Identification of Select Emerging Compounds in the Public Water Supply Reservoir Jordan Lake

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER RESOURCES
WATER SCIENCES SECTION

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Jordan Lake

North Carolina Department of Environmental Quality
Division of Water resources
Water Science Section
Intensive Survey Branch
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Division of Water Resources Identification of Select Emerging PFAS Compounds in Public Water Supply Reservoirs Jordan Lake (2021)

Introduction

In response to the rising interest in the public health effects associated with per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane in drinking water sources, the Intensive Survey Branch (ISB) conducted a special study alongside our Ambient Lakes Monitoring Program to characterize the presence and concentrations of these emerging compounds (EC) in public drinking water supply reservoir Jordan Lake. Beginning in March of 2021, ISB staff collected surface water samples for 1,4-dioxane and 28 different per- and polyfluoroalkyl substances at the five sampling locations at Jordan Lake. Analytical results indicated the presence of at least one PFAS analyte above the laboratory practical quantitation limit (PQL [2 ng/L]) at each site during the 2021 sampling season. Of the 1,4-dioxane samples collected during this study period, five were detected above the PQL (1.0 µg/l). It is important to note that all analytical data presented in this document reflect levels of target analytes detected in untreated surface waters, as opposed to finished drinking water.

Background

This study follows a previous survey conducted by ISB in 2018 evaluating the presence of PFAS and 1,4-dioxane in public water supply reservoirs in the Cape Fear, New, and Watauga River Basins and a 2020 study conducted in the Yadkin and Broad River Basins. Both studies highlighted the ubiquitous distribution of these emerging compounds. PFAS and 1,4-dioxane were selected as compounds of interest for this study in response to the rising interest in the public health effects of consumption of these compounds in drinking water sources. In 2020, the Division of Water Resources (DWR) expansion of the Organic Chemistry Branch to include the capability of analyzing PFAS allowed for increased analytical capacity. Samples from the selected locations (Table 1 & Figure 1) were collected monthly from March to December 2021.

1,4-Dioxane is a synthetic industrial organic compound that is completely miscible in water. It is persistent in the environment and is difficult to remove through standard water and wastewater treatment processes. 1,4-Dioxane is used as an industrial solvent and is formed as a byproduct of some industrial processes. The International Agency for Research on Cancer (IARC), the U.S. Department of Health and Human Services and the U.S. Environmental Protection Agency (USEPA) have determined that 1,4-dioxane is classified as likely to be carcinogenic to humans and is identified in the Third Unregulated Contaminant Monitoring Rule (UCMR) as a potential compound of concern in public drinking water by the USEPA.

Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic chemicals used in the production of a wide variety of manufactured goods. These compounds are composed of fluorinated carbon chains that readily transport in the environment and are highly resistant to degradation. There are many different

possible sources of PFAS contamination in surface water, including industrial and consumer derived waste. PFAS are used in various consumer products including non-stick cookware, water-repellent clothing, stain resistant fabrics, cosmetics, food packaging materials and fire-retardant foams. Although 28 PFAS compounds were the focus of this study, thousands of PFAS compounds exist. Of these compounds, PFOA and PFOS have been the most extensively produced and studied. The USEPA has stated that exposure to PFAS can lead to adverse health effects in humans. Though many companies have significantly decreased or ceased use of PFOA and PFOS in manufacturing, other PFAS compounds are currently being used as replacements. The 28 PFAS compounds selected for this study are abbreviated throughout this document for better readability but are identified more fully in Appendix 1.

Methods

Selected sites were sampled in conjunction with regularly scheduled sampling events as part of ALMP monitoring. Samples were collected in accordance with ISB's Standard Operating Procedures Manual: Physical and Chemical Monitoring v2.1, Dec. 20147 and Ambient Lakes Quality Assurance Project Plan v2.0, March 20148, as well as ISB's Draft Standard Operating Procedures Manual: Per- and Polyfluorinated Alkyl Substances (PFAS) - Field Collection Method. Physical parameters were collected at surface (0.15 m) using an In-Situ multiparameter hydrosonde. Chemical samples were collected as surface grab samples. All PFAS and 1,4- dioxane samples were analyzed by the DWR central laboratory in Raleigh, NC. Appropriate QA/QC samples were collected during each sampling event including trip blanks, field blanks, duplicates, matrix spikes and matrix spike duplicates. Guidance on acceptable supplies, equipment, and personal care products is provided within the ISB Draft Standard Operating Procedures Manual: Per- and Polyfluorinated Alkyl Substances (PFAS) - Field Collection Method. Physical and chemical parameters collected are shown below in Table 2.

Station	Station Description	Latitude	Longitude
CPF055CSUR	ABOVE STINKING CK NR PITTSBORO NC	35.69131	-79.0791
CPF087DSUR	MOUTH WHITE OAK CK NR SEAFORTH NC	35.73864	-79.0242
CPF086FSUR	NEAR FARRINGTON NC	35.797	-79.0108
CPF081A1CSUR	MOUTH OF NEW HOPE CREEK	35.81622	-78.9868
CPF086CSUR	MOUTH OF MORGAN CK NR FARRINGTON	35.82151	-78.9974

Table 1. Station ID, Description, and coordinates of sampled sites

Results

PFAS analysis was conducted by DWR at the Central Laboratory in Raleigh, NC. Of the 28 PFAS compounds selected for this study, the following 16 compounds were found above the PQL on at least one occasion: PFBA; PFBS; 11Cl-PFONS; N-EtFOSAA; N-MeFOSAA; PFHpA; PFHxA; PFHxS; PFOS; PFHeA; PFHeS; PFDoA; PFDoS; PFTeDA; PFTrDA. One or more of these compounds were found at all five sites during the 2021 sampling season (March-December). These results again demonstrate the widespread distribution of detectable PFAS in public water supply reservoirs.

1,4-Dioxane was found above the PQL (1 µg/l) in five samples taken from Jordan lake. 1,4-Dioxane was found only at station CPF055CSUR with the highest level detected in July (18 µg/l).

Summary

Evaluation of physical and chemical results from this study suggest that while there are detectable levels of target analytes at the public water supply reservoir, Jordan Lake, additional long-term monitoring would need to be conducted to evaluate persistence of these compounds and their associated effects on drinking water. Jordan Lake exhibited the greatest diversity of target analytes at stations CPF055CSUR and CPF081A1CSUR (n=8). Station CPF055CSUR also exhibited the highest total single event PFAS concentration (139.0 ng/L) and station CPF086CSUR exhibited the second highest total PFAS concentration for a single sampling event (137.7 ng/L). The highest PFOA concentrations were detected at station CFP055CSUR exhibiting the two highest PFOA concentrations (15.0 ng/l and 14.6 ng/l respectively). The highest PFOs concentrations were detected at station CFP055CSUR exhibiting the two highest PFOs concentrations (22.2 ng/l and 22.1 ng/l respectively.)

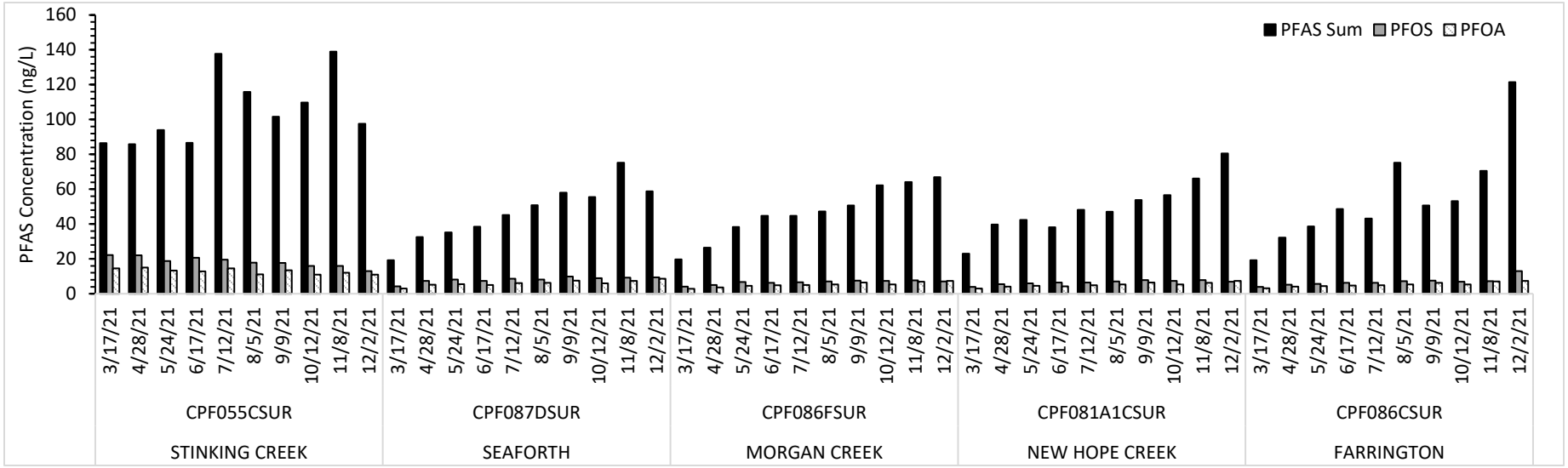

Figure 1. Per- and polyfluoroalkyl concentrations at Jordan lake monitoring stations. Only values greater than the PQL (2 ng/l).

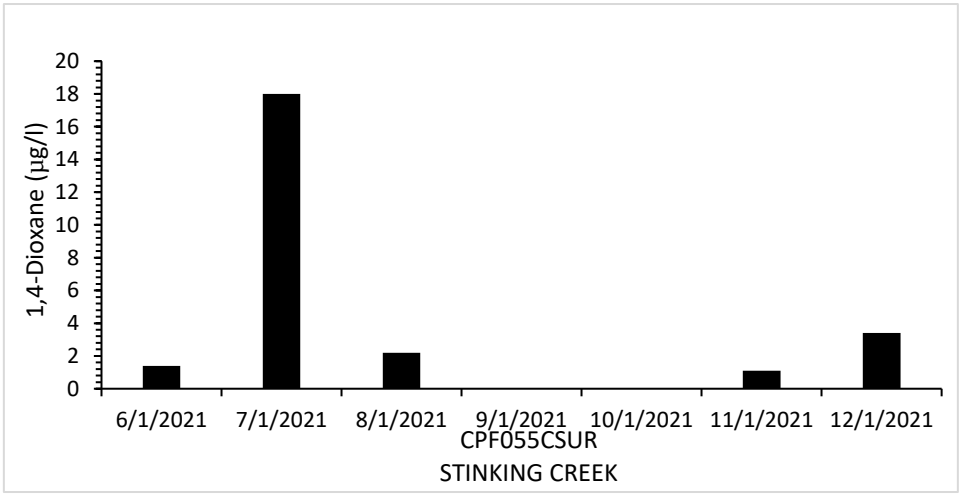

Figure 2. 1,4- Dioxane concentrations at Jordan lake monitoring Stations. Only values Greater than PQL (1 µg/l).

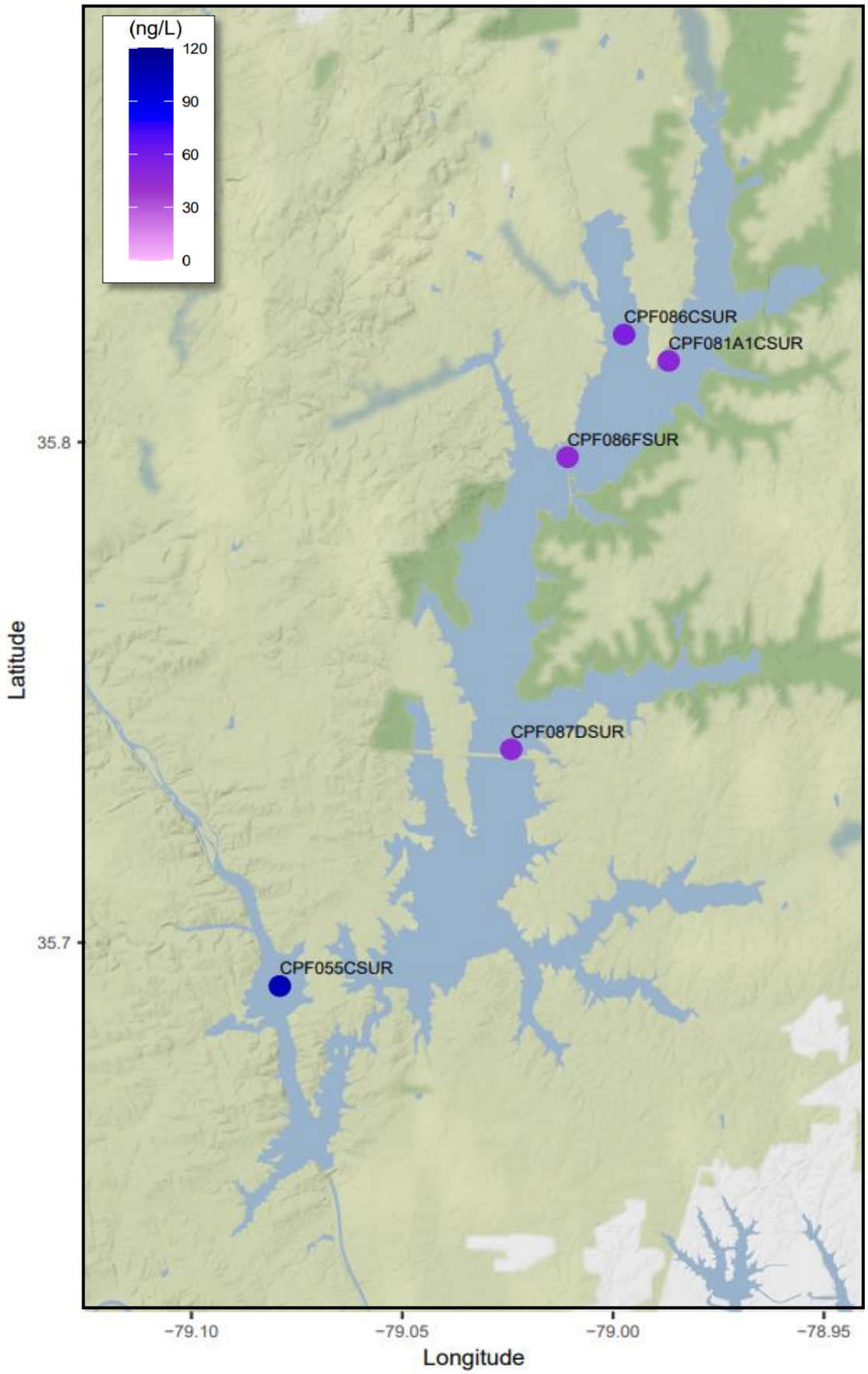

Figure 3. Per- and polyfluoroalkyl concentrations at Jordan lake monitoring stations. Only values greater than the PQL (2 ng l^{-1}).

Abbreviation	*Name*	*CAS#*
PFBA	Perfluorobutanoate	45048-62-2
PFPeA	Perfluoropentanoate	45167-47-3
PFHxA	Perfluorohexanoate	92612-52-7
PFHpA	Perfluoroheptanoate	120885-29-2
PFOA	Perfluorooctanoate	45285-51-6
PFNA	Perfluorononanoate	72007-68-2
PFDA	Perfluorodecanoate	73829-36-4
PFUnA	Perfluoroundecanoate	196859-54-8
PFDoA	Perfluorododecanoate	171978-95-3
PFTrDA	Perfluorotridecanoate	862374-87-6
PFTeDA	Perfluorotetradecanoate	365971-87-5
PFBS	Perfluorobutanesulfonate	45187-15-3
PFPeS	Perfluoropentanesulfonate	175905-36-9
PFHxS	Perfluorohexanesulfonate	108427-53-8
PFHpS	Perfluoroheptanesulfonate	146689-46-5
PFOS	Perfluorooctanesulfonate	45298-90-6
PFNS	Perfluorononanesulfonate	474511-07-4
PFDS	Perfluorodecanesulfonate	126105-34-8
PFDoS	Perfluorododecanesulfonate	343629-43-6
4:2 FTS	4:2 fluorotelomersulfonate	414911-30-1
6:2 FTS	6:2 fluorotelomersulfonate	425670-75-3
8:2 FTS	8:2 fluorotelomersulfonate	481071-78-7
N-MeFOSAA	N-Methylperfluorooctanesulfonamidoacetic acid	2355-31-9
N-EtFOSAA	N-Ethylperfluorooctanesulfonamidoacetic acid	2991-50-6
HFPO-DA	Hexafluoropropylene oxide dimer acid	13252-13-6
ADONA	4,8-dioxa-3H-perfluorononanoic acid	919005-14-4
11Cl-PFOUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9
9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	756426-58-1

Appendix 1 – List of PFAS Compounds

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
CPF087DSUR	3/17/2021	19.22	6	22	2.69-4.29	PFBA PFBS PFHxA PFOA PFOS PFPeA	3.52 2.77 3.01 2.96 4.29 2.69	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
CPF086FSUR	3/17/2021	15.71	6	22	2.7-4.02	PFBA PFBS PFHxA PFOA PFOS PFPeA	3.80 3.28 3.03 2.91 4.02 2.70	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
CPF081A1CSUR	3/17/2021	23.01	7	21	2.28-4.06	PFBA PFBS PFHpS PFHxA PFOA PFOS PFPeA	4.06 3.44 2.28 3.32 2.96 3.99 2.95	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHxS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
CPF086CSUR	3/17/2021	19.24	6	22	2.66-3.98	PFBA PFBS PFHxA PFOA PFOS PFPeA	3.44 3.02 3.05 3.09 3.98 2.66	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
CPF055CSUR	3/17/2021	86.44	8	20	4.88-22.24	PFBA PFBS	4.88 9.21	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHpA	7.96	
						PFHxA	11.82	
						PFHxS	5.92	
						PFOA	14.56	
						PFOS	22.24	
						PFPeA	9.86	
CPF087DSUR	4/28/2021	32.58	8	20	2.42-7.35	PFOS	7.35	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBA	3.82	
						PFBS	3.49	
						PFHpA	2.44	
						PFHxA	4.40	
						PFHxS	2.42	
						PFOA	5.13	
						PFPeA	3.53	
CPF086FSUR	4/28/2021	26.39	7	21	2.08-4.96	PFOS	4.96	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFBS; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxA; PFHxS; PFNA; PFNS; PFOA; PFOS; PFPeA; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBA	4.58	
						PFBS	2.94	
						PFHxA	4.38	
						PFHxS	2.08	
						PFOA	3.62	
						PFPeA	3.85	
CPF081A1CSUR	4/28/2021	39.78	10	18	2.2-5.63	N-MeFOSAA	2.88	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBA	5.63	
						N-EtFOSAA	2.32	
						PFBS	4.40	
						PFHpA	2.20	
						PFHxA	5.56	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHxS	2.32	
						PFOA	4.06	
						PFOS	5.47	
						PFPeA	4.95	
CPF086CSUR	4/28/2021	32.19	8	20	2.01-4.94	PFBA	4.94	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	4.17	
						PFHpA	2.01	
						PFHxA	5.12	
						PFHxS	2.22	
						PFOA	4.04	
						PFOS	5.21	
						PFPeA	4.49	
CPF055CSUR	4/28/2021	85.88	8	20	5.44-22.07	PFBA	5.44	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	9.66	
						PFHpA	7.50	
						PFHxA	11.67	
						PFHxS	6.54	
						PFOA	15.02	
						PFOS	22.07	
						PFPeA	7.98	
CPF087DSUR	5/24/2021	35.2	7	21	2.8-8.2	PFBS	5.50	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFDA; PFDoA; PFDoS; PFDS; PFHxS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFHpA	2.80	
						PFHxA	5.80	
						PFHxS	2.80	
						PFOA	5.50	
						PFOS	8.20	
						PFPeA	4.60	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
CPF086FSUR	5/24/2021	38.3	7	21	2.4-7.3	PFBS	7.30	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFHpA	2.40	
						PFHxA	7.30	
						PFHxS	2.70	
						PFOA	4.60	
						PFOS	6.70	
						PFPeA	7.30	
CPF081A1CSUR	5/24/2021	42.4	9	19	2.1-7	PFBA	5.70	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.20	
						PFHpA	2.10	
						PFHpS	2.10	
						PFHxA	7.00	
						PFHxS	2.50	
						PFOA	4.50	
						PFOS	6.00	
						PFPeA	6.30	
CPF086CSUR	5/24/2021	38.70	8	20	2.5-6.8	PFBA	5.20	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.80	
						PFHpA	2.50	
						PFHxA	6.40	
						PFHxS	2.30	
						PFOA	4.40	
						PFOS	5.70	
						PFPeA	5.40	
CPF055CSUR	5/24/2021	93.90	8	20	6-18.8	PFBA	9.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	13.50	
						PFHpA	7.30	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHxA	14.20	
						PFHxS	6.00	
						PFOA	13.30	
						PFOS	18.80	
						PFPeA	11.80	
CPF087DSUR	6/17/2021	38.5	8	20	2.5-7.4	PFBA	5.10	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	5.50	
						PFHpA	2.60	
						PFHxA	5.60	
						PFHxS	2.50	
						PFOA	5.10	
						PFOS	7.40	
						PFPeA	4.70	
CPF086FSUR	6/17/2021	44.8	9	19	2.1-7.4	PFBA	6.30	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHxS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	5.50	
						PFHpA	2.40	
						PFHpS	3.50	
						PFHxA	7.40	
						PFHxS	2.10	
						PFOA	4.80	
						PFOS	6.30	
						PFPeA	6.50	
CPF081A1CSUR	6/17/2021	38.1	8	20	2.3-7.7	PFBS	5.70	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFHpA	2.40	
						PFHpS	2.40	
						PFHxA	7.70	
						PFHxS	2.30	
						PFOA	4.20	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFOS	6.40	
						PFPeA	7.00	
CPF086CSUR	6/17/2021	48.7	9	19	2.3-7.3	PFBA	6.10	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.20	
						PFHpA	2.30	
						PFHpS	7.00	
						PFHxA	7.30	
						PFHxS	2.30	
						PFOA	4.70	
						PFOS	6.30	
						PFPeA	6.50	
CPF055CSUR	6/17/2021	86.6	7	21	5.9-20.7	PFBS	11.10	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFDA; PFDoA; PFDoS; PFDS; PFHxS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFHpA	6.90	
						PFHxA	14.80	
						PFHxS	5.90	
						PFOA	12.80	
						PFOS	20.70	
						PFPeA	14.40	
CPF087DSUR	7/12/2021	45.2	8	20	2.9-8.7	PFBA	5.10	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	5.80	
						PFHpA	3.00	
						PFHxA	6.80	
						PFHxS	2.90	
						PFOA	6.20	
						PFOS	8.70	
						PFPeA	6.70	
CPF086FSUR	7/12/2021	44.8	9	19	2.4-6.9	PFBA	6.50	
						PFBS	5.90	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHpA	2.40	
						PFHpS	2.50	
						PFHxA	6.90	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFHxS	2.50	
						PFOA	5.00	
						PFOS	6.60	
						PFPeA	6.50	
						PFBA	7.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.40	
						PFHpA	2.20	
						PFHpS	4.60	
CPF081A1CSUR	7/12/2021	48.2	9	19	2.2-7.1	PFHxA	7.10	
						PFHxS	2.40	
						PFOA	4.90	
						PFOS	6.50	
						PFPeA	7.10	
						PFBA	6.30	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.00	
						PFHpA	2.10	
						PFHpS	2.30	
CPF086CSUR	7/12/2021	43.2	9	19	2.1-6.5	PFHxA	6.50	
						PFHxS	2.40	
						PFOA	4.80	
						PFOS	6.30	
						PFPeA	6.50	
						PFBA	23.90	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
CPF055CSUR	7/12/2021	137.7	9	19	2.1-25.10	PFBS	15.60	
						PFHpA	9.20	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHpS	2.10	
						PFHxA	21.50	
						PFHxS	6.20	
						PFOA	14.60	
						PFOS	19.50	
						PFPeA	25.10	
CPF087DSUR	8/5/2021	50.8	9	19	2.5-8.2	PFBA	5.80	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.20	
						PFHpA	5.60	
						PFHpS	2.50	
						PFHxA	7.10	
						PFHxS	2.80	
						PFOA	6.30	
						PFOS	8.20	
						PFPeA	6.30	
CPF086FSUR	8/5/2021	47.3	9	19	2.4-7.1	PFBA	6.90	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	5.80	
						PFHpA	2.70	
						PFHpS	3.60	
						PFHxA	7.00	
						PFHxS	2.40	
						PFOA	5.40	
						PFOS	7.10	
						PFPeA	6.40	
CPF081A1CSUR	8/5/2021	47.1	9	19	2.5-7.2	PFBA	7.20	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.00	
						PFHpA	2.50	
						PFHpS	2.80	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHxA	7.00	
						PFHxS	2.50	
						PFOA	5.30	
						PFOS	7.10	
						PFPeA	6.70	
CPF086CSUR	8/5/2021	75.2	17	11	2.1-7.2	11Cl-PF3ONS	3.10	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; HPFO-DA; NaDONA; PFDA; PFNA; PFNS; PFPeS; PFUnA
						N-EtFOSAA	4.00	
						N-MeFOSAA	2.80	
						PFBA	7.20	
						PFBS	6.10	
						PFDoA	3.50	
						PFDoS	2.80	
						PFDS	2.10	
						PFHpA	2.50	
						PFHpS	3.30	
						PFHxA	7.00	
						PFHxS	2.30	
						PFOA	5.30	
						PFOS	7.20	
						PFPeA	6.60	
						PFTeDA	5.50	
						PFTrDA	3.90	
CPF055CSUR	8/5/2021	115.9	15	13	2.5-17.9	11Cl-PF3ONS	3.20	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; HPFO-DA; NaDONA; N-MeFOSAA; PFDA; PFHpS; PFNA; PFNS; PFPeS; PFUnA
						N-EtFOSAA	2.50	
						PFBA	11.80	
						PFBS	11.30	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFDoA	3.40	
						PFDoS	2.10	
						PFDS	2.40	
						PFHpA	8.80	
						PFHxA	14.90	
						PFHxS	5.10	
						PFOA	11.20	
						PFOS	17.90	
						PFPeA	15.70	
						PFTeDA	2.80	
						PFTrDA	2.80	
CPF087DSUR	9/9/2021	58	10	18	2.2-.9	N-EtFOSAA	2.50	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBA	6.20	
						PFBS	5.50	
						PFHpA	3.70	
						PFHpS	2.20	
						PFHxA	8.80	
						PFHxS	3.20	
						PFOA	7.50	
						PFOS	9.90	
						PFPeA	8.50	
CPF086FSUR	9/9/2021	50.6	8	20	2.7-8.2	PFBA	7.30	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	5.80	
						PFHpA	4.50	
						PFHxA	8.20	
						PFHxS	2.70	
						PFOA	6.40	
						PFOS	7.60	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFPeA	8.10	
CPF081A1CSUR	9/9/2021	53.8	8	20	2.8-9.3	PFBA	8.40	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	7.00	
						PFHpA	3.00	
						PFHxA	9.10	
						PFHxS	2.80	
						PFOA	6.40	
						PFOS	7.80	
						PFPeA	9.30	
CPF086CSUR	9/9/2021	50.7	8	20	2.6-8.6	PFBA	7.90	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.40	
						PFHpA	3.00	
						PFHxA	8.60	
						PFHxS	2.60	
						PFOA	6.30	
						PFOS	7.50	
						PFPeA	8.40	
CPF055CSUR	9/9/2021	101.7	8	20	5.2-19.9	PFBA	8.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	11.30	
						PFHpA	9.20	
						PFHxA	17.00	
						PFHxS	5.20	
						PFOA	13.40	
						PFOS	17.70	
						PFPeA	19.90	
CPF087DSUR	10/12/2021	55.5	9	19	2.1-8.9	PFBA	6.70	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	6.60	
						PFHpA	5.30	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHpS	2.10	
						PFHxA	8.50	
						PFHxS	3.00	
						PFOA	5.90	
						PFOS	8.90	
						PFPeA	8.50	
CPF086FSUR	10/12/2021	62.2	9	19	2.5-12	PFBA	8.10	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	12.00	
						PFHpA	4.80	
						PFHpS	2.50	
						PFHxA	9.40	
						PFHxS	2.90	
						PFOA	5.40	
						PFOS	7.30	
						PFPeA	9.80	
CPF081A1CSUR	10/12/2021	56.6	9	19	2.8-10	PFBA	8.10	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	7.70	
						PFHpA	3.20	
						PFHpS	2.90	
						PFHxA	9.20	
						PFHxS	2.80	
						PFOA	5.40	
						PFOS	7.30	
						PFPeA	10.00	
CPF086CSUR	10/12/2021	53.1	8	20	2.6-9.4	PFBA	7.90	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	7.50	
						PFHpA	4.40	
						PFHxA	9.10	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHxS	2.60	
						PFOA	5.30	
						PFOS	6.90	
						PFPeA	9.40	
CPF055CSUR	10/12/2021	109.8	8	20	4.9-18	PFBA	18.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	14.00	
						PFHpA	8.90	
						PFHxA	17.00	
						PFHxS	4.90	
						PFOA	11.00	
						PFOS	16.00	
						PFPeA	20.00	
CPF087DSUR	11/8/2021	75.2	8	20	3.2-22	PFBS	6.80	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFHpA	5.70	
						PFHpS	22.00	
						PFHxA	9.90	
						PFHxS	3.20	
						PFOA	7.40	
						PFOS	9.20	
						PFPeA	11.00	
CPF086FSUR	11/8/2021	64.1	8	20	3.1-13	PFBA	9.60	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	9.10	
						PFHpA	3.70	
						PFHxA	11.00	
						PFHxS	3.10	
						PFOA	6.90	
						PFOS	7.70	
						PFPeA	13.00	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
CPF081A1CSUR	11/8/2021	66.2	9	19	3.1-12	PFBA	9.60	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	9.70	
						PFHpA	3.40	
						PFHpS	3.30	
						PFHxA	11.00	
						PFHxS	3.10	
						PFOA	6.30	
						PFOS	7.80	
						PFPeA	12.00	
CPF086CSUR	11/8/2021	70.5	9	19	13-Mar	PFBA	10.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	9.90	
						PFHpA	5.80	
						PFHpS	3.50	
						PFHxA	11.00	
						PFHxS	3.00	
						PFOA	7.10	
						PFOS	7.20	
						PFPeA	13.00	
CPF055CSUR	11/8/2021	139	9	19	5.8-28	PFBA	28.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFDA; PFDoA; PFDoS; PFDS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	18.00	
						PFHpA	7.90	
						PFHpS	6.30	
						PFHxA	21.00	
						PFHxS	5.80	
						PFOA	12.00	
						PFOS	16.00	
						PFPeA	24.00	
CPF087DSUR	12/2/2021	58.8	7	21	3.3-12	PFBA	8.60	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFHxA	11.00	
						PFHpA	5.90	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBS; PFDA; PFDoA; PFDoS; PFDS; PFHpS; PFNA; PFNS; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFHxS	3.30	
						PFOA	8.60	
						PFOS	9.40	
						PFPeA	12.00	
CPF086FDUR	12/2/2021	67	8	20	3.3-12	PFBA	9.80	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFBS; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxA; PFHxS; PFNA; PFNS; PFOA; PFOS; PFPeA; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	11.00	
						PFHpA	5.60	
						PFHpS	3.30	
						PFOA	7.30	
						PFOS	7.00	
						PFPeA	12.00	
						PFPeS	11.00	
CPF081A1CSUR	12/2/2021	80.6	8	20	3.1-17	PFBA	12.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFBS; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxA; PFHxS; PFNA; PFNS; PFOA; PFOS; PFPeA; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	17.00	
						PFHpA	6.20	
						PFHxA	13.00	
						PFHxS	3.10	
						PFOA	7.40	
						PFOS	6.90	
						PFPeA	15.00	
CPF086CSUR	12/2/2021	121.4	9	19	5.7-51.0	PFBA	11.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFBS; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxA; PFHxS; PFNA; PFNS; PFOA; PFOS; PFPeA; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	12.00	
						PFHpA	5.70	
						PFHpS	51.00	
						PFHxA	12.00	
						PFHxS	3.00	

Station	Date	PFAS Sum	Analytes detected	Analytes Below PQL	Range (ng/l)	Analyte	Result (ng/l)	PFAS Analytes below PQL
						PFOA	7.40	
						PFOS	6.30	
						PFPeA	13.00	
CPF055CSUR	12/2/2021	97.5	8	20	4.6-19.0	PFBA	10.00	4:2 FTS; 6:2 FTS; 8:2 FTS; 9cl-PF3ONS; 11cl-PF3ONS; HPFO-DA; NaDONA; N-EtFOSAA; N-MeFOSAA; PFBA; PFBS; PFDA; PFDoA; PFDoS; PFDS; PFHpA; PFHpS; PFHxA; PFHxS; PFNA; PFNS; PFOA; PFOS; PFPeA; PFPeS; PFTeDA; PFTrDA; PFUnA
						PFBS	16.00	
						PFHpA	6.90	
						PFHxA	17.00	
						PFHxS	4.60	
						PFOA	11.00	
						PFOS	13.00	
						PFPeA	19.00	

Appendix Table 2. Values of detected PFAS compounds and detection date for sites with values above PQL (2 ng/l).

Station ID	Date	Result (µg/l)	Average (µg/l)	Range (µg/l)
CPF055CSUR	6/17/2021	1.4	5.22	1.1-18
	7/12/2021	18		
	8/5/2021	2.2		
	11/8/2021	1.1		
	12/2/2021	3.4		

Appendix Table 3. Values of Detected 1,4-dioxane and detection dates for site with values above PQL (1 µg/L)