92	4.81
PFTrDA	72629-94-8	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.27	0.96	4.81
PFTeDA	376-06-7	2.40 U	H6079DUP-FS(3)	10.000	6/15/2020	1.04	2.40	4.81
NMeFOSAA	2355-31-9	2.40 U	H6079DUP-FS(3)	10.000	6/15/2020	0.98	2.40	4.81
NEtFOSAA	2991-50-6	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.72	1.92	4.81
PFOSA	754-91-6	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.40	0.96	4.81
PFBS	375-73-5	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.34	0.96	4.81
PFPeS	2706-91-4	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.42	0.96	4.81
PFHxS	355-46-4	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.78	1.92	4.81
PFHpS	375-92-8	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.75	1.92	4.81
PFOS	1763-23-1	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.66	1.92	4.81
PFNS	68259-12-1	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.54	1.92	4.81
PFDS	335-77-3	0.48 U	H6079DUP-FS(3)	10.000	6/15/2020	0.23	0.48	4.81
4:2FTS	757124-72-4	2.40 U	H6079DUP-FS(3)	10.000	6/15/2020	1.15	2.40	4.81
6:2FTS	27619-97-2	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.77	1.92	4.81
8:2FTS	39108-34-4	2.88 U	H6079DUP-FS(3)	10.000	6/15/2020	1.38	2.88	4.81
HFPO-DA	13252-13-6	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.62	1.92	4.81
Adona	919005-14-4	1.92 U	H6079DUP-FS(3)	10.000	6/15/2020	0.80	1.92	4.81
11Cl-PF3OUdS	763051-92-9	1.44 U	H6079DUP-FS(3)	10.000	6/15/2020	0.50	1.44	4.81
9Cl-PF3ONS	756426-58-1	0.96 U	H6079DUP-FS(3)	10.000	6/15/2020	0.46	0.96	4.81

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	350 C
Battelle ID	H6079DUP-FS
Sample Type	QADU
Collection Date	06/07/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS

Surrogate Recoveries (%)	**Recovery**	**Extract ID**	**Analysis Date**
13C4-PFBA	94	H6079DUP-FS(3)	6/15/2020
13C5-PFPeA	99	H6079DUP-FS(3)	6/15/2020
13C5-PFHxA	109	H6079DUP-FS(3)	6/15/2020
13C4-PFHpA	119	H6079DUP-FS(3)	6/15/2020
13C8-PFOA	109	H6079DUP-FS(3)	6/15/2020
13C9-PFNA	105	H6079DUP-FS(3)	6/15/2020
13C6-PFDA	108	H6079DUP-FS(3)	6/15/2020
13C7-PFUnA	114	H6079DUP-FS(3)	6/15/2020
13C2-PFDoA	115	H6079DUP-FS(3)	6/15/2020
13C2-PFTeDA	113	H6079DUP-FS(3)	6/15/2020
13C8-FOSA	99	H6079DUP-FS(3)	6/15/2020
d3-MeFOSAA	116	H6079DUP-FS(3)	6/15/2020
d5-EtFOSAA	128	H6079DUP-FS(3)	6/15/2020
13C3-PFBS	126	H6079DUP-FS(3)	6/15/2020
13C3-PFHxS	135	H6079DUP-FS(3)	6/15/2020
13C8-PFOS	123	H6079DUP-FS(3)	6/15/2020
13C2-4:2FTS	127	H6079DUP-FS(3)	6/15/2020
13C2-6:2FTS	127	H6079DUP-FS(3)	6/15/2020
13C2-8:2FTS	117	H6079DUP-FS(3)	6/15/2020
13C3-HFPO-DA	103	H6079DUP-FS(3)	6/15/2020

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	400 C
Battelle ID	H6080-FS
Sample Type	SA
Collection Date	05/31/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS
% Moisture	0.33
Matrix	SOLID
Sample Size	1.97
Size Unit-Basis	g

Analyte	CAS No.	Result (ng/g_Dry)	Extract ID	DF	Analysis Date	DL	LOD	LOQ
PFBA	375-22-4	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.74	2.03	5.08
PFPeA	2706-90-3	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.46	1.02	5.08
PFHxA	307-24-4	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.72	2.03	5.08
PFHpA	375-85-9	1.52 U	H6080-FS(3)	10.000	6/15/2020	0.52	1.52	5.08
PFOA	335-67-1	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.62	2.03	5.08
PFNA	375-95-1	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.50	1.02	5.08
PFDA	335-76-2	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.47	1.02	5.08
PFUnA	2058-94-8	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.47	1.02	5.08
PFDoA	307-55-1	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.62	2.03	5.08
PFTrDA	72629-94-8	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.28	1.02	5.08
PFTeDA	376-06-7	2.54 U	H6080-FS(3)	10.000	6/15/2020	1.10	2.54	5.08
NMeFOSAA	2355-31-9	2.54 U	H6080-FS(3)	10.000	6/15/2020	1.04	2.54	5.08
NEtFOSAA	2991-50-6	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.76	2.03	5.08
PFOSA	754-91-6	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.43	1.02	5.08
PFBS	375-73-5	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.36	1.02	5.08
PFPeS	2706-91-4	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.45	1.02	5.08
PFHxS	355-46-4	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.82	2.03	5.08
PFHpS	375-92-8	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.79	2.03	5.08
PFOS	1763-23-1	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.70	2.03	5.08
PFNS	68259-12-1	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.57	2.03	5.08
PFDS	335-77-3	0.51 U	H6080-FS(3)	10.000	6/15/2020	0.24	0.51	5.08
4:2FTS	757124-72-4	2.54 U	H6080-FS(3)	10.000	6/15/2020	1.22	2.54	5.08
6:2FTS	27619-97-2	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.81	2.03	5.08
8:2FTS	39108-34-4	3.05 U	H6080-FS(3)	10.000	6/15/2020	1.46	3.05	5.08
HFPO-DA	13252-13-6	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.65	2.03	5.08
Adona	919005-14-4	2.03 U	H6080-FS(3)	10.000	6/15/2020	0.84	2.03	5.08
11Cl-PF3OUdS	763051-92-9	1.52 U	H6080-FS(3)	10.000	6/15/2020	0.53	1.52	5.08
9Cl-PF3ONS	756426-58-1	1.02 U	H6080-FS(3)	10.000	6/15/2020	0.49	1.02	5.08

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	400 C
Battelle ID	H6080-FS
Sample Type	SA
Collection Date	05/31/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS

Surrogate Recoveries (%)	**Recovery**	**Extract ID**	**Analysis Date**
13C4-PFBA	93	H6080-FS(3)	6/15/2020
13C5-PFPeA	97	H6080-FS(3)	6/15/2020
13C5-PFHxA	105	H6080-FS(3)	6/15/2020
13C4-PFHpA	113	H6080-FS(3)	6/15/2020
13C8-PFOA	98	H6080-FS(3)	6/15/2020
13C9-PFNA	100	H6080-FS(3)	6/15/2020
13C6-PFDA	98	H6080-FS(3)	6/15/2020
13C7-PFUnA	102	H6080-FS(3)	6/15/2020
13C2-PFDoA	103	H6080-FS(3)	6/15/2020
13C2-PFTeDA	106	H6080-FS(3)	6/15/2020
13C8-FOSA	99	H6080-FS(3)	6/15/2020
d3-MeFOSAA	98	H6080-FS(3)	6/15/2020
d5-EtFOSAA	116	H6080-FS(3)	6/15/2020
13C3-PFBS	124	H6080-FS(3)	6/15/2020
13C3-PFHxS	137	H6080-FS(3)	6/15/2020
13C8-PFOS	123	H6080-FS(3)	6/15/2020
13C2-4:2FTS	130	H6080-FS(3)	6/15/2020
13C2-6:2FTS	124	H6080-FS(3)	6/15/2020
13C2-8:2FTS	121	H6080-FS(3)	6/15/2020
13C3-HFPO-DA	101	H6080-FS(3)	6/15/2020

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID		Carbon						
Battelle ID		H6081-FS						
Sample Type		SA						
Collection Date		06/07/2020						
Extraction Date		06/11/2020						
Analytical Instrument		Sciex 5500 LC/MS/MS						
% Moisture		6.90						
Matrix		SOLID						
Sample Size		2.01						
Size Unit-Basis		g						
Analyte	CAS No.	Result (ng/g_Dry)	Extract ID	DF	Analysis Date	DL	LOD	LOQ
PFBA	375-22-4	64.52	H6081-FS(3)	10.000	6/15/2020	0.73	1.99	4.98
PFPeA	2706-90-3	41.02	H6081-FS(3)	10.000	6/15/2020	0.45	1.00	4.98
PFHxA	307-24-4	117.21	H6081-FS(3)	10.000	6/15/2020	0.71	1.99	4.98
PFHpA	375-85-9	12.36	H6081-FS(3)	10.000	6/15/2020	0.51	1.49	4.98
PFOA	335-67-1	10.61	H6081-FS(3)	10.000	6/15/2020	0.61	1.99	4.98
PFNA	375-95-1	0.74 J	H6081-FS(3)	10.000	6/15/2020	0.49	1.00	4.98
PFDA	335-76-2	0.56 J	H6081-FS(3)	10.000	6/15/2020	0.46	1.00	4.98
PFUnA	2058-94-8	1.00 U	H6081-FS(3)	10.000	6/15/2020	0.46	1.00	4.98
PFDoA	307-55-1	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.61	1.99	4.98
PFTrDA	72629-94-8	1.00 U	H6081-FS(3)	10.000	6/15/2020	0.28	1.00	4.98
PFTeDA	376-06-7	2.49 U	H6081-FS(3)	10.000	6/15/2020	1.07	2.49	4.98
NMeFOSAA	2355-31-9	2.49 U	H6081-FS(3)	10.000	6/15/2020	1.01	2.49	4.98
NEtFOSAA	2991-50-6	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.75	1.99	4.98
PFOSA	754-91-6	32.16	H6081-FS(3)	10.000	6/15/2020	0.42	1.00	4.98
PFBS	375-73-5	0.37 J	H6081-FS(3)	10.000	6/15/2020	0.35	1.00	4.98
PFPeS	2706-91-4	1.00 U	H6081-FS(3)	10.000	6/15/2020	0.44	1.00	4.98
PFHxS	355-46-4	0.94 J	H6081-FS(3)	10.000	6/15/2020	0.81	1.99	4.98
PFHpS	375-92-8	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.78	1.99	4.98
PFOS	1763-23-1	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.69	1.99	4.98
PFNS	68259-12-1	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.56	1.99	4.98
PFDS	335-77-3	0.50 U	H6081-FS(3)	10.000	6/15/2020	0.24	0.50	4.98
4:2FTS	757124-72-4	2.49 U	H6081-FS(3)	10.000	6/15/2020	1.19	2.49	4.98
6:2FTS	27619-97-2	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.80	1.99	4.98
8:2FTS	39108-34-4	2.99 U	H6081-FS(3)	10.000	6/15/2020	1.43	2.99	4.98
HFPO-DA	13252-13-6	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.64	1.99	4.98
Adona	919005-14-4	1.99 U	H6081-FS(3)	10.000	6/15/2020	0.83	1.99	4.98
11Cl-PF3OUdS	763051-92-9	1.49 U	H6081-FS(3)	10.000	6/15/2020	0.52	1.49	4.98
9Cl-PF3ONS	756426-58-1	1.00 U	H6081-FS(3)	10.000	6/15/2020	0.48	1.00	4.98

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	Carbon
Battelle ID	H6081-FS
Sample Type	SA
Collection Date	06/07/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS

Surrogate Recoveries (%)	**Recovery**	**Extract ID**	**Analysis Date**
13C4-PFBA	80	H6081-FS(3)	6/15/2020
13C5-PFPeA	85	H6081-FS(3)	6/15/2020
13C5-PFHxA	86	H6081-FS(3)	6/15/2020
13C4-PFHpA	92	H6081-FS(3)	6/15/2020
13C8-PFOA	77	H6081-FS(3)	6/15/2020
13C9-PFNA	75	H6081-FS(3)	6/15/2020
13C6-PFDA	73	H6081-FS(3)	6/15/2020
13C7-PFUnA	69	H6081-FS(3)	6/15/2020
13C2-PFDoA	61	H6081-FS(3)	6/15/2020
13C2-PFTeDA	51	H6081-FS(3)	6/15/2020
13C8-FOSA	64	H6081-FS(3)	6/15/2020
d3-MeFOSAA	52	H6081-FS(3)	6/15/2020
d5-EtFOSAA	51	H6081-FS(3)	6/15/2020
13C3-PFBS	106	H6081-FS(3)	6/15/2020
13C3-PFHxS	104	H6081-FS(3)	6/15/2020
13C8-PFOS	80	H6081-FS(3)	6/15/2020
13C2-4:2FTS	96	H6081-FS(3)	6/15/2020
13C2-6:2FTS	91	H6081-FS(3)	6/15/2020
13C2-8:2FTS	76	H6081-FS(3)	6/15/2020
13C3-HFPO-DA	83	H6081-FS(3)	6/15/2020

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID		KZ87 IB			
Battelle ID		KZ87 IB_06/11/2020			
Sample Type		IB			
Collection Date		NA			
Extraction Date		NA			
Analysis Date		06/11/2020			
Analytical Instrument		Sciex 5500 LC/MS/MS			
% Moisture		NA			
Matrix		Solid			
Sample Size		2.00			
Size Unit-Basis		g			
Analyte	CAS No.	Result (ng/g_Dry)	DL	LOD	LOQ
PFBA	375-22-4	2.00 U	0.73	2.00	5.00
PFPeA	2706-90-3	1.00 U	0.45	1.00	5.00
PFHxA	307-24-4	2.00 U	0.71	2.00	5.00
PFHpA	375-85-9	1.50 U	0.51	1.50	5.00
PFOA	335-67-1	2.00 U	0.61	2.00	5.00
PFNA	375-95-1	1.00 U	0.49	1.00	5.00
PFDA	335-76-2	1.00 U	0.46	1.00	5.00
PFUnA	2058-94-8	1.00 U	0.46	1.00	5.00
PFDoA	307-55-1	2.00 U	0.61	2.00	5.00
PFTrDA	72629-94-8	1.00 U	0.28	1.00	5.00
PFTeDA	376-06-7	2.50 U	1.08	2.50	5.00
NMeFOSAA	2355-31-9	2.50 U	1.02	2.50	5.00
NEtFOSAA	2991-50-6	2.00 U	0.75	2.00	5.00
PFOSA	754-91-6	1.00 U	0.42	1.00	5.00
PFBS	375-73-5	1.00 U	0.35	1.00	5.00
PFPeS	2706-91-4	1.00 U	0.44	1.00	5.00
PFHxS	355-46-4	2.00 U	0.81	2.00	5.00
PFHpS	375-92-8	2.00 U	0.78	2.00	5.00
PFOS	1763-23-1	2.00 U	0.69	2.00	5.00
PFNS	68259-12-1	2.00 U	0.56	2.00	5.00
PFDS	335-77-3	0.50 U	0.24	0.50	5.00
4:2FTS	757124-72-4	2.50 U	1.20	2.50	5.00
6:2FTS	27619-97-2	2.00 U	0.80	2.00	5.00
8:2FTS	39108-34-4	3.00 U	1.44	3.00	5.00
HFPO-DA	13252-13-6	2.00 U	0.64	2.00	5.00
Adona	919005-14-4	2.00 U	0.83	2.00	5.00
11Cl-PF3OUdS	763051-92-9	1.50 U	0.52	1.50	5.00
9Cl-PF3ONS	756426-58-1	1.00 U	0.48	1.00	5.00

Surrogate Recoveries (%)	
13C4-PFBA	103
13C5-PFPeA	102
13C5-PFHxA	103
13C4-PFHpA	102
13C8-PFOA	103
13C9-PFNA	103
13C6-PFDA	96
13C7-PFUnA	98
13C2-PFDoA	99
13C2-PFTeDA	95
13C8-FOSA	105
d3-MeFOSAA	102
d5-EtFOSAA	110
13C3-PFBS	100
13C3-PFHxS	98
13C8-PFOS	101
13C2-4:2FTS	98
13C2-6:2FTS	95
13C2-8:2FTS	100
13C3-HFPO-DA	96

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID		KZ87 IB			
Battelle ID		KZ87 IB_06/15/2020			
Sample Type		IB			
Collection Date		NA			
Extraction Date		NA			
Analysis Date		06/15/2020			
Analytical Instrument		Sciex 5500 LC/MS/MS			
% Moisture		NA			
Matrix		Solid			
Sample Size		2.00			
Size Unit-Basis		g			
Analyte	CAS No.	Result (ng/g_Dry)	DL	LOD	LOQ
PFBA	375-22-4	2.00 U	0.73	2.00	5.00
PFPeA	2706-90-3	1.00 U	0.45	1.00	5.00
PFHxA	307-24-4	2.00 U	0.71	2.00	5.00
PFHpA	375-85-9	1.50 U	0.51	1.50	5.00
PFOA	335-67-1	2.00 U	0.61	2.00	5.00
PFNA	375-95-1	1.00 U	0.49	1.00	5.00
PFDA	335-76-2	1.00 U	0.46	1.00	5.00
PFUnA	2058-94-8	1.00 U	0.46	1.00	5.00
PFDoA	307-55-1	2.00 U	0.61	2.00	5.00
PFTrDA	72629-94-8	1.00 U	0.28	1.00	5.00
PFTeDA	376-06-7	2.50 U	1.08	2.50	5.00
NMeFOSAA	2355-31-9	2.50 U	1.02	2.50	5.00
NEtFOSAA	2991-50-6	2.00 U	0.75	2.00	5.00
PFOSA	754-91-6	1.00 U	0.42	1.00	5.00
PFBS	375-73-5	1.00 U	0.35	1.00	5.00
PFPeS	2706-91-4	1.00 U	0.44	1.00	5.00
PFHxS	355-46-4	2.00 U	0.81	2.00	5.00
PFHpS	375-92-8	2.00 U	0.78	2.00	5.00
PFOS	1763-23-1	2.00 U	0.69	2.00	5.00
PFNS	68259-12-1	2.00 U	0.56	2.00	5.00
PFDS	335-77-3	0.50 U	0.24	0.50	5.00
4:2FTS	757124-72-4	2.50 U	1.20	2.50	5.00
6:2FTS	27619-97-2	2.00 U	0.80	2.00	5.00
8:2FTS	39108-34-4	3.00 U	1.44	3.00	5.00
HFPO-DA	13252-13-6	2.00 U	0.64	2.00	5.00
Adona	919005-14-4	2.00 U	0.83	2.00	5.00
11Cl-PF3OUdS	763051-92-9	1.50 U	0.52	1.50	5.00
9Cl-PF3ONS	756426-58-1	1.00 U	0.48	1.00	5.00

Surrogate Recoveries (%)	
13C4-PFBA	96
13C5-PFPeA	97
13C5-PFHxA	100
13C4-PFHpA	100
13C8-PFOA	100
13C9-PFNA	94
13C6-PFDA	95
13C7-PFUnA	100
13C2-PFDoA	98
13C2-PFTeDA	96
13C8-FOSA	99
d3-MeFOSAA	108
d5-EtFOSAA	117
13C3-PFBS	98
13C3-PFHxS	98
13C8-PFOS	104
13C2-4:2FTS	98
13C2-6:2FTS	89
13C2-8:2FTS	94
13C3-HFPO-DA	97

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID		Procedural Blank						
Battelle ID		CZ158PB-FS						
Sample Type		PB						
Collection Date		06/11/2020						
Extraction Date		06/11/2020						
Analytical Instrument		Sciex 5500 LC/MS/MS						
% Moisture		0.00						
Matrix		SEDIMENT						
Sample Size		2.13						
Size Unit-Basis		g						
Analyte	CAS No.	Result (ng/g_Dry)	Extract ID	DF	Analysis Date	DL	LOD	LOQ
PFBA	375-22-4	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.69	1.88	4.69
PFPeA	2706-90-3	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.42	0.94	4.69
PFHxA	307-24-4	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.67	1.88	4.69
PFHpA	375-85-9	1.41 U	CZ158PB-FS(3)	10.000	6/15/2020	0.48	1.41	4.69
PFOA	335-67-1	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.57	1.88	4.69
PFNA	375-95-1	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.46	0.94	4.69
PFDA	335-76-2	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.43	0.94	4.69
PFUnA	2058-94-8	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.43	0.94	4.69
PFDoA	307-55-1	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.57	1.88	4.69
PFTrDA	72629-94-8	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.26	0.94	4.69
PFTeDA	376-06-7	2.35 U	CZ158PB-FS(3)	10.000	6/15/2020	1.01	2.35	4.69
NMeFOSAA	2355-31-9	2.35 U	CZ158PB-FS(3)	10.000	6/15/2020	0.96	2.35	4.69
NEtFOSAA	2991-50-6	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.70	1.88	4.69
PFOSA	754-91-6	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.39	0.94	4.69
PFBS	375-73-5	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.33	0.94	4.69
PFPeS	2706-91-4	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.41	0.94	4.69
PFHxS	355-46-4	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.76	1.88	4.69
PFHpS	375-92-8	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.73	1.88	4.69
PFOS	1763-23-1	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.65	1.88	4.69
PFNS	68259-12-1	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.53	1.88	4.69
PFDS	335-77-3	0.47 U	CZ158PB-FS(3)	10.000	6/15/2020	0.23	0.47	4.69
4:2FTS	757124-72-4	2.35 U	CZ158PB-FS(3)	10.000	6/15/2020	1.13	2.35	4.69
6:2FTS	27619-97-2	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.75	1.88	4.69
8:2FTS	39108-34-4	2.82 U	CZ158PB-FS(3)	10.000	6/15/2020	1.35	2.82	4.69
HFPO-DA	13252-13-6	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.60	1.88	4.69
Adona	919005-14-4	1.88 U	CZ158PB-FS(3)	10.000	6/15/2020	0.78	1.88	4.69
11Cl-PF3OUdS	763051-92-9	1.41 U	CZ158PB-FS(3)	10.000	6/15/2020	0.49	1.41	4.69
9Cl-PF3ONS	756426-58-1	0.94 U	CZ158PB-FS(3)	10.000	6/15/2020	0.45	0.94	4.69

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	Procedural Blank
Battelle ID	CZ158PB-FS
Sample Type	PB
Collection Date	06/11/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS

Surrogate Recoveries (%)	**Recovery**	**Extract ID**	**Analysis Date**
13C4-PFBA	105	CZ158PB-FS(3)	6/15/2020
13C5-PFPeA	111	CZ158PB-FS(3)	6/15/2020
13C5-PFHxA	116	CZ158PB-FS(3)	6/15/2020
13C4-PFHpA	127	CZ158PB-FS(3)	6/15/2020
13C8-PFOA	114	CZ158PB-FS(3)	6/15/2020
13C9-PFNA	111	CZ158PB-FS(3)	6/15/2020
13C6-PFDA	105	CZ158PB-FS(3)	6/15/2020
13C7-PFUnA	117	CZ158PB-FS(3)	6/15/2020
13C2-PFDoA	114	CZ158PB-FS(3)	6/15/2020
13C2-PFTeDA	115	CZ158PB-FS(3)	6/15/2020
13C8-FOSA	77	CZ158PB-FS(3)	6/15/2020
d3-MeFOSAA	116	CZ158PB-FS(3)	6/15/2020
d5-EtFOSAA	124	CZ158PB-FS(3)	6/15/2020
13C3-PFBS	125	CZ158PB-FS(3)	6/15/2020
13C3-PFHxS	119	CZ158PB-FS(3)	6/15/2020
13C8-PFOS	115	CZ158PB-FS(3)	6/15/2020
13C2-4:2FTS	132	CZ158PB-FS(3)	6/15/2020
13C2-6:2FTS	117	CZ158PB-FS(3)	6/15/2020
13C2-8:2FTS	112	CZ158PB-FS(3)	6/15/2020
13C3-HFPO-DA	109	CZ158PB-FS(3)	6/15/2020

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID		Laboratory Control Sample								
Battelle ID		CZ159LCS-FS								
Sample Type		LCS								
Collection Date		06/11/2020								
Extraction Date		06/11/2020								
Analytical Instrument		Sciex 5500 LC/MS/MS								
% Moisture		0.00								
Matrix		SEDIMENT								
Sample Size		1.91								
Size Unit-Basis		g								
					Analysis				Control Limits	
Analyte	CAS No.	Result (ng/g_Dry)	Extract ID	DF	Date	Target	Recovery	Qual	Lower	Upper
PFBA	375-22-4	23.98	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	92		71	135
PFPeA	2706-90-3	23.88	CZ159LCS-FS(3)	10.000	6/15/2020	26.44	90		69	132
PFHxA	307-24-4	22.87	CZ159LCS-FS(3)	10.000	6/15/2020	26.44	86		70	132
PFHpA	375-85-9	23.79	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	91		71	131
PFOA	335-67-1	23.27	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	89		69	133
PFNA	375-95-1	25.29	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	97		72	129
PFDA	335-76-2	25.57	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	98		69	133
PFUnA	2058-94-8	23.76	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	91		64	136
PFDoA	307-55-1	23.94	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	91		69	135
PFTrDA	72629-94-8	23.38	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	89		66	139
PFTeDA	376-06-7	23.74	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	91		69	133
NMeFOSAA	2355-31-9	22.77	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	87		63	144
NEtFOSAA	2991-50-6	23.22	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	89		61	139
PFOSA	754-91-6	23.35	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	89		67	137
PFBS	375-73-5	23.29	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	89		72	128
PFPeS	2706-91-4	22.97	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	88		73	123
PFHxS	355-46-4	24.92	CZ159LCS-FS(3)	10.000	6/15/2020	26.44	94		67	130
PFHpS	375-92-8	21.26	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	81		70	132
PFOS	1763-23-1	22.68	CZ159LCS-FS(3)	10.000	6/15/2020	26.44	86		68	136
PFNS	68259-12-1	22.55	CZ159LCS-FS(3)	10.000	6/15/2020	26.44	85		69	125
PFDS	335-77-3	22.14	CZ159LCS-FS(3)	10.000	6/15/2020	26.44	84		59	134
4:2FTS	757124-72-4	19.04	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	73		62	145
6:2FTS	27619-97-2	21.34	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	82		64	140
8:2FTS	39108-34-4	20.60	CZ159LCS-FS(3)	10.000	6/15/2020	26.44	78		65	137
HFPO-DA	13252-13-6	22.93	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	88		71	153
Adona	919005-14-4	24.46	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	93		61	139
11Cl-PF3OUdS	763051-92-9	25.06	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	96		40	160
9Cl-PF3ONS	756426-58-1	25.87	CZ159LCS-FS(3)	10.000	6/15/2020	26.18	99		60	140

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063

Client ID	Laboratory Control Sample
Battelle ID	CZ159LCS-FS
Sample Type	LCS
Collection Date	06/11/2020
Extraction Date	06/11/2020
Analytical Instrument	Sciex 5500 LC/MS/MS

Surrogate Recoveries (%)	**Recovery**	**Extract ID**	**Analysis Date**
13C4-PFBA	98	CZ159LCS-FS(3)	6/15/2020
13C5-PFPeA	104	CZ159LCS-FS(3)	6/15/2020
13C5-PFHxA	111	CZ159LCS-FS(3)	6/15/2020
13C4-PFHpA	123	CZ159LCS-FS(3)	6/15/2020
13C8-PFOA	104	CZ159LCS-FS(3)	6/15/2020
13C9-PFNA	105	CZ159LCS-FS(3)	6/15/2020
13C6-PFDA	103	CZ159LCS-FS(3)	6/15/2020
13C7-PFUnA	106	CZ159LCS-FS(3)	6/15/2020
13C2-PFDoA	115	CZ159LCS-FS(3)	6/15/2020
13C2-PFTeDA	112	CZ159LCS-FS(3)	6/15/2020
13C8-FOSA	99	CZ159LCS-FS(3)	6/15/2020
d3-MeFOSAA	127	CZ159LCS-FS(3)	6/15/2020
d5-EtFOSAA	121	CZ159LCS-FS(3)	6/15/2020
13C3-PFBS	117	CZ159LCS-FS(3)	6/15/2020
13C3-PFHxS	129	CZ159LCS-FS(3)	6/15/2020
13C8-PFOS	120	CZ159LCS-FS(3)	6/15/2020
13C2-4:2FTS	136	CZ159LCS-FS(3)	6/15/2020
13C2-6:2FTS	125	CZ159LCS-FS(3)	6/15/2020
13C2-8:2FTS	133	CZ159LCS-FS(3)	6/15/2020
13C3-HFPO-DA	106	CZ159LCS-FS(3)	6/15/2020

Glossary of Data Qualifiers

Flag:	Application:
B	Analyte found in the sample at a concentration <10x the level found in the procedural blank
D	Dilution Run. Initial run outside the initial calibration range of the instrument
E	Estimate, result is greater than the highest concentration level in the calibration
J	Analyte detected below the Limit of Quantitation (LOQ)
MI	Significant Matrix Interference - value could not be determined.
N	Quality Control (QC) value is outside the accuracy or precision Data Quality Objective (DQO)
NA	Not Applicable
T	Holding Time (HT) exceeded
U	Analyte not detected or detected below the Detection Limit (DL) value, Limit of Detection (LOD) reported

Miscellaneous Documentation

QA/QC Summary
Batch 20-0645

Project:	PFAS in Solids
Client Project Manager:	Emily Crownover / Dan Oberle
Parameters:	PFAS
Laboratory:	Battelle, Norwell, MA
Matrix:	SOLID
Data Set:	DP-20-0559
Analytical SOP:	5-369
Method Reference:	PFAS to QSM 5.3 Table B-15

Sample Custody		
Collection Date	Receipt Date	Temp (°C)
5/31 and 6/7/2020	6/10/2020	2.1
Corrective Actions	None	
Sample Storage	The water samples were stored frozen until extraction.	
Related samples	NA	

	METHOD SUMMARIES
Sample Preparation	Solid samples were homogenized and aliquoted into extraction tubes and fortified with surrogates prior to the addition of solvent. The sample was extracted on the Geno/Grinder with methanol and extraction salts ($MgSO_4$ and NaCl). Post centrifugation, 1.5 mL of extract was suspended in 60 mL of Millipore water and processed through Weak-anion exchange (WAX) solid phase extraction (SPE) cartridges. Target analytes are eluted from the WAX SPE using 0.5% NH_3 in methanol. Extracts were further refined using Envi-carb to remove co-extracted interferences. Extracts were concentrated to approximately 500 µL under nitrogen with a water bath set between 50 °C and 60 °C, reconstituted with methanol/water and fortified with internal standard. Extracts were transferred for LC-MS/MS analysis in 80:20 methanol/water (V/V).
Prep comments	pH of all samples prior to SPE extraction was verified between 6 and 8. The initial split for sample H6079DUP-FS (350 C) was made incorrectly, the sample was weight out again, extracted, and caught up with the rest of the samples.
Analysis	PFAS were measured by liquid chromatography tandem mass spectrometry (LC-MS/MS) in the multiple reaction monitoring (MRM). An initial calibration consisting of representative target analytes, labelled analogs, and internal standards was analyzed prior to analysis to demonstrate the linear range of analysis. Calibration verification was performed at the beginning and end of 10 injections and at the end of each sequence. Target PFAS were quantified using the isotope dilution method. Samples are reported in ng/g concentrations on a dry weight basis.
Analysis Comments	Samples analyzed on Sciex 5500 LC-MS/MS. MeFOSAA, EtFOSAA, PFHxS, and PFOS in the LCS, and field samples when detected, were found and reported as a combination of the branched and linear isomers.

QA/QC Summary
Batch 20-0645

	Due to the potential contribution of high concentration of native compounds to labelled analogs, in cases where the native PFOA and PFOS are reported from a dilution, the extracted internal standards reported from 13C2-PFOA and 13C4-PFOS are reported from the same dilution level. In all other cases, the extracted internal standard is reported from the same dilution level as the native compound. PFOSA in the level one for the secondary transition of the calibration curve was not used in the calibration curve. The secondary transition is monitored solely for peak identification, not quantification. There is no impact on the reported data. 8:2 FTS in the level one and level two for the secondary transition of the calibration curve, were not used in the calibration curve. The secondary transition is monitored solely for peak identification, not quantification. There is no impact on the reported data.

Holding Times	Extraction Date(s)	Analysis Date(s)
	6/11/2020	6/11, 15, and 16/2020

Procedural Blank (PB)	A PB was prepared with this analytical batch to ensure the sample extraction and analysis methods are free of contamination.
≤ ½ the LOQ Samples >10x PB	No exceedances noted.
	No comments.

Laboratory Control Spike (LCS)	A LCS was prepared with this analytical batch. The percent recoveries of target analytes were calculated to measure accuracy.
Laboratory derived control limits for recovery	No exceedances noted.
	No comments.

Matrix Spike and Matrix Spike Duplicate (MS/MSD)	A MS/MSD was prepared with this analytical batch. The percent recoveries of target analytes were calculated to measure accuracy.
Laboratory derived control limits for recovery and <30% RPD	Project specific MS/MSD not included in this data set.
	No comments.

Extracted Internal Standard Analytes	Labelled analog compounds were added prior to extraction. The recoveries are calculated to measure extraction efficiency.
50-150% of true value	No exceedances noted.
	No comments.

Internal Standard Analytes	Labelled analog compounds were added prior to analysis.
+/- 50% of the area of the L5 calibration point.	No exceedances noted.
	No comments.

QA/QC Summary
Batch 20-0645

Initial Calibration (ICAL)	The LC-MS/MS was calibrated with multi-level calibration curve for all compounds using linear or quadradic curve fitting.
+/- 30% of true value, $R^2 \geq 0.99$	No exceedances noted.
	No comments.

Independent Calibration Check (ICC)	The independent check was run after each initial calibration to verify the calibration. This standard is from a different source than the ICAL.
+/- 30% of true value	No exceedances noted.
	No comments.

Continuing Calibration Verification (CCV)	Continuing calibration standards were run at the beginning and end of 10 injections and at the end of the sequence to ensure that initial calibration is still valid.
+/- 30% of true value	No exceedances noted.
	The following secondary transitions are outside of criteria: • PFOSA in KZ83 CCV (6/15/2020 11:44:16) The secondary transition is monitored solely for peak identification, not quantification. There is no impact on the reported data

Instrument Blank (IB)	Immediately following the highest standard analyzed and daily prior to sample analysis.
≤ ½ the LOQ	No exceedances noted.
	No comments.

BATTELLE
It can be done

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project Number: 100105456-0063
Preparation Batch: 20-0645
Data Set: DP-20-0559
Test Code: Master_369B

QC Parameter:	Exceed:	Justification:
Procedural Blank	0	None
PB Measurement Quality Objective	0	None
Laboratory Control Sample	0	None
Matrix Spike / Matrix Spike Duplicate Recovery	NA	None
Matrix Spike / Matrix Spike Duplicate Precision	NA	None
Extracted Internal Standard Analytes (Surrogates)	0	None
Instrument Calibration	0	None
Instrument Blank	0	None
Independent Calibration Check	0	None
Continuing Calibration Verification	0	None

BATTELLE
It can be done

BATTELLE - NORWELL OPERATIONS
MISCELLANEOUS DOCUMENTATION FORM

Project Title:	TRS Group - PFAS in Solids	**Data Set Number:**	DP-20-0559
Project Number:	100105456-0063	**Prep Batch Number:**	20-0645
Entered By:	Denise Schumitz	**Entered On:**	06/15/2020
Test Code (Matrix Type):	Master_369B(S)		

Samples that were manually integrated are noted on the quant reports with the comment (TRUE).
DMS 6/16/2020

PFOSA in the level one for the secondary transition of the calibration curve was not used in the calibration curve. The secondary transition is monitored solely for peak identification, not quantification. There is no impact on the reported data.
DMS 6/16/2020

8:2FTS in the level one and level two for the secondary transition of the calibration curve, were not used in the calibration curve. The secondary transition is monitored solely for peak identification, not quantification. There is no impact on the reported data.
DMS 6/16/2020

PFOSA is outside of passing criteria for the secondary transition in KZ83 CCV (6/15/2020 11:44:16). The primary transition passes, the secondary is only being monitored and there is no impact on the data.
EMF 6/17/2020

Due to the potential contribution of high concentration of native compounds to labelled analogs, in cases where the native PFOA and PFOS are reported from a dilution, the extracted internal standards reported from 13C2-PFOA and 13C4-PFOS are reported from the same dilution level. In all other cases, the extracted internal standard is reported from the same dilution level as the native compound.
EMF 6/17/2020

Task Leader Approval:

SupervisorApproval:

Digitally signed by Jonathan Thorn
Date: 2020.06.16 15:15:46 -04'00'

PM Approval:

BATTELLE
It can be done

Project Client: TRS Group
Project Name: TRS Group - PFAS in Solids
Project No.: 100105456-0063
Preparation Batch: 20-0645
Data Set: DP-20-0559

		CZ158PB-FS (Procedural Blank)	CZ159LCS-FS (Laboratory Control Sample)	H6078-FS (Control)	H6079-FS (350 C)	H6079DUP-FS (350 C)	H6080-FS (400 C)	H6081-FS (Carbon)
PFBA	375-22-4	-	L	-	-	-	-	L
PFPeA	2706-90-3	-	L	-	-	-	-	L
PFHxA	307-24-4	-	L	L	-	-	-	L
PFHpA	375-85-9	-	L	-	-	-	-	L
PFOA	335-67-1	-	L	L	-	-	-	L
PFNA	375-95-1	-	L	-	-	-	-	L
PFDA	335-76-2	-	L	-	-	-	-	L
PFUnA	2058-94-8	-	L	-	-	-	-	-
PFDoA	307-55-1	-	L	-	-	-	-	-
PFTrDA	72629-94-8	-	L	-	-	-	-	-
PFTeDA	376-06-7	-	L	-	-	-	-	-
NMeFOSAA	2355-31-9	-	L/Br	L/Br	-	-	-	-
NEtFOSAA	2991-50-6	-	L/Br	L/Br	-	-	-	-
PFOSA	754-91-6	-	L	L	-	-	-	L
PFBS	375-73-5	-	L	-	-	-	-	L
PFPeS	2706-91-4	-	L	-	-	-	-	-
PFHxS	355-46-4	-	L/Br	L/Br	-	-	-	L/Br
PFHpS	375-92-8	-	L	L	-	-	-	-
PFOS	1763-23-1	-	L/Br	L/Br	L/Br	-	-	-
PFNS	68259-12-1	-	L	L	-	-	-	-
PFDS	335-77-3	-	L	L	-	-	-	-
4:2FTS	414911-30-1	-	L	-	-	-	-	-
6:2FTS	27619-97-2	-	L	L	-	-	-	-
8:2FTS	39108-34-4	-	L	-	-	-	-	-
HFPO-DA	13252-13-6	-	L	-	-	-	-	-
Adona	919005-14-4	-	L	-	-	-	-	-
11Cl-PF3OUdS	763051-92-9	-	L	-	-	-	-	-
9Cl-PF3ONS	756426-58-1	-	L	-	-	-	-	-

"L" :Linear
"Br": branched
"L/Br": Linear/Branched
"-": Not detected

ACCREDITATIONS

Accrediting Authority	Laboratory ID
U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP)	91667
State of Florida Department of Health	E87856
State of New York Department of Health	12105
State of Washington Department of Ecology	C1050
State of California	3045
Commonwealth of Massachusetts	E87856
State of Maine	MA00056
State of Vermont	VT 87856
State of New Hampshire	2137
Commonwealth of Pennsylvania Department of Environmental Protection	68-05687
State of Alaska Department of Environmental Conservation	19-005
State of Rhode Island	E87856

Current certificates and lists of accredited parameters are available upon request.

APPENDIX B

PACE LABORATORY RESULTS

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

June 18, 2020

TRS Group, Inc.

Sample Delivery Group:	L1227783
Samples Received:	06/10/2020
Project Number:	31.50E.2340P
Description:	Defense
Site:	31.50E.2340P
Report To:	Mr. Daniel Oberle PO Box 737 Longview, WA 98632

Entire Report Reviewed By:

Jennifer Huckaba

Jennifer Huckaba
Project Manager

TABLE OF CONTENTS

C-1 H6067 L1227783-01 Solid

Collected by: Daniel Oberle | Collected date/time: 05/31/20 13:30 | Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

C-2 H6068 L1227783-02 Solid

Collected by: Daniel Oberle | Collected date/time: 05/31/20 13:30 | Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

C-3 H6069 L1227783-03 Solid

Collected by: Daniel Oberle | Collected date/time: 05/31/20 13:30 | Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

350-1 H6070 L1227783-04 Solid

Collected by: Daniel Oberle | Collected date/time: 06/07/20 15:00 | Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

350-2 H6071 L1227783-05 Solid

Collected by: Daniel Oberle | Collected date/time: 06/07/20 15:00 | Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

350-3 H6072 L1227783-06 Solid

Collected by: Daniel Oberle | Collected date/time: 06/07/20 15:00 | Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

400-1 H6073 L1227783-07 Solid

Collected by: Daniel Oberle | Collected date/time: 05/31/20 13:30 | Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

400-2 H6074 L1227783-08 Solid

Collected by: Daniel Oberle
Collected date/time: 05/31/20 13:30
Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

400-3 H6075 L1227783-09 Solid

Collected by: Daniel Oberle
Collected date/time: 05/31/20 13:30
Received date/time: 06/10/20 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Total Solids by Method 2540 G-2011	WG1491972	1	06/14/20 01:07	06/14/20 01:18	KBC	Mt. Juliet, TN
Wet Chemistry by Method D2974	WG1492022	1	06/15/20 12:37	06/15/20 12:37	MMF	Mt. Juliet, TN

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Jennifer Huckaba

Jennifer Huckaba
Project Manager

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	88.3		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.00190	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.334	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	87.7		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.00190	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.324	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	94.4		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.00180	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.314	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	95.7		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.000300	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.0562	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	89.8		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.000400	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.0751	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	88.6		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.000400	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.0618	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	99.5		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.000400	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.0704	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	83.7		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.000200	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.0408	%		1	06/15/2020 12:37	WG1492022

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	100		1	06/14/2020 01:18	WG1491972

Wet Chemistry by Method D2974

Analyte	Result	Units	Qualifier	Dilution	Analysis	Batch
					date / time	
Fractional Organic Carbon	0.000100	g C/g soil		1	06/15/2020 12:37	WG1492022
Fractional Organic Matter	0.0120	%		1	06/15/2020 12:37	WG1492022

Method Blank (MB)

(MB) R3538816-1 06/14/20 01:18

Analyte	MB Result %	MB Qualifier	MB MDL %	MB RDL %
Total Solids	0.000			

L1227783-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1227783-01 06/14/20 01:18 • (DUP) R3538816-3 06/14/20 01:18

Analyte	Original Result %	DUP Result %	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Total Solids	88.3	86.9	1	1.55		10

Laboratory Control Sample (LCS)

(LCS) R3538816-2 06/14/20 01:18

Analyte	Spike Amount %	LCS Result %	LCS Rec. %	Rec. Limits %	LCS Qualifier
Total Solids	50.0	50.0	100	85.0-115	

Method Blank (MB)

(MB) R3540254-1 06/15/20 12:37

Analyte	MB Result g C/g soil	MB Qualifier	MB MDL g C/g soil	MB RDL g C/g soil
Fractional Organic Carbon	0.000			
Fractional Organic Matter	0.000			

L1227783-09 Original Sample (OS) • Duplicate (DUP)

(OS) L1227783-09 06/15/20 12:37 • (DUP) R3540254-2 06/15/20 12:37

Analyte	Original Result g C/g soil	DUP Result g C/g soil	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Fractional Organic Carbon	0.000100	0.000	1	0.000		20
Fractional Organic Matter	0.0120	0.00800	1	0.000		20

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Results Disclaimer - Information that may be provided by the customer, and contained within this report, include Permit Limits, Project Name, Sample ID, Sample Matrix, Sample Preservation, Field Blanks, Field Spikes, Field Duplicates, On-Site Data, Sampling Collection Dates/Times, and Sampling Location. Results relate to the accuracy of this information provided, and as the samples are received.

Abbreviations and Definitions

MDL	Method Detection Limit.
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description

The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

ACCREDITATIONS & LOCATIONS

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN-03-2002-34
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	n/a
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	90010	South Carolina	84004
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana [1]	LA180010	Texas	T104704245-18-15
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	TN00003
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	460132
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA

Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.