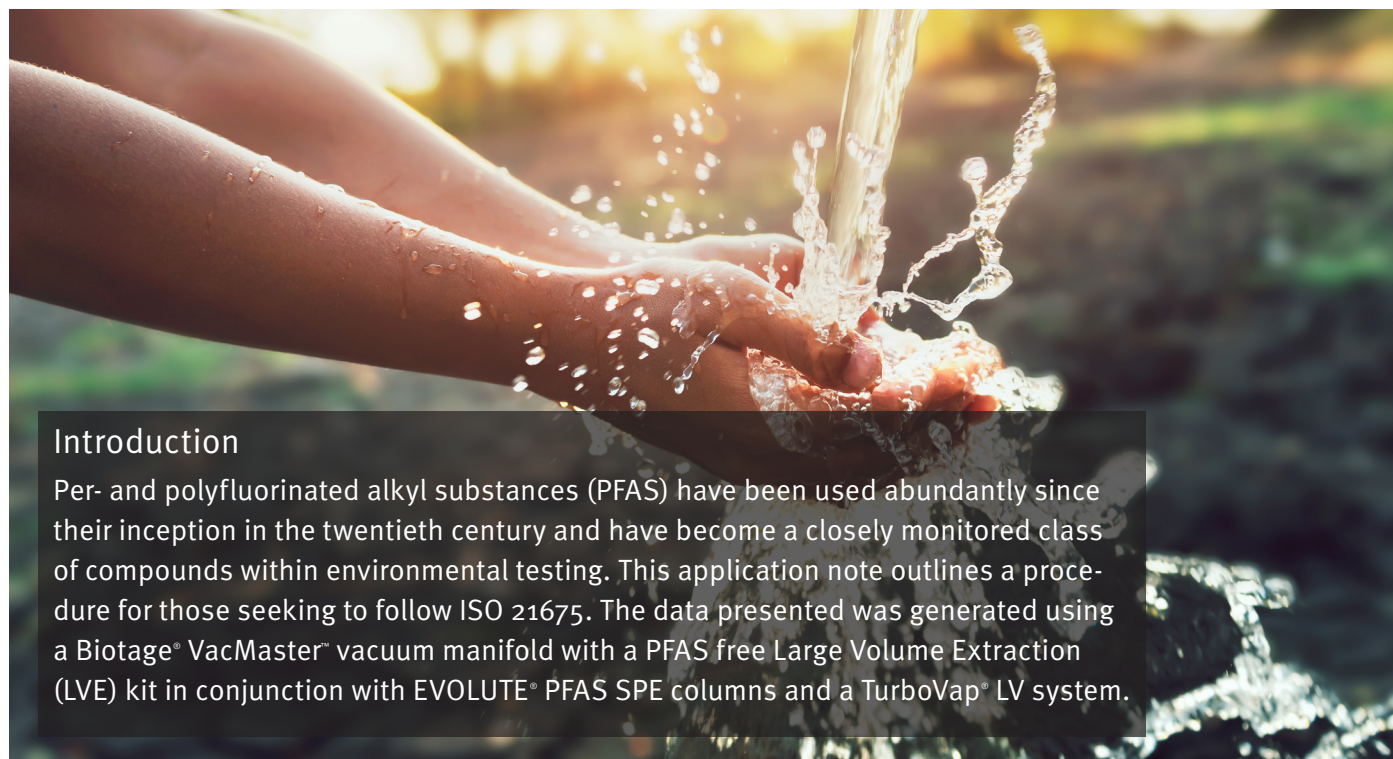


# Manual Extraction of PFAS in Drinking Water in Compliance with ISO 21675

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## Introduction

Per- and polyfluorinated alkyl substances (PFAS) have been used abundantly since their inception in the twentieth century and have become a closely monitored class of compounds within environmental testing. This application note outlines a procedure for those seeking to follow ISO 21675. The data presented was generated using a Biotage® VacMaster™ vacuum manifold with a PFAS free Large Volume Extraction (LVE) kit in conjunction with EVOLUTE® PFAS SPE columns and a TurboVap® LV system.

## Equipment and Materials Used

### Biotage

- » Biotage® VacMaster™ 20 Sample Processing Station With 15 mm Rack, p/n 121-2015ML, fitted with polypropylene (PFAS free) stopcocks (p/n 121-0009-PP)
- » Biotage® VacMaster™ LVE Kit (PFAS) for 1, 3, 6 mL SPE Columns (p/n 121-2190)
- » EVOLUTE® PFAS 500 mg/6 mL SPE Columns, p/n 614-0050-CP
- » EVOLUTE® PFAS 150 mg/6 mL SPE Columns, p/n 614-0015-CP
- » TurboVap® LV Automated Solvent Evaporation System, p/n 415000
- » TurboVap® LV Multi Rack (48 Positions, 10–20 mm Tubes), p/n 414964

### Wellington Laboratories

- » ISO 21675:2019 Labelled Stock Solution, 1.2 mL, p/n ISO 21675-LSS
- » ISO 21675:2019 Native Stock Solution, 1.2 mL, p/n ISO 21675-NSS

### Agilent

- » InfinityLab PFC Delay Column, 4.6 x 30 mm, p/n 5062-8100
- » ZORBAX RRHD Eclipse Plus C18, 95 Å, 2.1 x 50 mm, 1.8 µm, p/n 959757-902

### Sigma-Aldrich

- » Ammonium Acetate, ACS Reagent Grade ≥ 97%, p/n 238074-25G
- » Acetic Acid, Glacial, ReagentPlus®, ≥ 99% p/n A6283

### Honeywell

- » Water, ACS Certified, HPLC Grade, p/n AH365-4
- » Methanol, Burdick & Jackson™, LC-MS Grade, p/n LC230-4

### VWR

- » 15 mL Polypropylene Centrifuge Tubes with Caps, p/n 21008-670
- » 250 mL Polypropylene Wide Mouth Bottles, p/n 414004-125

## Analytes

**Table 1.** Listing of Target Analytes and Internal Standards.

Target Analyte	Acronym	CAS
Perfluoro-n-butanesulfonic acid	PFBS	375-73-5
Perfluoro-n-hexanesulfonic acid	PFHxS	355-46-4
Perfluoro-n-heptanesulfonic acid	PFHpS	375-92-8
Perfluoro-n-octanesulfonic acid	PFOS	1763-23-1
Perfluoro-n-decanesulfonic acid	PFDS	335-77-3
Perfluorooctanesulfonamide	FOSA	754-91-6
N-methyl perfluorooctanesulfonamide	N-MeFOSA	31506-32-8
N-ethyl perfluorooctanesulfonamide	N-EtFOSA	4151-50-2
N-methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9
N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6
6:2 Fluorotelomer sulfonic acid	6:2 FTSA	27619-97-2
8:2 Fluorotelomer sulfonic acid	8:2 FTSA	39108-34-4
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	73606-19-6
Perfluoro-n-butanoic acid	PFBA	375-22-4
Perfluoro-n-pentanoic acid	PFPeA	2706-90-3
Perfluoro-n-hexanoic acid	PFHxA	307-24-4
Perfluoro-n-heptanoic acid	PFHpA	375-85-9
Perfluoro-n-octanoic acid	PFOA	335-67-1
Perfluoro-n-nonanoic acid	PFNA	375-95-1
Perfluoro-n-decanoic acid	PFDA	335-76-2
Perfluoro-n-undecanoic acid	PFUnDA	2058-94-8
Perfluoro-n-dodecanoic acid	PFDoDA	307-55-1
Perfluoro-n-tridecanoic acid	PFTTrDA	72629-94-8
Perfluoro-n-tetradecanoic acid	PFTeDA	376-06-7
Perfluoro-n-hexadecanoic acid	PFHxDA	67905-19-5
Perfluoro-n-octadecanoic acid	PFOcDA	16517-11-6
8:2 Fluorotelomer unsaturated carboxylic acid	8:2 FTUCA	70887-84-2
8:2 Polyfluoroalkyl phosphate diester	8:2 diPAP	678-41-1
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6
4,8-Dioxa-3H-perfluorononanoic acid	DONA	919005-14-4

Target Analyte	Acronym	CAS
<b>Internal Standard</b>		
Sodium perfluoro-1-[2,3,4- <sup>13</sup> C <sub>3</sub> ]butanesulfonate	<sup>13</sup> C <sub>3</sub> -PFBS	
Sodium perfluoro-1-[1,2,3- <sup>13</sup> C <sub>3</sub> ]hexanesulfonate	<sup>13</sup> C <sub>3</sub> -PFHxS	
Sodium perfluoro-1-[1,2,3- <sup>18</sup> O <sub>2</sub> ]hexanesulfonate	<sup>18</sup> O <sub>2</sub> -PFHxS	
Sodium perfluoro-1-[1,2,3,4- <sup>13</sup> C <sub>4</sub> ]octanesulfonate	<sup>13</sup> C <sub>4</sub> -PFOS	
Sodium perfluoro-1-[1,2,3,4- <sup>13</sup> C <sub>8</sub> ]octanesulfonate	<sup>13</sup> C <sub>8</sub> -PFOS	
Perfluoro-1-[ <sup>13</sup> C <sub>8</sub> ]octanesulfonamide	<sup>13</sup> C <sub>8</sub> -FOSA	
N-methyl-d <sub>3</sub> -perfluoro-1-octanesulfonamide	d <sub>3</sub> -N-MeFOSA	
N-ethyl-d <sub>5</sub> -perfluoro-1-octanesulfonamide	d <sub>5</sub> -N-EtFOSA	
N-deuteriomethylperfluoro-1-octanesulfonamidoacetic acid	d <sub>3</sub> -N-MeFOSAA	
N-deuterioethylperfluoro-1-octanesulfonamidoacetic acid	d <sub>5</sub> -N-EtFOSAA	
Sodium 1H,1H,2H,2H-perfluoro-1-[1,2- <sup>13</sup> C <sub>2</sub> ]-octane sulfonate	<sup>13</sup> C <sub>2</sub> -6:2 FTSA	
Sodium 1H,1H,2H,2H-perfluoro-1-[1,2- <sup>13</sup> C <sub>2</sub> ]-decane sulfonate	<sup>13</sup> C <sub>2</sub> -8:2 FTSA	
Perfluoro-n-[1,2,3,4- <sup>13</sup> C <sub>4</sub> ]butanoic acid	<sup>13</sup> C <sub>4</sub> -PFBA	
Perfluoro-n-[1,2,3,4,5- <sup>13</sup> C <sub>5</sub> ]pentanoic acid	<sup>13</sup> C <sub>5</sub> -PFPeA	
Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]hexanoic acid	<sup>13</sup> C <sub>2</sub> -PFHxA	
Perfluoro-n-[1,2- <sup>13</sup> C <sub>5</sub> ]hexanoic acid	<sup>13</sup> C <sub>5</sub> -PFHxA	
Perfluoro-n-[1,2,3,4- <sup>13</sup> C <sub>4</sub> ]heptanoic acid	<sup>13</sup> C <sub>4</sub> -PFHpA	
Perfluoro-[1,2- <sup>13</sup> C <sub>4</sub> ]octanoic acid	<sup>13</sup> C <sub>4</sub> -PFOA	
Perfluoro-[1,2- <sup>13</sup> C <sub>8</sub> ]octanoic acid	<sup>13</sup> C <sub>8</sub> -PFOA	
Perfluoro-n-[ <sup>13</sup> C <sub>5</sub> ]nonanoic acid	<sup>13</sup> C <sub>5</sub> -PFNA	
Perfluoro-n-[ <sup>13</sup> C <sub>9</sub> ]nonanoic acid	<sup>13</sup> C <sub>9</sub> -PFNA	
Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]decanoic acid	<sup>13</sup> C <sub>2</sub> -PFDA	
Perfluoro-n-[1,2- <sup>13</sup> C <sub>6</sub> ]decanoic acid	<sup>13</sup> C <sub>6</sub> -PFDA	
Perfluoro-n-[1,2,3,4,5,6,7- <sup>13</sup> C <sub>2</sub> ]undecanoic acid	<sup>13</sup> C <sub>2</sub> -PFUnDA	
Perfluoro-n-[1,2,3,4,5,6,7- <sup>13</sup> C <sub>7</sub> ]undecanoic acid	<sup>13</sup> C <sub>7</sub> -PFUnDA	
Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]dodecanoic acid	<sup>13</sup> C <sub>2</sub> -PFDODA	
Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]tetradecanoic acid	<sup>13</sup> C <sub>2</sub> -PFTeDA	
Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]hexadecanoic acid	<sup>13</sup> C <sub>2</sub> -PFHxDA	
2H-Perfluoro-[1,2- <sup>13</sup> C <sub>2</sub> ]-2-decenoic acid	<sup>13</sup> C <sub>2</sub> -8:2 FTUCA	
Sodium bis(1H,1H,2H,2H-[1,2- <sup>13</sup> C <sub>2</sub> ]perfluorodecyl)-phosphate	<sup>13</sup> C <sub>4</sub> -8:2 diPAP	
Tetrafluoro-2-heptafluoropropoxy- <sup>13</sup> C <sub>3</sub> -propanoic acid	<sup>13</sup> C <sub>3</sub> -HFPO-DA	

## Solution Preparation

### Ammonia/Methanol Solution

1. Add 400  $\mu\text{L}$  of  $\text{NH}_4\text{OH}$  for every 100 mL of methanol to a clean beaker.
2. Agitate to homogenize.
3. Prepare new solution daily.

### Acetate Buffer

1. Measure out 499.5 mL of reagent water in a clean beaker.
2. Add 0.193 g of  $\text{NH}_4\text{Ac}$ .
3. Sonicate the solution for 5 minutes until the salt is fully dissolved.
4. Add 570  $\mu\text{L}$  of glacial acetic acid.
5. Agitate to homogenize the solution.

### Working Spiking Solution

1. Dilute 100  $\mu\text{L}$  of the native stock solution with 900  $\mu\text{L}$  of methanol to achieve a 10 ppt solution.



## Summary of SPE method

### SPE Column Format

EVOLUTE® PFAS 500 mg/6 mL or EVOLUTE® PFAS 150 mg/6 mL

### Sample Pre-Treatment

Adjust the pH of each sample to 3 using glacial acetic acid. Add targets and internal standards.

### Conditioning

Condition each column with 0.1 %  $\text{NH}_4\text{OH}$  in methanol (10 mL) followed by methanol (10 mL).

### Equilibration

Equilibrate each column with reagent water (10 mL).

### Sample Loading

Load sample at a flow rate of 5 mL/min.

### Wash

Rinse the sample container with acetate buffer solution (10 mL) and load onto the column. Repeat using reagent water (10 mL).

### Dry

Dry the column for 5 minutes at a flow rate of 5 mL/min.

### Elution

Rinse the sample container with methanol (5 mL) and use to elute the analytes from the column at a flow rate of 2 mL/min. Repeat using 0.1 %  $\text{NH}_4\text{OH}$  in methanol (5 mL).

### Post Extraction

Concentrate the extract to a volume of 1 mL and analyze.



## Sample Preparation Procedure

- Clean all parts of the Biotage® VacMaster™ system per the procedure given in Appendix A.
- Set up and fill new sample containers with of water; 250–500 mL are typical for this method.
- Add glacial acetic acid to each of the sample containers to reduce the pH to 3 (approximately 100 µL for 250 mL sample volumes and 200 µL for 500 mL sample volumes).
- Verify the pH of the sample is 3 using pH paper. To reduce the possibility of contamination, a duplicate volume was collected and adjusted to the appropriate pH and the same volume of acid was added to the sample container.
- Prepare for the determination of the initial sample volume by either marking the level of the sample on the container or by weighing the sample container.
- Add 20 µL of the undiluted Labeled Stock Solution to each of the sample containers. If desired, fortify a sample using target analytes: the addition of 125 µL or 37.5 µL of the native stock solution will yield either 50 ppt or 15 ppt concentrations respectively, while the addition of 50 µL of the working spiking solution will yield a 2 ppt concentration. If the mixes used were different than the ones outlined in this note, adjust the concentration or spiking amounts as needed.
- Load the desired EVOLUTE® PFAS columns onto the Biotage® VacMaster™. Seal any unused positions using VacMaster™ Port Sealing Plugs (p/n 121-0005)
- Rinse each column with 10 mL of 0.1 % NH<sub>4</sub>OH in methanol and apply vacuum at 10 mL/min to pull it to waste. Do not allow the sorbent to go dry.
- Rinse each column with 10 mL of methanol and apply vacuum at 10 mL/min to pull it to waste. Do not allow the sorbent to go dry.
- Rinse each column with 10 mL of reagent water and apply vacuum at 10 mL/min to send it to waste. Do not allow the water level to drop below the top of the packing.
- Using the Biotage® VacMaster™ LVE Kit, place one end of the cleaned tubing into the bottom of each of the sample containers, and secure in position using the clips provided.
- Load the samples onto the columns using a flow rate of 5 mL/min.
- Once the sample has been fully loaded, rinse the sample containers using 10 mL of acetate buffer solution, swirl to ensure the full rinsing of the container, and load the aliquot onto the column at a rate of 5 mL/min.
- Rinse the sample containers using 10 mL of reagent water, swirl to ensure the full rinsing of the container, and load the aliquot onto the column at a rate of 5 mL/min.
- Dry the column for 5 minutes at a rate of 5 mL/min.
- Load 15 mL centrifuge tubes into the rack corresponding to each of the column positions and load into the Biotage® VacMaster™.
- Rinse each sample container using 5 mL of methanol and swirl to ensure the full rinsing of the container. Load the aliquot through the appropriate column and collect at a dropwise rate.
- Rinse each sample container using 5 mL of 0.1% NH<sub>4</sub>OH in methanol and swirl to ensure the full rinsing of the container. Load the aliquot through the appropriate column and collect at a dropwise rate.
- Determine the initial sample volume by either using a graduated cylinder and filling the sample container to the original mark or by taking an additional weight of the container.
- Transfer the centrifuge tubes to the TurboVap® LV system and concentrate the samples to just under 1 mL using nitrogen according to the parameters in Table 2.
- Bring the final extract to 1 mL and transfer to an autosampler vial.
- Load the extract onto a calibrated LC-MS/MS system and process using the conditions given in the below sections.

**Table 2.** TurboVap® LV Concentration Protocol.

<b>Bath Temp:</b>	60 °C
<b>Evaporation Mode</b>	Method (Ramp Gradient)
<b>Manifold Setup</b>	48 positions
<b>Rack Row Height</b>	120 mm*
<b>Step 1:</b>	1.5 L/min for 20 min
<b>Step 2:</b>	3.0 L/min for 15 min
<b>Step 3:</b>	3.5 L/min for 45 min

\*The nozzle position was adjusted such that it was as far to the right as possible to give the user a clear view of the vortex within the tube.



## LC-MS/MS Conditions

### Agilent 1290 Infinity II LC System

- » 1290 Infinity II Multicolumn Thermostat, G7116B
- » 1290 Infinity II Multisampler, G7167B
- » 1290 Infinity II High Speed Pump, G7120A
- » InfinityLab PFC-free HPLC Conversion Kit, 5004-0006

### Columns

- » InfinityLab PFC Delay Column, 4.6 x 30 mm, p/n 5062-8100
- » ZORBAX RRHD Eclipse Plus C18, 95 Å, 2.1 x 50 mm, 1.8 µm, p/n 959757-902

### Mobile Phases

- » A: 20 mM Ammonium Acetate in Water
- » B: Methanol

Table 3. LC Gradient.

Time (min)	%A	%B
0.50	95.00	5.00
3.00	60.00	40.00
16.00	20.00	80.00
18.00	20.00	80.00
20.00	5.00	95.00
20.50	0.00	100.00
25.00	0.00	100.00
26.00	5.00	95.00

- » Flow Rate: 0.2 mL/min
- » Injection Volume: 5 µL
- » Column Temperature: 50 °C

### Agilent 6470 MS/MS, G6470B

- » Gas Temperature: 230 °C
- » Gas Flow: 4 L/min
- » Nebulizer: 20 psi
- » Sheath Gas Temperature: 375 °C
- » Sheath Gas Flow: 12 L/min
- » Capillary Voltage (Positive): 3500 V
- » Capillary Voltage (Negative): 3500 V
- » Nozzle Voltage (Positive): 500 V
- » Nozzle Voltage (Negative): 0 V

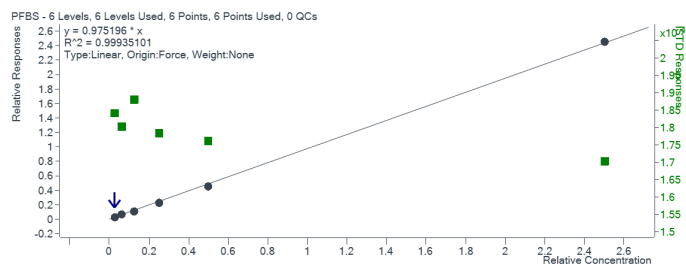
For a complete listing of MRM Transitions, see Appendix B

## Results

### System Calibration

For the work being done here, a total of six points were used in the calibration covering a range of 0.2–20 ppt. The lowest three points were below the calculated MRL. The curve was forced through zero and achieved excellent linearity across the calibration range.

### PFBS



### PFHxS

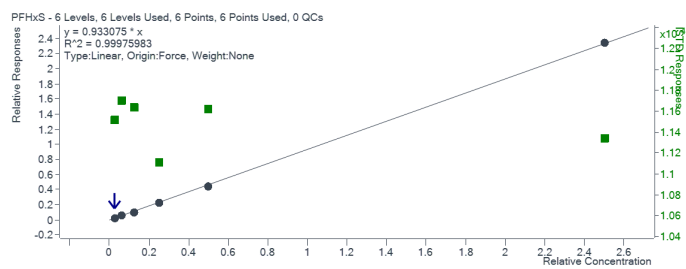


Figure 1. Calibration curves for PFBS and PFHxS. Calibration curves for the remaining target analytes in Table 1 are shown in Appendix C.

### Determination of the Minimum Reporting Level (MRL) and Detection Limits (DL)

A target MRL of 2 ng/L was selected and at least seven replicate laboratory fortified blanks (LFBs) were created and run at that concentration. Figure 2 below illustrates the results of this test for both the 150 mg and 500 mg columns using 250 mL sample volumes; all compounds were recovered within 15% of the spiked amount and had less than 10% CV.

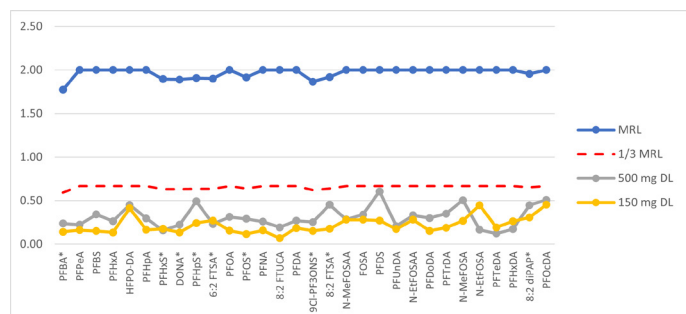
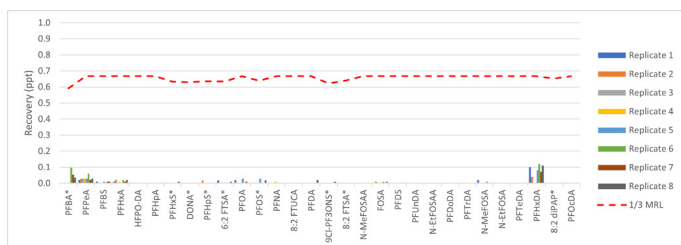


Figure 2. MRL and DL Recoveries. Those compounds with an asterisk were used in salt form.

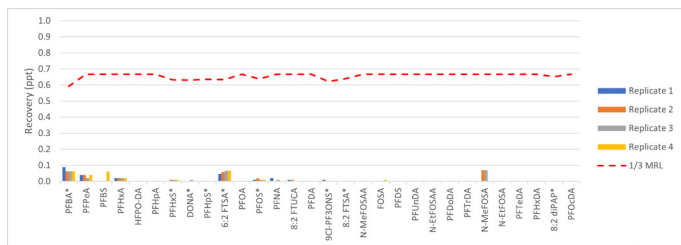
The data for individual compounds is shown in Appendix D.

### Demonstration of Low System Background

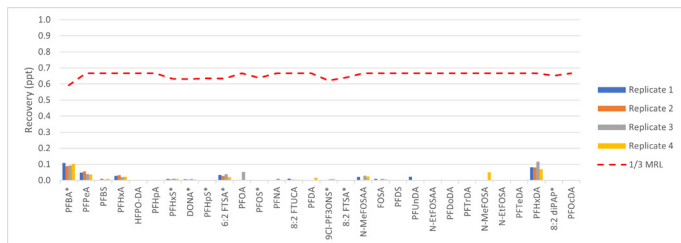
An investigation into the background of the complete process was done in three steps. The first step was to run blank injections of methanol on the analytical system (system blank). The second step was to load centrifuge tubes containing a similar volume of methanol as would result from the extraction process onto the evaporation system, allowing them to concentrate and then run on the analytical system (evaporation blank). The third and final step was to create a full Laboratory Reagent Blank (LRB), extract and concentrate it, and run it on the analytical system. By separating the process into three steps it becomes easier to determine what, if any, contribution to the overall background each of the steps has. The result of these tests are given in Appendix E and selected data are shown below in Figures 3–5.



**Figure 3.** Contribution of the TurboVap® LV to the PFAS Background. Those compounds with an asterisk were used in salt form.



**Figure 4.** PFAS Background for full LRB using EVOLUTE® PFAS 500 mg/6 mL columns. Those compounds with an asterisk were used in salt form.



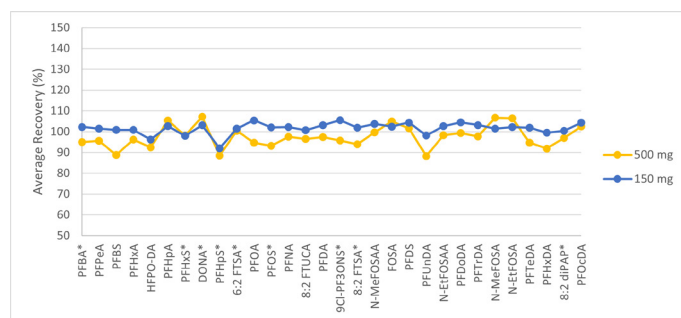
**Figure 5.** PFAS Background for full LRB using EVOLUTE® PFAS 150 mg/6 mL columns. Those compounds with an asterisk were used in salt form.

For those results which were generated using only the analytical system, all target analytes were N.D. (unable to be separated from the noise in the baseline) and so were not listed out in the previous tables.

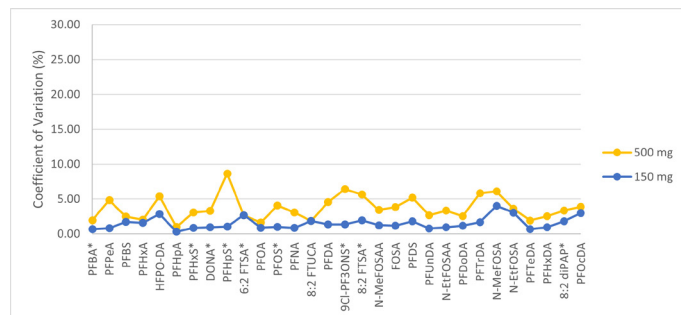
When examining the data resulting for both the TurboVap® LV and the full LRB tests (which includes the Biotage® VacMaster® manifold, PFAS Free Large Volume Loading Kit, and the EVOLUTE® cartridges as well as the TurboVap® LV) there are clear indications of the presence of a PFAS background. However, even at the highest concentrations detected, all levels are much lower than the 1/3 MRL limit indicating that the background is acceptable and will not interfere with future sample runs.

### Initial Demonstration of Precision and Accuracy (IDP, IDA)

To determine the precision and accuracy of the sample preparation process, four LFB samples were prepared at concentrations of 15 ppt. The data is given in Appendix F and illustrated in Figures 6 and 7.



**Figure 6.** Initial Demonstration of Accuracy (15 ng/L, n=4). Those compounds with an asterisk were used in salt form.

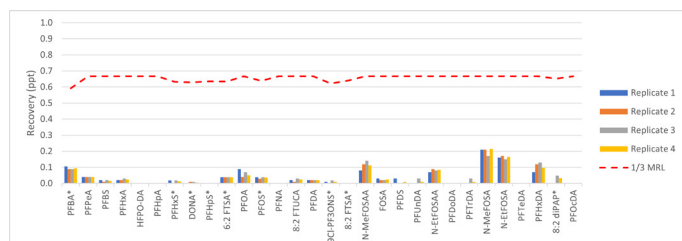


**Figure 7.** Initial Demonstration of Precision (15 ng/L, n=4). Those compounds with an asterisk were used in salt form.

The results show that the average recovery for each target analyte was within 15% of the nominal value and that the coefficient of variation (CV) for each analyte fell under 10% on average.

## Examination of System Carryover

To simulate an influent sample, four LFB samples were created with concentrations which were above the range of the calibration curve. These samples were extracted, and the cleanup procedure given in Appendix A was run three times. To ensure that the system background was adequately reduced, a set of four LRB samples were extracted immediately afterwards and analyzed. The LRB data is presented in Appendix G and illustrated in Figure 8.



**Figure 8.** Results of carryover study following four, 50 ng/L LFB samples using EVOLUTE® PFAS 500 mg/6 mL columns. Those compounds with an asterisk were used in salt form.

The graph shown in Figure 8 shows a clear indication that the cleaning procedure in Appendix A was successful in reducing the background of PFAS compounds to below the 1/3 MRL limit. For further reductions in the background, additional cleaning steps could be employed.

## Conclusion

With the scrutiny being given to the presence of PFAS compounds in the environment, it is essential to find reliable products which can meet the requirements of ISO 21675. This application note has shown that the Biotage® VacMaster® vacuum manifold with PFAS free accessories, EVOLUTE® PFAS SPE columns and the TurboVap® LV can be used to easily meet and exceed the demands of the method.

## Ordering Information

Part Number	Description	Qty
<b>121-2015ML</b>	Biotage® VacMaster® 20 Sample Processing Station With 15 mm Rack	1
<b>121-2190</b>	Biotage® VacMaster® LVE Kit (PFAS) for 1, 3, 6 mL SPE Columns	1
<b>121-0009-PP</b>	Polypropylene (PFAS) Stopcocks	10
<b>614-0050-CP</b>	EVOLUTE® PFAS 500 mg/6 mL columns	30
<b>614-0015-CP</b>	EVOLUTE® PFAS 150 mg/6 mL columns	30
<b>415000</b>	TurboVap® LV Automated Solvent Evaporation System	1
<b>414964</b>	TurboVap® LV Multi Rack (48 Positions, 10–20 mm Tubes)	1





# Appendix A

## Biotage® VacMaster™ Cleaning Procedure

For the best results, it is recommended that this procedure be completed before the use of the Biotage® VacMaster™ each day and at the end of each extraction prior to proceeding with the next set of samples.

1. Ensure that a column and column adapter is installed onto each VacMaster™ position slated to be cleaned.
2. Fill a clean beaker with 50 mL of methanol and place no more than four of the LVE Kit lines into the beaker.
3. Apply vacuum to the manifold and pull the methanol through the positions into the waste container.
4. Remove the column and discard.
5. Using methanol in a squeeze bottle, clean the exterior of the LVE Kit's lines, the column adapters, the stopcock, and the metal cannula. Discard all rinsate.
6. Repeat this up to three times for all positions which require cleaning.

Note: In situations where the previous sample was highly concentrated, the above cleaning procedure may need to be repeated multiple times. If there is concern regarding potential carryover contamination regardless of the cleaning procedure, a laboratory reagent blank should be run in that position to ensure its cleanliness.



# Appendix B

## MRM Transitions

Table 4. MRM Transitions for Agilent 6470 MS/MS.

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Frag (V)	CE (V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
6:2FTS	No	427	Unit/Enh (6490)	406.8	Unit/Enh (6490)	125	24	5	13.3	1.37	Negative
6:2FTS	No	427	Unit/Enh (6490)	80.9	Unit/Enh (6490)	125	40	5	13.3	1.37	Negative
8:2 diPAP	No	989	Unit/Enh (6490)	543	Unit/Enh (6490)	100	20	5	22.15	2.33	Negative
8:2 diPAP	No	989	Unit/Enh (6490)	97	Unit/Enh (6490)	100	20	5	22.15	2.33	Negative
8:2 FTS	No	527	Unit/Enh (6490)	506.8	Unit/Enh (6490)	170	28	5	16.2	1.64	Negative
8:2 FTS	No	527	Unit/Enh (6490)	80.9	Unit/Enh (6490)	170	40	5	16.2	1.64	Negative
8:2 FTUCA	No	457	Unit/Enh (6490)	393	Unit/Enh (6490)	100	28	5	15.25	1.56	Negative
8:2 FTUCA	No	457	Unit/Enh (6490)	343	Unit/Enh (6490)	100	28	5	15.25	1.56	Negative
9CI-PF3ONS	No	530.9	Unit/Enh (6490)	350.9	Unit/Enh (6490)	145	28	5	15.7	1.6	Negative
9CI-PF3ONS	No	530.9	Unit/Enh (6490)	83	Unit/Enh (6490)	145	32	5	15.7	1.6	Negative
ADONA	No	377	Unit/Enh (6490)	250.9	Unit/Enh (6490)	80	12	5	11.8	1.23	Negative
ADONA	No	377	Unit/Enh (6490)	85	Unit/Enh (6490)	80	36	5	11.8	1.23	Negative
C2-6:2FTS	No	429	Unit/Enh (6490)	81	Unit/Enh (6490)	125	24	5	13.3	1.37	Negative
C2-8:2FTS	No	529	Unit/Enh (6490)	81	Unit/Enh (6490)	170	28	5	16.2	1.64	Negative
C2-8:2FTUCA	No	459	Unit/Enh (6490)	394	Unit/Enh (6490)	100	28	5	15.25	1.56	Negative
C2-PFDoA	No	615	Unit/Enh (6490)	570	Unit/Enh (6490)	79	5	5	18.2	1.84	Negative
C2-PFHxDA	No	815	Unit/Enh (6490)	770	Unit/Enh (6490)	100	20	5	21.5	2.19	Negative
C2-PFTeDA	No	715	Unit/Enh (6490)	670	Unit/Enh (6490)	79	5	5	19.9	2.03	Negative
C3-HFPO-DA	No	287	Unit/Enh (6490)	169	Unit/Enh (6490)	155	4	5	10.3	1	Negative
C3-PFBS	No	302	Unit/Enh (6490)	80	Unit/Enh (6490)	100	45	5	7.9	1.61	Negative
C3-PFHxS	No	402	Unit/Enh (6490)	80	Unit/Enh (6490)	100	49	5	11.7	1.5	Negative
C4-8:2diPAP	No	993	Unit/Enh (6490)	545	Unit/Enh (6490)	100	20	5	22.15	2.23	Negative
C4-PFBA	No	217	Unit/Enh (6490)	172	Unit/Enh (6490)	60	8	5	5.1	1.45	Negative
C4-PFHpA	No	367	Unit/Enh (6490)	322	Unit/Enh (6490)	72	0	5	11.6	1.2	Negative
C5-PFHxA	No	318	Unit/Enh (6490)	273	Unit/Enh (6490)	70	8	5	9.7	1.14	Negative
C5-PFPeA	No	268	Unit/Enh (6490)	223	Unit/Enh (6490)	60	20	5	7.4	1.55	Negative
C6-PFDA	No	519	Unit/Enh (6490)	474	Unit/Enh (6490)	81	4	5	16.2	1.65	Negative
C7-PFUdA	No	570	Unit/Enh (6490)	525	Unit/Enh (6490)	100	20	5	17.2	1.75	Negative
C8-FOSA	No	506	Unit/Enh (6490)	78	Unit/Enh (6490)	150	20	5	16.8	1.71	Negative
C8-PFOA	No	421	Unit/Enh (6490)	376	Unit/Enh (6490)	80	8	5	13.4	1.38	Negative
C8-PFOS	No	507	Unit/Enh (6490)	80	Unit/Enh (6490)	100	50	5	15	1.53	Negative
C9-PFNA	No	472	Unit/Enh (6490)	427	Unit/Enh (6490)	66	4	5	14.9	1.52	Negative
d3-N-MeFOSA	No	515	Unit/Enh (6490)	169	Unit/Enh (6490)	100	28	5	18.8	1.91	Negative
d3-N-MeFOSAA	No	573	Unit/Enh (6490)	419	Unit/Enh (6490)	100	20	5	16.7	1.7	Negative
d5-N-EtFOSA	No	531	Unit/Enh (6490)	169	Unit/Enh (6490)	100	32	5	19.6	1.2	Negative
d5-N-EtFOSAA	No	589	Unit/Enh (6490)	419	Unit/Enh (6490)	100	20	5	17.25	1.75	Negative
FOSA	No	498	Unit/Enh (6490)	169	Unit/Enh (6490)	100	38	5	16.8	1.71	Negative
FOSA	No	498	Unit/Enh (6490)	78	Unit/Enh (6490)	150	38	5	16.8	1.71	Negative

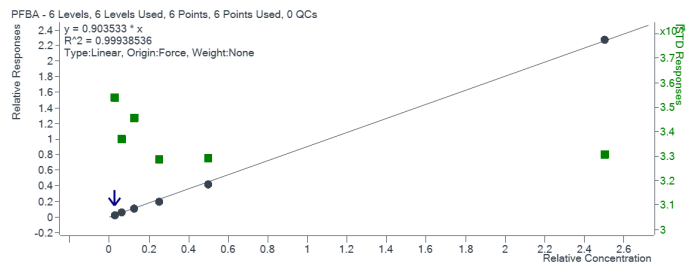
Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Frag (V)	CE (V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
HFPO-DA-CO2	No	285	Unit/Enh (6490)	184.9	Unit/Enh (6490)	155	16	5	10.3	1.5	Negative
HFPO-DA-CO2	No	285	Unit/Enh (6490)	168.9	Unit/Enh (6490)	155	4	5	10.3	1.5	Negative
N-EtFOSA	No	526	Unit/Enh (6490)	219	Unit/Enh (6490)	100	32	5	19.6	1.99	Negative
N-EtFOSA	No	526	Unit/Enh (6490)	169	Unit/Enh (6490)	100	28	5	19.6	1.99	Negative
N-EtFOSAA	No	584	Unit/Enh (6490)	526	Unit/Enh (6490)	100	20	5	17.3	1.75	Negative
N-EtFOSAA	No	584	Unit/Enh (6490)	419	Unit/Enh (6490)	100	20	5	17.3	1.75	Negative
N-MeFOSA	No	512	Unit/Enh (6490)	219	Unit/Enh (6490)	100	28	5	18.8	1.91	Negative
N-MeFOSA	No	512	Unit/Enh (6490)	169	Unit/Enh (6490)	100	28	5	18.8	1.91	Negative
N-MeFOSAA	No	570	Unit/Enh (6490)	512	Unit/Enh (6490)	100	20	5	16.7	1.7	Negative
N-MeFOSAA	No	570	Unit/Enh (6490)	419	Unit/Enh (6490)	100	20	5	16.7	1.7	Negative
PFBA	No	213	Unit/Enh (6490)	168.9	Unit/Enh (6490)	60	8	5	5.1	1.48	Negative
PFBS	No	298.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	100	29	5	7.9	1.41	Negative
PFBS	No	298.9	Unit/Enh (6490)	80	Unit/Enh (6490)	100	45	5	7.9	1.41	Negative
PFDA	No	513	Unit/Enh (6490)	469	Unit/Enh (6490)	81	4	5	16.2	1.65	Negative
PFDA	No	513	Unit/Enh (6490)	218.7	Unit/Enh (6490)	100	16	5	16.2	1.65	Negative
PFDoA	No	613	Unit/Enh (6490)	569	Unit/Enh (6490)	79	5	5	18.2	1.84	Negative
PFDoA	No	613	Unit/Enh (6490)	268.7	Unit/Enh (6490)	100	20	5	18.2	1.84	Negative
PFDS	No	599	Unit/Enh (6490)	99	Unit/Enh (6490)	100	40	5	17.15	1.75	Negative
PFDS	No	599	Unit/Enh (6490)	80	Unit/Enh (6490)	100	40	5	17.15	1.75	Negative
PFHpA	No	362.9	Unit/Enh (6490)	319	Unit/Enh (6490)	72	0	5	11.6	1.2	Negative
PFHpA	No	362.9	Unit/Enh (6490)	169	Unit/Enh (6490)	72	12	5	11.6	1.2	Negative
PFHpS	No	448.9	Unit/Enh (6490)	98.7	Unit/Enh (6490)	100	44	5	13.5	1.39	Negative
PFHpS	No	448.9	Unit/Enh (6490)	79.7	Unit/Enh (6490)	100	52	5	13.5	1.39	Negative
PFHxA	No	313	Unit/Enh (6490)	268.9	Unit/Enh (6490)	70	8	5	9.7	1.12	Negative
PFHxA	No	313	Unit/Enh (6490)	119	Unit/Enh (6490)	70	18	5	9.7	1.12	Negative
PFHxDA	No	813	Unit/Enh (6490)	769	Unit/Enh (6490)	79	5	5	21.5	2.19	Negative
PFHxDA	No	813	Unit/Enh (6490)	369	Unit/Enh (6490)	100	20	5	21.5	2.19	Negative
PFHxS	No	398.9	Unit/Enh (6490)	99	Unit/Enh (6490)	100	45	5	11.7	1.5	Negative
PFHxS	No	398.9	Unit/Enh (6490)	80	Unit/Enh (6490)	100	49	5	11.7	1.5	Negative
PFNA	No	463	Unit/Enh (6490)	419	Unit/Enh (6490)	66	4	5	14.9	1.52	Negative
PFNA	No	463	Unit/Enh (6490)	219	Unit/Enh (6490)	66	17	5	14.9	1.52	Negative
PFOA	No	413	Unit/Enh (6490)	369	Unit/Enh (6490)	69	4	5	13.4	1.38	Negative
PFOA	No	413	Unit/Enh (6490)	169	Unit/Enh (6490)	69	12	5	13.4	1.38	Negative
PFOcDA	No	913	Unit/Enh (6490)	869	Unit/Enh (6490)	79	5	5	22.35	2.25	Negative
PFOcDA	No	913	Unit/Enh (6490)	369	Unit/Enh (6490)	100	20	5	22.35	2.25	Negative
PFOS	No	498.9	Unit/Enh (6490)	99	Unit/Enh (6490)	100	50	5	15	1.53	Negative
PFOS	No	498.9	Unit/Enh (6490)	80	Unit/Enh (6490)	100	50	5	15	1.53	Negative
PFPeA	No	263	Unit/Enh (6490)	218.9	Unit/Enh (6490)	60	8	5	7.4	1.77	Negative
PFTeDA	No	713	Unit/Enh (6490)	669	Unit/Enh (6490)	79	5	5	19.9	2.03	Negative
PFTeDA	No	713	Unit/Enh (6490)	369	Unit/Enh (6490)	100	20	5	19.9	2.03	Negative
PFTTrDA	No	663	Unit/Enh (6490)	619	Unit/Enh (6490)	79	5	5	19	1.93	Negative
PFTTrDA	No	663	Unit/Enh (6490)	269	Unit/Enh (6490)	100	20	5	19	1.93	Negative
PFUnA	No	563	Unit/Enh (6490)	519	Unit/Enh (6490)	73	5	5	17.2	1.75	Negative
PFUnA	No	563	Unit/Enh (6490)	269	Unit/Enh (6490)	100	20	5	17.2	1.75	Negative

# Appendix C

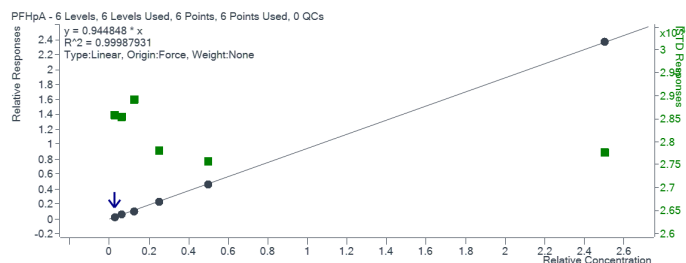
## Calibration Curves

**Figure 9.** Calibration curves for the target analytes in Table 1, covering a concentration range of 0.2-20 ppt.

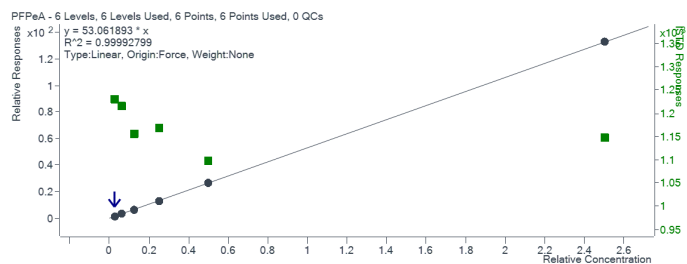
### PFBA



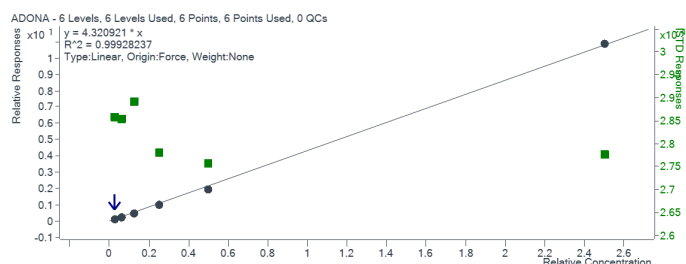
### PFHpA



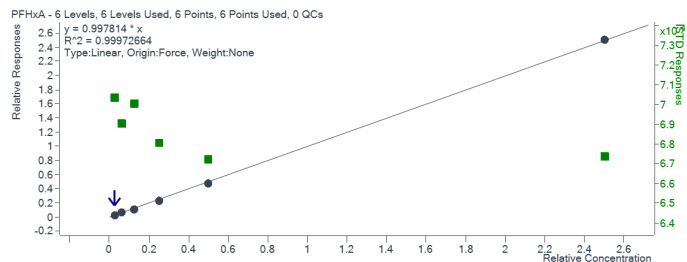
### PFPeA



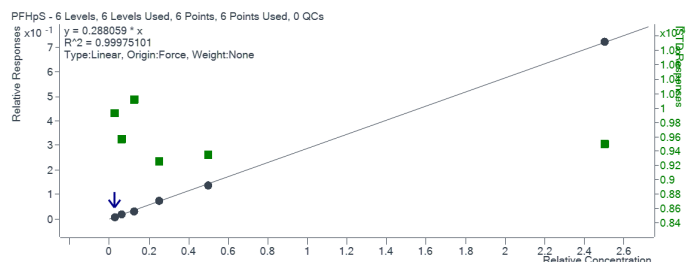
### ADONA



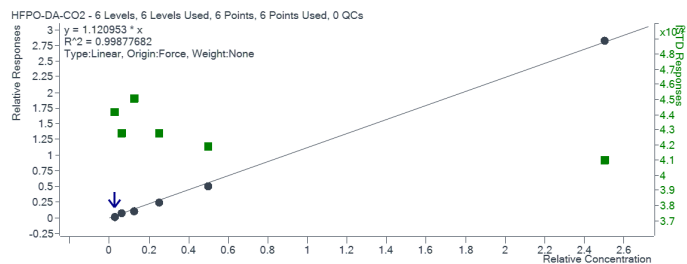
### PFHxA



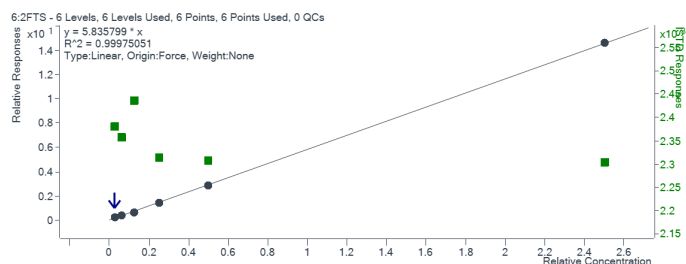
### PFHpS



### HFPO-DA-CO2

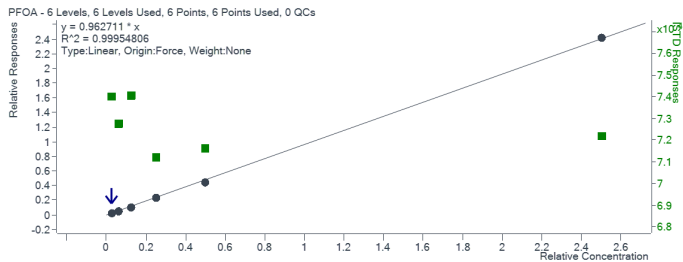


### 6:2 FTS

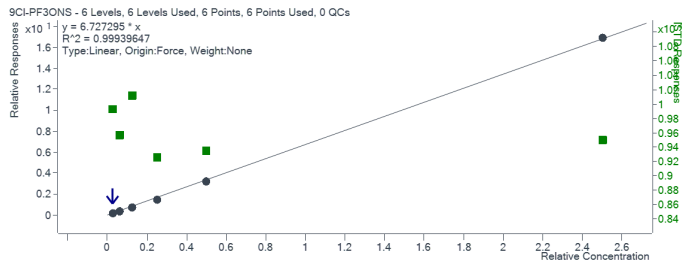




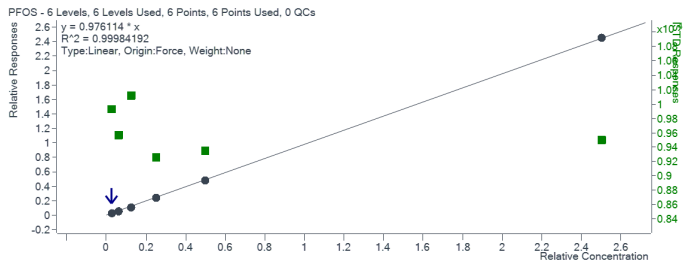
### PFOA



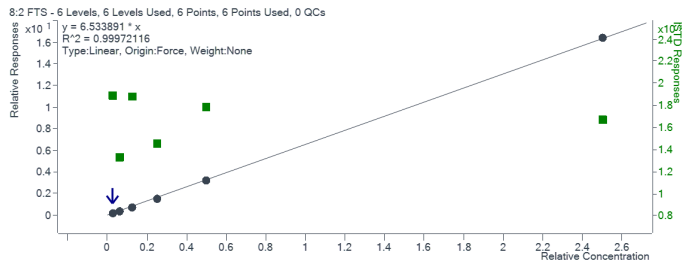
### 9Cl-PF3ONS



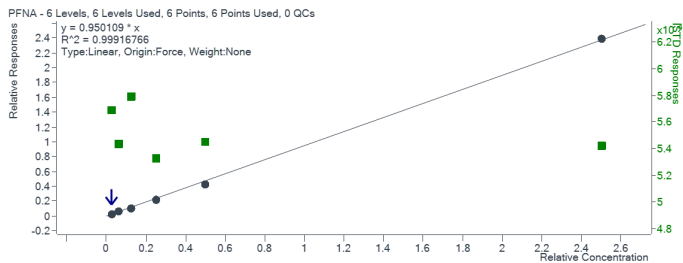
### PFOS



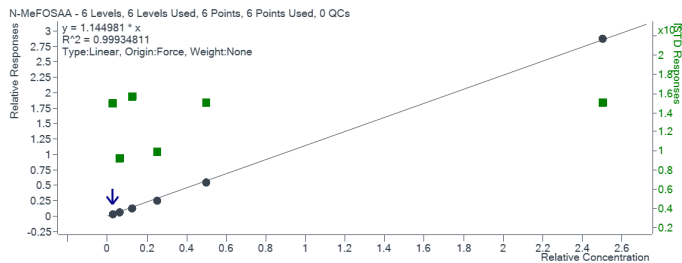
### 8:2 FTS



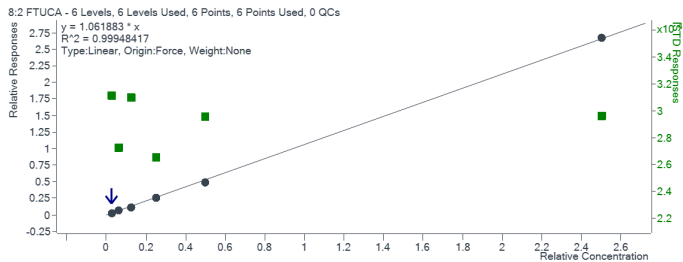
### PFNA



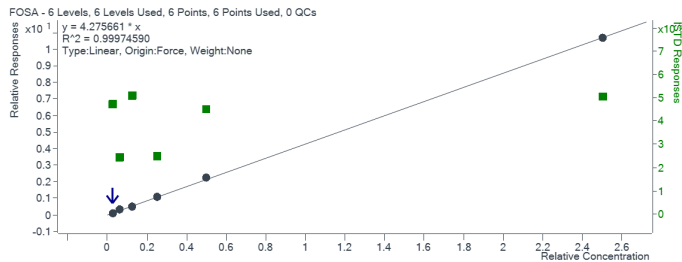
### N-MeFOSAA



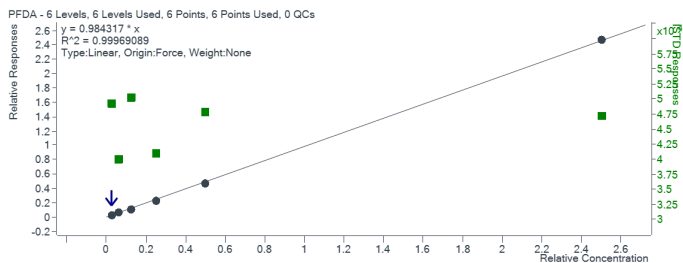
### 8:2 FTUCA



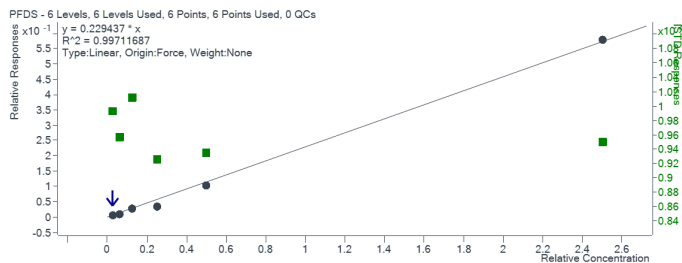
### FOSA



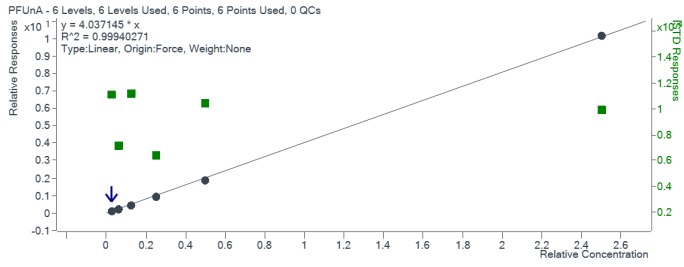
### PFDA



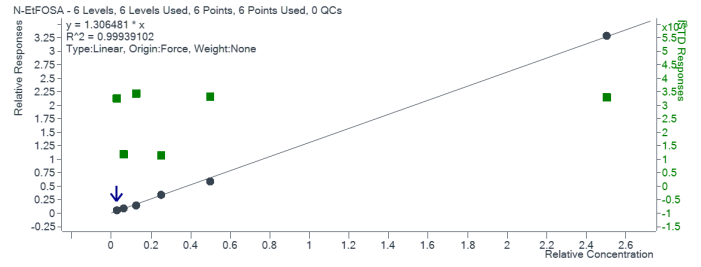
### PFDS



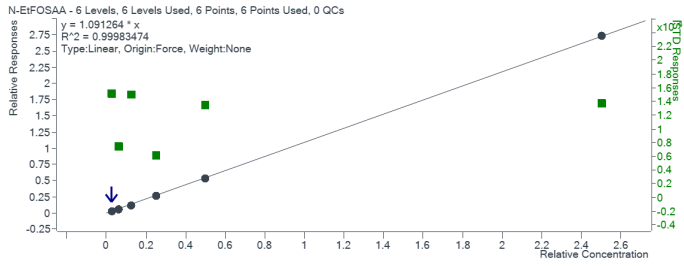
### PFUnA



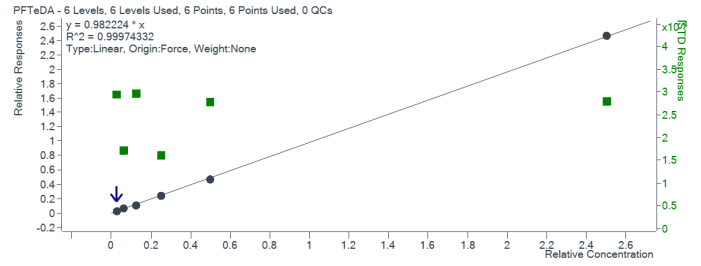
### N-EtFOSA



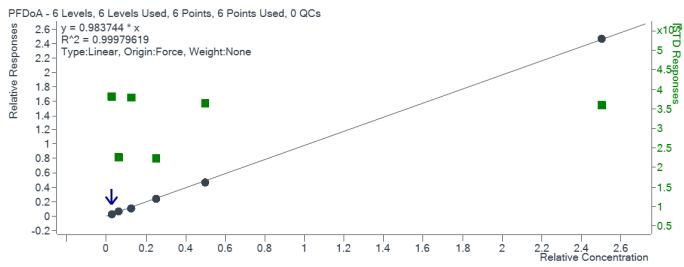
### N-EtFOSAA



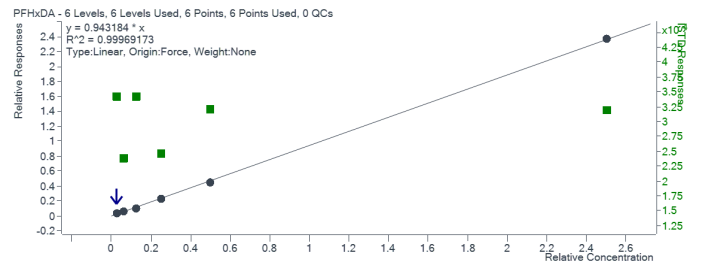
### PFTeDA



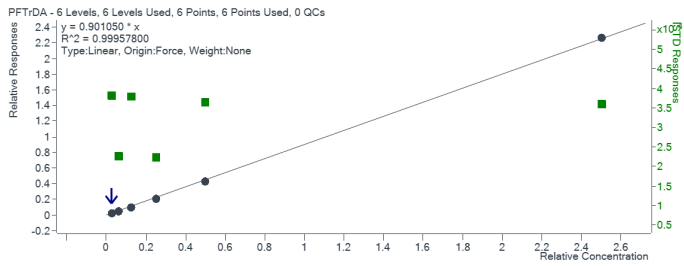
### PFDoA



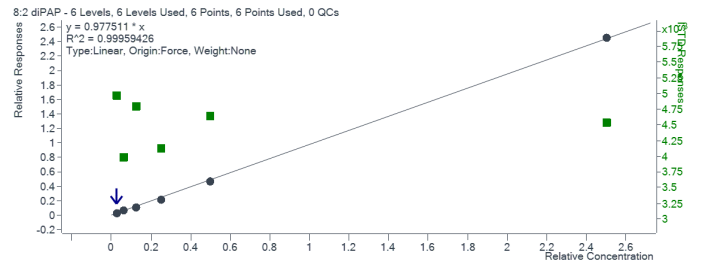
### PFHxDA



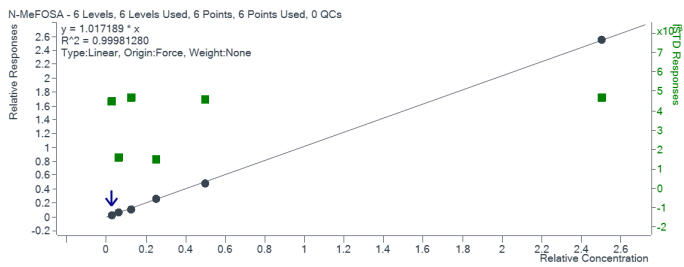
### PFTrDA



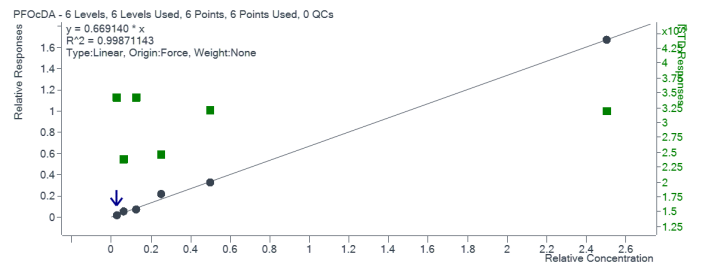
### 8:2 diPAP



### N-MeFOSA



### PFOcDA



# Appendix D

## MRL and DL Data

**Table 5.** MRL and DL Recoveries for EVOLUTE® PFAS 500 mg/6 mL columns.

	Conc. (ng/L)	1 (ng/L)	2 (ng/L)	3 (ng/L)	4 (ng/L)	5 (ng/L)	6 (ng/L)	7 (ng/L)	$\bar{x}$ (ng/L)	$\bar{x}$ (%)	s (ng/L)	C <sub>v</sub> (%)	DL (ng/L)
<b>PFBA*</b>	1.77	1.67	1.71	1.67	1.68	1.81	1.60	1.80	1.71	96	0.08	4.43	0.24
<b>PFPeA</b>	2.00	1.85	1.83	1.92	1.97	1.88	1.75	1.91	1.87	94	0.07	3.81	0.22
<b>PFBS</b>	2.00	1.73	1.90	1.82	1.70	1.73	1.65	1.95	1.78	89	0.11	6.12	0.34
<b>PFHxA</b>	2.00	1.80	1.92	1.89	1.80	1.98	1.75	1.92	1.87	93	0.08	4.50	0.26
<b>HFPO-DA</b>	2.00	1.80	1.58	1.48	1.83	1.89	1.73	1.69	1.71	86	0.14	8.39	0.45
<b>PFHpA</b>	2.00	1.96	2.06	2.04	1.94	2.01	1.80	2.08	1.99	99	0.09	4.75	0.30
<b>PFHxS*</b>	1.90	1.85	1.78	1.77	1.70	1.82	1.73	1.77	1.77	94	0.05	2.84	0.16
<b>DONA*</b>	1.89	1.76	1.85	1.79	1.85	1.79	1.64	1.80	1.78	94	0.07	3.98	0.22
<b>PFHpS*</b>	1.91	1.90	1.90	1.86	1.65	1.92	1.51	1.73	1.78	93	0.16	8.79	0.49
<b>6:2 FTSA*</b>	1.90	1.80	1.87	1.88	1.86	1.87	1.68	1.86	1.83	96	0.07	4.02	0.23
<b>PFOA</b>	2.00	1.80	1.86	1.93	1.91	1.94	1.67	1.94	1.86	93	0.10	5.34	0.31
<b>PFOS*</b>	1.92	1.96	1.89	1.79	1.89	1.92	1.69	1.89	1.86	97	0.09	4.98	0.29
<b>PFNA</b>	2.00	1.88	1.92	1.95	1.90	1.94	1.79	2.07	1.92	96	0.08	4.30	0.26
<b>8:2 FTUCA</b>	2.00	1.93	1.87	1.90	1.95	2.05	1.89	1.97	1.94	97	0.06	3.15	0.19
<b>PFDA</b>	2.00	1.87	1.89	1.87	1.83	2.01	1.79	2.01	1.89	95	0.09	4.55	0.27
<b>9CI-PF3ONS*</b>	1.87	1.75	1.71	1.76	1.73	1.74	1.53	1.75	1.71	92	0.08	4.72	0.25
<b>8:2 FTSA*</b>	1.92	1.73	1.83	1.72	1.77	1.90	1.70	2.10	1.82	95	0.14	7.93	0.45
<b>N-MeFOSAA</b>	2.00	1.83	1.90	1.92	1.81	1.94	1.76	2.02	1.88	94	0.09	4.80	0.28
<b>FOSA</b>	2.00	2.09	2.06	2.12	1.97	2.16	1.98	2.28	2.09	105	0.11	5.17	0.34
<b>PFDS</b>	2.00	2.10	2.06	1.95	2.14	1.70	1.64	1.93	1.93	97	0.19	9.98	0.61
<b>PFUnDA</b>	2.00	1.89	1.91	1.90	1.81	1.88	1.75	1.94	1.87	93	0.07	3.51	0.21
<b>N-EtFOSAA</b>	2.00	2.04	1.86	2.00	1.98	1.99	1.73	1.94	1.93	97	0.11	5.44	0.33
<b>PFDoDA</b>	2.00	1.85	1.96	1.96	1.81	2.00	1.75	1.96	1.90	95	0.10	5.04	0.30
<b>PFTTrDA</b>	2.00	1.79	1.85	1.87	1.98	2.02	1.75	2.04	1.90	95	0.11	5.89	0.35
<b>N-MeFOSA</b>	2.00	2.17	2.14	2.01	1.94	2.36	2.04	2.34	2.14	107	0.16	7.50	0.51
<b>N-EtFOSA</b>	2.00	1.99	1.97	2.06	2.11	2.09	1.99	2.03	2.03	102	0.05	2.59	0.17
<b>PFTeDA</b>	2.00	1.79	1.82	1.91	1.85	1.89	1.83	1.86	1.85	93	0.04	2.12	0.12
<b>PFHxDA</b>	2.00	1.95	1.94	1.93	1.99	1.95	1.89	2.07	1.96	98	0.06	2.81	0.17
<b>8:2 diPAP*</b>	1.96	1.79	1.85	2.00	1.90	1.78	1.78	2.16	1.90	97	0.14	7.51	0.45
<b>PFOcDA</b>	2.00	1.71	1.88	2.07	1.60	1.71	1.64	1.75	1.77	88	0.16	9.18	0.51

\*Analytes were used in salt form and calculated concentrations were corrected to compensate where needed.

**Table 6.** MRL and DL Recoveries for EVOLUTE® PFAS 150 mg/6 mL columns.

	Conc. (ng/L)	1 (ng/L)	2 (ng/L)	3 (ng/L)	4 (ng/L)	5 (ng/L)	6 (ng/L)	7 (ng/L)	8 (ng/L)	$\bar{x}$ (ng/L)	$\bar{x}$ (%)	s (ng/L)	C <sub>v</sub> (%)	DL (ng/L)
<b>PFBA*</b>	1.77	1.88	1.83	1.87	1.94	1.83	1.86	1.79	1.83	1.85	104	0.05	2.56	0.14
<b>PFPeA</b>	2.00	1.96	1.92	1.96	2.05	1.97	1.93	1.86	1.96	1.95	98	0.05	2.79	0.16
<b>PFBS</b>	2.00	1.87	1.76	1.84	1.73	1.77	1.81	1.73	1.75	1.78	89	0.05	2.83	0.15
<b>PFHxA</b>	2.00	2.09	2.00	2.04	2.10	2.03	2.09	1.98	2.08	2.05	103	0.05	2.20	0.14
<b>HFPO-DA</b>	2.00	1.97	1.92	1.82	1.92	1.89	2.14	2.16	2.17	2.00	100	0.14	6.92	0.41
<b>PFHpA</b>	2.00	2.08	1.96	1.98	1.91	2.04	1.95	2.01	2.01	1.99	100	0.06	2.76	0.17
<b>PFHxS*</b>	1.90	1.75	1.83	1.80	1.85	1.66	1.74	1.77	1.74	1.77	93	0.06	3.34	0.18
<b>DONA*</b>	1.89	1.98	1.90	1.96	1.96	1.93	1.84	1.96	1.90	1.93	102	0.05	2.35	0.14
<b>PFHpS*</b>	1.91	1.77	1.78	1.85	1.79	1.64	1.66	1.69	1.64	1.73	91	0.08	4.69	0.24
<b>6:2 FTSA*</b>	1.90	1.91	1.84	1.97	1.92	2.05	2.06	2.01	2.11	1.98	104	0.09	4.58	0.27
<b>PFOA</b>	2.00	1.96	1.99	2.01	2.08	1.97	2.05	1.91	1.97	1.99	100	0.05	2.59	0.15
<b>PFOS*</b>	1.92	2.00	1.89	1.93	2.01	1.95	1.95	1.98	1.96	1.96	102	0.04	1.99	0.12
<b>PFNA</b>	2.00	2.08	1.94	2.02	2.01	2.04	2.08	2.11	2.02	2.03	102	0.05	2.59	0.16
<b>8:2 FTUCA</b>	2.00	1.93	1.92	1.97	1.95	1.94	1.98	1.95	1.98	1.95	98	0.02	1.17	0.07
<b>PFDA</b>	2.00	1.99	1.89	1.96	1.99	1.91	2.03	2.07	2.04	1.98	99	0.06	3.12	0.19
<b>9CI-PF3ONS*</b>	1.87	1.96	1.92	1.91	1.97	1.86	1.84	1.83	1.92	1.90	102	0.05	2.68	0.15
<b>8:2 FTSA*</b>	1.92	1.92	1.93	2.01	1.99	1.90	1.84	1.88	1.97	1.93	101	0.06	3.06	0.18
<b>N-MeFOSAA</b>	2.00	1.85	1.84	1.84	1.85	1.91	2.00	2.03	2.06	1.92	96	0.09	4.87	0.28
<b>FOSA</b>	2.00	1.96	2.00	1.99	2.12	2.16	2.20	2.16	2.15	2.09	105	0.09	4.49	0.28
<b>PFDS</b>	2.00	1.92	2.08	1.81	2.04	2.01	1.93	2.04	1.90	1.97	98	0.09	4.61	0.27
<b>PFUnDA</b>	2.00	2.09	1.97	1.93	1.95	1.89	1.97	1.95	1.98	1.97	98	0.06	2.94	0.17
<b>N-EtFOSAA</b>	2.00	1.86	1.93	1.98	1.98	1.96	2.16	2.10	2.02	2.00	100	0.09	4.68	0.28
<b>PFDoDA</b>	2.00	2.08	1.91	2.02	2.05	2.02	2.03	2.04	2.04	2.02	101	0.05	2.52	0.15
<b>PFTTrDA</b>	2.00	2.01	1.93	1.85	1.99	1.94	2.06	1.98	1.99	1.97	98	0.06	3.21	0.19
<b>N-MeFOSA</b>	2.00	2.01	2.13	2.03	1.93	2.13	2.18	1.96	2.02	2.05	102	0.09	4.37	0.27
<b>N-EtFOSA</b>	2.00	1.86	2.10	1.88	2.27	1.91	2.16	2.05	2.13	2.04	102	0.15	7.30	0.45
<b>PFTeDA</b>	2.00	2.07	2.03	1.91	2.03	1.98	1.99	2.13	2.05	2.02	101	0.06	3.17	0.19
<b>PFHxDA</b>	2.00	2.01	1.91	1.81	2.08	2.05	1.95	2.02	2.03	1.98	99	0.09	4.43	0.26
<b>8:2 diPAP*</b>	1.96	2.05	2.03	2.03	2.06	2.05	2.11	1.78	1.94	2.01	103	0.10	5.12	0.31
<b>PFocDA</b>	2.00	1.99	2.32	2.39	2.06	2.07	2.11	2.00	2.02	2.12	106	0.15	7.13	0.45

\*Analytes were used in salt form and calculated concentrations were corrected to compensate where needed.



# Appendix E

## PFAS Background Study

**Table 7.** Results of PFAS Background Study for EVOLUTE® PFAS 500 mg/6 mL columns (recoveries in ng/L).

Replicate	TurboVap® LV								Laboratory Reagent Blanks			
	1	2	3	4	5	6	7	8	1	2	3	4
PFBA*	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.04	0.09	0.06	0.06	0.06
PFPeA	0.02	0.03	0.03	0.03	0.03	0.06	0.02	0.03	0.04	0.04	0.02	0.04
PFBS	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.06
PFHxA	0.01	0.02	0.00	0.01	0.00	0.02	0.01	0.02	0.02	0.02	0.02	0.02
HFPO-DA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFHpA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFHxS*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
DONA*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
PFHpS*	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:2 FTSA*	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.06	0.07	0.07
PFOA	0.02	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00
PFOS*	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.02	0.01	0.02	0.01	0.01
PFNA	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00
8:2 FTUCA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
PFDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
9CI-PF3ONS*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
8:2 FTSA*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N-MeFOSAA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FOSA	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01
PFDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFUnDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N-EtFOSAA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFDoDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFTTrDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N-MeFOSA	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.07	0.07	0.00
N-EtFOSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFTeDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFHxDA	0.10	0.04	0.00	0.00	0.08	0.12	0.07	0.11	0.00	0.00	0.00	0.00
8:2 diPAP*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFOcDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\*Analytes were used in salt form and calculated concentrations were corrected to compensate where needed.

**Table 8.** Results of PFAS Background Study for EVOLUTE® PFAS 150 mg/6 mL columns (recoveries in ng/L).

Replicate	TurboVap® LV				Laboratory Reagent Blanks			
	1	2	3	4	1	2	3	4
PFBA*	0.06	0.02	0.01	0.00	0.11	0.09	0.09	0.10
PFPeA	0.03	0.03	0.03	0.02	0.05	0.06	0.04	0.04
PFBS	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01
PFHxA	0.02	0.02	0.01	0.00	0.03	0.03	0.02	0.02
HFPO-DA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFHpA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFHxS*	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01
DONA*	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00
PFHpS*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:2 FTSA*	0.01	0.00	0.00	0.00	0.03	0.03	0.04	0.02
PFOA	0.00	0.02	0.03	0.00	0.00	0.00	0.05	0.00
PFOS*	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
PFNA	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00
8:2 FTUCA	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00
PFDA	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
9CI-PF3ONS*	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
8:2 FTSA*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N-MeFOSAA	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.02
FOSA	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01
PFDS	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
PFUnDA	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
N-EtFOSAA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFDoDA	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
PFTTrDA	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
N-MeFOSA	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.05
N-EtFOSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFTeDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFHxDA	0.07	0.08	0.08	0.06	0.08	0.08	0.12	0.07
8:2 diPAP*	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
PFOcDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\*Analytes were used in salt form and calculated concentrations were corrected to compensate where needed.

# Appendix F

## IDP and IDA Data

**Table 9.** Results of IDP and IDA for EVOLUTE® PFAS 500 mg/6 mL columns (15 ng/L, n=4).

Replicate	1 (%)	2 (%)	3 (%)	4 (%)	$\bar{x}$ (%)	s (%)	C <sub>v</sub> (%)
PFBA*	93.97	93.52	97.66	94.56	94.93	1.87	1.97
PFPeA	91.10	99.84	99.34	92.16	95.61	4.62	4.83
PFBS	88.73	88.20	91.76	86.48	88.79	2.20	2.47
PFHxA	94.83	95.12	99.13	95.85	96.23	1.98	2.06
HFPO-DA	88.53	89.13	99.41	92.60	92.42	4.99	5.40
PFHpA	104.38	106.43	104.54	106.18	105.38	1.07	1.02
PFHxS*	95.20	99.75	101.57	95.96	98.12	3.04	3.10
DONA*	102.56	111.10	108.04	107.16	107.22	3.53	3.30
PFHpS*	89.31	87.18	98.22	79.57	88.57	7.67	8.66
6:2 FTSA*	96.43	102.56	100.83	101.53	100.34	2.70	2.69
PFOA	94.28	94.77	96.59	92.79	94.61	1.56	1.65
PFOS*	91.58	93.17	98.48	89.66	93.22	3.79	4.06
PFNA	93.76	98.27	100.96	96.89	97.47	2.99	3.07
8:2 FTUCA	95.54	99.14	95.99	95.27	96.49	1.79	1.86
PFDA	96.19	91.59	101.20	100.51	97.38	4.45	4.57
9CI-PF3ONS*	94.73	93.29	104.59	90.45	95.76	6.15	6.42
8:2 FTSA*	87.94	97.85	90.95	98.83	93.89	5.30	5.64
N-MeFOSAA	102.65	101.19	100.15	94.75	99.68	3.44	3.45
FOSA	106.21	102.48	110.06	100.99	104.94	4.06	3.87
PFDS	96.50	102.88	108.47	98.56	101.60	5.29	5.21
PFUnDA	88.89	85.05	87.96	90.74	88.16	2.37	2.69
N-EtFOSAA	97.35	101.86	99.64	94.11	98.24	3.31	3.37
PFDoDA	96.65	99.00	102.74	98.79	99.30	2.53	2.55
PFTTrDA	104.99	91.30	96.05	98.68	97.76	5.71	5.84
N-MeFOSA	103.38	114.84	108.73	99.89	106.71	6.53	6.12
N-EtFOSA	103.01	111.52	107.20	103.88	106.40	3.86	3.63
PFTeDA	92.57	95.31	96.88	94.10	94.71	1.83	1.93
PFHxDA	90.55	89.61	92.53	94.89	91.89	2.34	2.54
8:2 diPAP*	92.57	99.94	98.71	96.49	96.93	3.24	3.34
PFOcDA	104.86	101.06	106.48	97.58	102.49	3.99	3.89

\*Analytes were used in salt form and calculated concentrations were corrected to compensate where needed.

**Table 10.** Results of IDP and IDA for EVOLUTE® PFAS 150 mg/6 mL columns (15 ng/L, n=4).

Replicate	1 (%)	2 (%)	3 (%)	4 (%)	$\bar{x}$ (%)	s (%)	$C_v$ (%)
PFBA*	102.37	101.69	101.80	103.26	102.28	0.72	0.70
PFPeA	101.89	102.16	101.32	100.30	101.42	0.82	0.81
PFBS	99.30	102.15	99.56	102.63	100.91	1.72	1.71
PFHxA	100.58	103.25	99.56	100.27	100.92	1.61	1.60
HFPO-DA	96.01	95.99	99.76	93.05	96.20	2.75	2.86
PFHpA	102.78	102.88	102.64	102.10	102.60	0.35	0.34
PFHxS*	97.07	98.52	98.87	97.40	97.96	0.86	0.88
DONA*	102.74	104.41	102.11	103.16	103.11	0.97	0.94
PFHpS*	91.57	92.08	90.92	93.18	91.94	0.95	1.04
6:2 FTSA*	99.40	99.12	104.89	102.46	101.47	2.74	2.70
PFOA	104.83	105.70	104.59	106.65	105.44	0.94	0.89
PFOS*	101.18	103.31	101.24	102.55	102.07	1.04	1.02
PFNA	102.52	103.28	101.34	101.57	102.18	0.90	0.88
8:2 FTUCA	98.30	100.36	102.72	101.33	100.68	1.86	1.84
PFDA	102.85	104.63	101.29	103.65	103.10	1.41	1.37
9CI-PF3ONS*	106.62	106.89	104.87	103.91	105.57	1.42	1.35
8:2 FTSA*	100.77	102.18	104.64	100.22	101.95	1.97	1.93
N-MeFOSAA	103.10	103.15	103.09	105.71	103.76	1.30	1.25
FOSA	103.88	101.39	103.04	101.42	102.43	1.23	1.20
PFDS	105.46	102.18	103.54	106.38	104.39	1.89	1.81
PFUnDA	98.55	97.67	97.27	98.90	98.10	0.76	0.77
N-EtFOSAA	101.28	102.59	103.05	103.63	102.64	1.00	0.97
PFDoDA	105.74	103.29	103.54	105.36	104.48	1.25	1.19
PFTTrDA	103.97	103.44	104.62	100.69	103.18	1.73	1.67
N-MeFOSA	95.71	101.62	105.13	103.48	101.48	4.11	4.05
N-EtFOSA	100.27	105.18	104.36	98.73	102.14	3.12	3.06
PFTeDA	102.22	102.79	101.51	101.23	101.94	0.71	0.69
PFHxDA	98.11	100.02	100.23	99.48	99.46	0.95	0.96
8:2 diPAP*	102.35	99.99	98.16	101.37	100.47	1.82	1.81
PFOcDA	106.66	107.30	101.64	101.58	104.30	3.11	2.99

\*Analytes were used in salt form and calculated concentrations were corrected to compensate where needed.



# Appendix G

## Carryover Data

**Table 11.** Results of carryover study following four, 50 ng/L LFB samples using EVOLUTE® PFAS 500 mg/6 mL columns.

Replicate	1 (ng/L)	2 (ng/L)	3 (ng/L)	4 (ng/L)	$\bar{x}$ (ng/L)
PFBA*	0.11	0.09	0.09	0.09	0.09
PFPeA	0.04	0.04	0.04	0.04	0.04
PFBS	0.02	0.01	0.02	0.01	0.02
PFHxA	0.02	0.02	0.03	0.03	0.03
HFPO-DA	0.00	0.00	0.00	0.00	0.00
PFHpA	0.00	0.00	0.00	0.00	0.00
PFHxS*	0.02	0.00	0.02	0.01	0.01
DONA*	0.00	0.01	0.01	0.00	0.00
PFHpS*	0.00	0.00	0.00	0.00	0.00
6:2 FTSA*	0.04	0.04	0.04	0.04	0.04
PFOA	0.09	0.04	0.07	0.00	0.05
PFOS*	0.04	0.03	0.04	0.04	0.04
PFNA	0.00	0.00	0.00	0.00	0.00
8:2 FTUCA	0.02	0.01	0.03	0.04	0.03
PFDA	0.02	0.02	0.02	0.02	0.02
9CI-PF3ONS*	0.01	0.00	0.02	0.01	0.01
8:2 FTSA*	0.00	0.00	0.00	0.00	0.00
N-MeFOSAA	0.08	0.12	0.14	0.11	0.11
FOSA	0.03	0.02	0.02	0.03	0.03
PFDS	0.03	0.00	0.00	0.00	0.01
PFUnDA	0.00	0.00	0.03	0.01	0.01
N-EtFOSAA	0.07	0.09	0.08	0.10	0.09
PFDoDA	0.00	0.00	0.00	0.00	0.00
PFTTrDA	0.00	0.00	0.03	0.00	0.01
N-MeFOSA	0.21	0.21	0.17	0.27	0.22
N-EtFOSA	0.16	0.17	0.15	0.18	0.17
PFTeDA	0.00	0.00	0.00	0.00	0.00
PFHxDA	0.07	0.12	0.13	0.07	0.10
8:2 diPAP*	0.00	0.00	0.05	0.08	0.03
PFocDA	0.00	0.00	0.00	0.00	0.00

\*Analytes were used in salt form and calculated concentrations were corrected to compensate where needed.

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