VERMONT AGENCY OF NATURAL RESOURCES

Vermont Department of Environmental Conservation 2022 PFAS Surface Water and Fish Tissue Monitoring Report

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VERMONT

DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION

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INTRODUCTION

In 2021, the Vermont Department of Environmental Conservation (VT DEC) Watershed Management Division, in cooperation with the Vermont Department of Fish & Wildlife (VT F&W), collected surface water and fish tissue samples from waterbodies in northern Vermont and analyzed the samples for per- and polyfluoroalkyl substances (PFAS). This was the first significant monitoring effort focused on PFAS in Vermont surface waters and was intended to develop a baseline understanding of potential contamination, as well as to identify areas requiring further assessment. The 2021 sampling targeted locations with known and probable sources of PFAS. Sites included the Lake Memphremagog watershed, the Winooski River, the Otter Creek, and the Stevens Branch.

The 2021 surface water results in all locations were below Vermont's PFAS drinking water maximum contaminant level (MCL) for five regulated compounds (see Table 1). The highest total PFAS concentration was observed in Muddy Brook, a tributary of the Winooski River located in an area with significant urban development. The 2021 fish tissue results found only one compound, perfluorooctanesulfonic acid (PFOS), detected above laboratory reporting limits. The sites with the highest total PFAS fish tissue concentrations were the mouth of the Winooski River and the mouth of Otter Creek. For additional details of the 2021 site selection and sampling effort, refer to the 2021 Monitoring Report at: https://dec.vermont.gov/sites/dec/files/wsm/mapp/docs/2021-PFAS-Surface-Water-Fish-Tissue-and-WWTF-Effluent-Monitoring-Report.pdf.

Based on the relatively higher PFAS concentrations observed, particularly in fish tissue, in the lower Winooski River and the lower Otter Creek, follow-up monitoring in 2022 was planned at additional locations in each waterbody. The 2022 effort also included surface water sampling above and below two wastewater discharges that are considered potential PFAS sources. Field sampling was performed by VT DEC and VT F&W between August 10, 2022 and December 14, 2022 at a total of 10 locations, with water collected at all sites and fish tissue collected at four sites. This report summarizes the results of the 2022 surface water and fish tissue monitoring.

BACKGROUND

According to the U.S. Environmental Protection Agency (U.S. EPA), PFAS are a group of thousands of human-made chemicals that have been in use since the 1940s. They are present in a wide variety of consumer and industrial products and are persistent in the environment, meaning that once released, PFAS degrade very slowly. Common sources of PFAS include nonstick cookware, waterproof clothing, fast food wrappers, manufacturing facilities, and some firefighting foams. Because they are persistent, PFAS have the potential to accumulate in humans, animals, and the environment. Although the health effects of many PFAS are not yet fully understood, certain PFAS are known to pose human health risks (U.S. EPA 2023b).

Since discovering PFOA in Bennington and North Bennington water supply wells in 2016, VT DEC has partnered with other state and federal agencies to identify and clean up existing PFAS contamination and mitigate future exposures. Sources investigated through this effort include industrial and manufacturing facilities, such as Teflon fabric coating facilities, wire coating facilities, semiconductor manufacturers, battery manufacturers, electroplating facilities,

carwashes, and tanneries. PFAS contamination has also been detected in waste streams, including landfills, landfill leachate, wastewater treatment facilities (WWTFs), and biosolids. VT DEC's 2023 PFAS Roadmap provides a summary of ongoing PFAS work.

PFAS in surface water may originate from groundwater, stormwater runoff, or direct discharges, such as those from industrial facilities or WWTFs (ITRC 2023b). PFAS can also be delivered by atmospheric deposition from long range transport or from a local source (ITRC 2023a). Human exposure to PFAS in surface waters occurs primarily through use of the waterbody as a drinking water source or consuming fish that have accumulated PFAS from their surroundings (ITRC 2023c).

MONITORING OBJECTIVES AND REGULATORY CRITERIA

The objective of the 2022 sampling effort was to gather additional data on the occurrence and magnitude of PFAS in Vermont surface waters and edible fish tissue, particularly in waterbodies known to contain quantifiable levels of PFAS. Monitoring sites were also selected with the goal of comparing pollutant concentrations upstream and downstream of potential PFAS sources.

In addition to evaluating the scope of PFAS impacts on aquatic resources, VT DEC will continue to coordinate with the Vermont Department of Health (Health) to review monitoring data that may inform potential future advisories issued by Health.

Water and fish tissue samples were analyzed for 36 compounds, which are listed along with common acronyms and basic chemical information in **Table 1**. Ambient water results are reported here in parts per trillion (ppt), which is equivalent to nanograms per liter (ng/L), while fish tissue results are reported in parts per billion (ppb), which is equivalent to micrograms per kilogram (µg/kg). Concentrations of PFAS are often orders of magnitude higher in fish than in surface waters due to bioaccumulation. Relative concentrations of PFAS in water and fish are different, meaning that a high concentration of one compound in water is not a predictor of its concentration in fish tissue (Pickard et al. 2022).

Table 1. PFAS Analytes for Surface Water and Fish Tissue Analysis

Analyte	Acronym	Number of Carbon Atoms	CAS Number
Carboxylic Acids			
Perfluorobutanoic acid	PFBA	4	375-22-4
Perfluoropentanoic acid	PFPeA	5	2706-90-3
Perfluorohexanoic acid	PFHxA	6	307-24-4
Perfluoroheptanoic acid	PFHpA	7	375-85-9
Perfluorooctanoic acid	PFOA	8	335-67-1
Perfluorononanoic acid	PFNA	9	375-95-1
Perfluorodecanoic acid	PFDA	10	335-76-2
Perfluoroundecanoic acid	PFUnA	11	2058-94-8
Perfluorododecanoic acid	PFDoA	12	307-55-1

Analyte	Acronym	Number of Carbon Atoms	CAS Number
Perfluorotridecanoic acid	PFTrDA	13	72629-94-8
Perfluorotetradecanoic acid	PFTA	14	376-06-7
Perfluoro-n-hexadecanoic acid	PFHxDA	16	67905-19-5
Perfluoro-n-octadecanoic acid	PFODA	18	16517-11-6
Sulfonic Acids			
Perfluorobutanesulfonic acid	PFBS	4	375-73-5
Perfluoropentanesulfonic acid	PFPeS	5	2706-91-4
Perfluorohexanesulfonic acid	PFHxS	6	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	7	375-92-8
Perfluorooctanesulfonic acid	PFOS	8	1763-23-1
Perfluorononanesulfonic acid	PFNS	9	68259-12-1
Perfluorodecanesulfonic acid	PFDS	10	335-77-3
4:2 Fluorotelomer sulfonic acid	4:2 FTS	6	757124-72-4
6:2 Fluorotelomer sulfonic acid	6:2 FTS	8	27619-97-2
8:2 Fluorotelomer sulfonic acid	8:2 FTS	10	39108-34-4
10:2 Fluorotelomer sulfonic acid	10:2 FTS	12	120226-60-0
Perfluorododecanesulfonic acid	PFDoDS	12	79780-39-5
Sulfonamides, Sulfomidoacetic Acids, Sulfonamidoethanols			
Perfluorooctanesulfonamide	FOSA	8	754-91-6
NMeFOSAA		11	2355-31-9
NEtFOSAA		12	2991-50-6
NEtFOSA		10	4151-50-2
NMeFOSA		9	31506-32-8
NMeFOSE		11	24448-09-7
NEtFOSE		12	1691-99-2
Replacement Chemicals			
9Cl-PF3ONS		8	756426-58-1
HFPO-DA	GenX	6	13252-13-6
11Cl-PF3OUdS		10	763051-92-9
ADONA		7	919005-14-4

VT DEC's 2023 PFAS Roadmap describes the Department's plan for adopting PFAS surface water quality criteria. Due to the significant resources and data required to develop Vermont-specific criteria, VT DEC typically adopts U.S. EPA's National Recommended Water Quality Criteria as they are developed and plans to follow this strategy for PFAS as well. To date, U.S. EPA has published draft recommended aquatic life criteria (water column, invertebrate, and fish tissue) for PFOA and PFOS (U.S. EPA 2022), which serve as benchmarks in assessing the 2022

results. U.S. EPA's 2021 PFAS Strategic Roadmap indicates that it expects to release human health-based ambient water quality criteria for PFAS in Fall 2024 (U.S. EPA 2021).

Table 2 summarizes all relevant promulgated and proposed PFAS criteria (U.S. EPA 2022, U.S. EPA 2023c, VT DEC 2020). Note that drinking water criteria are included for reference, although those standards do not directly apply to ambient surface water.

Table 2. Promulgated and Proposed Regulatory Criteria for PFAS

Criterion	Analyte(s)	Duration	Magnitude
VT Drinking Water MCL	PFOA, PFOS, PFHxS, PFNA, PFHpA	2-sample average	20 ppt[1]
U.S. EPA Proposed Drinking Water MCL	PFOA	Running annual average	4 ppt
	PFOS	Running annual average	4 ppt
	HFPO-DA (GenX), PFBS, PFNA, PFHxS	Running annual average	Hazard Index[2] = 1.0
U.S. EPA Draft Recommended Aquatic Life Ambient Water Quality Criteria	PFOA	1-hour average	49,000,000 ppt
		4-day average	94,000 ppt
	PFOS	1-hour average	3,000,000 ppt
		4-day average	8,400 ppt
U.S. EPA Draft Recommended Aquatic Life Fish Tissue Criteria	PFOA (Fish Whole-Body)	Instantaneous	6,100 ppb wet weight
	PFOS (Fish Whole-Body)	Instantaneous	6,750 ppb wet weight
	PFOA (Fish Muscle)	Instantaneous	125 ppb wet weight
	PFOS (Fish Muscle)	Instantaneous	2,910 ppb wet weight

Footnotes:
[1]The sum of the five analytes must be below 20 ng/L
[2]Hazard index = $\frac{[\text{HFPO-DA}]}{10\text{ ppt}} + \frac{[\text{PFBS}]}{2{,}000\text{ ppt}} + \frac{[\text{PFNA}]}{10\text{ ppt}} + \frac{[\text{PFHxS}]}{9.0\text{ ppt}}$

SAMPLING LOCATIONS AND SCHEDULE

Surface water and fish tissue samples were collected from sites targeted based on known and probable sources of PFAS. In 2021, the highest fish tissue PFAS concentrations were observed in the lower Winooski River and lower Otter Creek. Both waterbodies have significant inputs from municipal wastewater treatment facilities (WWTFs), industrial waste dischargers, and urban runoff, all of which are common sources of PFAS (Spahr et al. 2019, U.S. EPA 2022). Sampling locations were selected with these sources in mind, with the goal of assessing how concentrations further upstream in the waterbody compared to those further downstream.

Two other sites of interest were also monitored in 2022. Sampling above and below the Montpelier Wastewater Treatment Facility was repeated from 2021 to assess whether discharges from that facility were elevating downstream PFAS concentrations in the Winooski River. VT DEC additionally sampled upstream and downstream of a new site, the WestRock paperboard mill, on the Missisquoi River.

A list of 2022 monitoring sites is provided in **Table 3**. Refer to **Figures 1**, **2**, and **3** at the end of the report for maps of the sampling locations.

Table 3. Monitoring Site Information

Waterbody and Site Name	IWIS[1] Location ID	River Mile	Site Description	Sample(s) Collected	Latitude	Longitude
Winooski River: Above Montpelier WWTF	501943	54.7	Upstream of Montpelier WWTF	Water	44.2582	-72.60649
Winooski River: Below Montpelier WWTF	501942	54.3	Downstream of Montpelier WWTF	Water	44.25820	-72.60649
Winooski River: Above Global Foundries	523261	19.3	Upstream of Global Foundries (formerly IBM) discharge	Water	44.47996	-73.08243
Winooski River: Essex 19 Dam	523972	16.6	Immediately downstream of Essex 19 dam	Water	44.48162	-73.11739
Winooski River: Salmon Hole	501930	9.5	Near island below Salmon Hole	Fish, Water	44.48833	-73.19056
Winooski River: Mouth	501923	2.2	Mouth, below Burlington North WWTF	Fish, Water	44.53046	-73.26611
Otter Creek: Vergennes	502226	7.5	Upstream of Vergennes dam and WWTF	Fish, Water	44.16528	-73.25500
Otter Creek: Mouth	505347	0.1	Mouth, near jog in Fort Cassin Road	Fish, Water	44.22189	-73.31625
Missisquoi River: Above Mill	515783	22.9	Upstream of WestRock paperboard mill and hydro facility	Water	44.90945	-72.96711
Missisquoi River: Below Mill	505183	21.7	Downstream of WestRock paperboard mill, upstream of hydro facility release	Water	44.90950	-72.98271

Footnote:
[1]IWIS = Integrated Watershed Information System, available at: https://anrweb.vt.gov/DEC/IWIS/

Fish mobility introduces uncertainty as to the conditions they experienced prior to sampling; however, dams on both rivers serve as fish barriers, providing an opportunity to compare tissue contaminant levels above and below the dams. Rather than limiting fish sampling to the exact location of water sampling, fish were collected from each larger bracketed river reach. On the lower Otter Creek, fish sampling occurred between the mouth and just below the WWTF. Above the Vergennes dam, sampling extended to the confluence of the Otter Creek with the Lemon Fair River. On the lower Winooski, sampling occurred between the mouth to just below the Burlington Riverside WWTF. Sampling at Salmon Hole was limited to just below the Winooski dam.

Although surface water samples were collected at all target locations, fish samples were successfully obtained at only four of the ten sites. This was due to a variety of factors, primarily that many sites were inaccessible to the backpack and boat electroshockers used for fish collection.

Field sampling began in August 2022 and was completed in December 2022. Surface water at each site was sampled once during this period, and fish collection was generally concurrent. At the Salmon Hole site, fish collection was conducted on two dates to obtain a larger sample size.

METHODS

To describe PFAS concentrations at target sites, "paired" surface water and fish tissue samples were collected and analyzed. The surface water and fish tissue were analyzed for 36 PFAS (see compound list in **Table 1**), including the five Vermont-regulated PFAS (PFHpA, PFHxS, PFOA, PFNA, PFOS) and all PFAS included in U.S. EPA's proposed criteria.

Surface Water Sampling

Grab water samples were collected 15-30 cm below the surface, as PFAS are known to accumulate at the air-water interface and surface samples may not be representative of bulk water column PFAS concentrations. Grab samples were collected directly into two 275-ml high density polyethylene (HDPE) pre-cleaned PFAS-free wide-mouth lab-prepared sample bottles (refer to **Appendix D** for Surface Water Sampling Standard Operating Procedures and Alpha Analytical Laboratory's PFAS Sampling Instructions for Non-Drinking Water for EPA Method 537).

At each surface water sampling site, water chemistry field parameters were collected as supporting data. A calibrated YSI Sonde was used at the boat-based sampling sites to record measurements of dissolved oxygen, temperature, conductivity, and pH. Surface water samples were also collected and analyzed for ancillary water quality parameters at the State of Vermont Agriculture and Environmental Laboratory (VAEL) (refer to **Appendix C** for results)**.** The collection and analysis of these supporting parameters followed guidance provided in the Ambient Biomonitoring Network Bioassessments of Flowing Waters in Vermont Quality Assurance Plan 2018. The VAEL Quality Systems Manual Revision 26, 2021 provides details on Quality Assurance for chemistry analysis and reporting.

Fish Tissue Sampling

Fish species chosen for collection were legal species and sizes typically consumed by anglers. Target fish included yellow perch (*Perca flavescens*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), bluegill sunfish (*Lepomis macrochirus)*, pumpkin seed (*Lepomis gibbosus),* and brown bullhead (*Ameiurus nebulosus*). These species are representative of different trophic levels and habitat (**Table 4**). Additionally, they do not migrate long distances and are therefore more likely to be representative of the conditions in the surface water where they are caught. Fish were collected by direct current boat electrofishing by VT F&W staff with DEC staff assistance.

Table 4. Target Fish Species and Characteristics

Species	Latin Name	Habitat	Target Size	Trophic Level Descriptors	Trophic Level
Bluegill Sunfish	*Lepomis macrochirus*	Benthic	>6”	Generalist	3
Brown Bullhead	*Ameiurus nebulosus*	Benthic	>8”	Benthic Insectivore	3
Brown Trout	*Salmo trutta*	Pelagic	12” on lower Winooski	Top Carnivore	4
Largemouth Bass	*Micropterus salmoides*	Pelagic	>12”	Top Carnivore	4
Northern Pike	*Esox lucius*	Pelagic	20” on lower Winooski	Top Carnivore	4
Pumpkin seed	*Lepomis gibbosus*	Benthic	>6”	Lower-Level Insectivore/Piscivore	3
Rainbow Trout	*Oncorhynchus mykiss*	Pelagic	12” on lower Winooski	Top Carnivore	4
Smallmouth Bass	*Micropterus dolomieu*	Pelagic	>12”	Top Carnivore	4
Yellow Perch	*Perca flavescens*	Pelagic	>8”	Lower-Level Insectivore/Piscivore	3

Up to nine fish of legal and edible size were sampled and analyzed as individuals representing up to three target species at each location. When deemed necessary to obtain sufficient tissue for analysis, composite samples consisting of three to five individuals were substituted for single fish samples. The weight, length, and observed anomalies of all fish retained for analysis were recorded (see **Appendix B).**

Single right-side, skin-off fillets of each fish or composite of target species were prepared. Alpha Analytical Laboratory performed the homogenization of fish tissue samples. A minimum of 50 grams of sample was submitted for analysis. A total of 30 fish tissue samples representing four species of fish were analyzed from the four fish collection sites (**Table 5**). Tissue samples were double bagged in a zip-seal bag and shipped frozen to the laboratory for PFAS analysis. Fish sampling and analysis procedures are further described in **Appendix E,** Fish Collection and Processing Standard Operating Procedure.

Table 5. Fish Counts and Species by Monitoring Site

Site Name	Largemouth Bass	Northern Pike	Smallmouth Bass	Yellow Perch	Fish Total at Site
Winooski River: Salmon Hole	--	--	3	1	4
Winooski River: Mouth	2	3	--	3	8
Otter Creek: Vergennes	--	3	3	3	9
Otter Creek: Mouth	--	3	3	3	9
Species Total	2	9	9	10	

Data Quality Objectives

Data quality objectives for the sampling effort were for all measurements to be representative of the actual site conditions and for all data resulting from field, sampling,

and analysis activities to be comparable. Data comparability was achieved by continuity of acceptable laboratory practices, method analysis, sample collection procedures, and sample handling. Guidelines for handling, management, and analysis of surface water and fish tissue samples and quality control samples followed protocols described in **Appendices D** and **E**.

The analytical method for the 36 PFAS analytes uses Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS), based on EPA 537.1 Modified Isotope Dilution (ID) method, and was completed by Alpha Analytical Laboratory in Westborough, Massachusetts. Fish tissue detection limits for the 36 PFAS analytes range from approximately 0.02 to 4 ppb, and surface water detection limits range from approximately 0.2 to 23 ppt. **Appendix A** provides specific detection and quantitation limits for these analytes in surface water and fish tissue.

Laboratories may obtain analyte results that fall below the level that their analysis method can confidently quantify (reporting limit or RL), but above the method detection limit. In this report, PFAS analyte values below the reporting limit and above the method detection limit are included in the results summary tables for informational purposes. Only results above the laboratory reporting limit are used for formal assessment of PFAS concentrations.

Performance acceptance criteria for data generated by Alpha Analytical Laboratory were based on principal data quality indicators, including precision, bias, representativeness, completeness, comparability, and sensitivity. The reporting limits and the acceptance limits for accuracy and precision for data generated by Alpha Analytical Laboratory were reviewed by VT DEC and determined to meet Data Quality Objectives.

Quality Assurance and Quality Control

Given the sensitivity of PFAS analyses and the potential for field or laboratory contamination, field duplicates, field blanks, and equipment blanks were collected and analyzed along with samples. All QA/QC samples were analyzed for PFAS using modified EPA Method 537.1.

Field Duplicates

In addition to primary samples, surface water and fish tissue field duplicates were collected and submitted to the laboratory as distinct samples. Field duplicates are used to verify the precision of field and laboratory activities. The field duplicate is a sample collected from a sample location at the same time and under identical circumstances as the field sample and treated the same throughout field and laboratory procedures. Field duplicate samples were collected to meet a minimum of 10% duplicate-to-primary sample ratio for surface water and a minimum of 5% duplicate-to-primary sample ratio for fish tissue. Fish tissue duplicate samples were prepared from left-side skin-off fillets of the chosen fish specimens. Left-side fillets were removed after right-side (primary sample) fillets and duplicate fillets were chosen at random for laboratory analysis.

Field Blank

Field blanks were collected to verify that the sampling environment did not introduce PFAS that could contaminate surface water samples. For the analysis of aqueous matrices, field blanks were collected by pouring PFAS-free reagent water stored in a laboratory-provided, PFAS-free container into an empty, clean sample container at the sampling site. Field blanks were treated identically to surface water samples throughout field and laboratory processing. At least one field blank sample was collected per day or one per twenty samples, whichever was more frequent.

Equipment Blank

Equipment blanks for fish tissue samples were collected by passing laboratory-verified PFAS-free water over or through field sampling and sample processing equipment before the collection and preparation of samples to evaluate potential contamination from the equipment used. Equipment blanks were collected at a minimum frequency of one per day or one per 20 samples, whichever was more frequent.

SUMMARY OF ANALYTICAL RESULTS

Surface water results are presented in **Table 6** and fish tissue results are presented in **Tables 7-8**. Ancillary water quality results are summarized in **Appendix C** and a side-by-side comparison of PFAS data from 2021 to 2022 is provided in **Appendix F**. Complete analytical results are available in **Appendix G**.

Surface Water Results

Table 6 summarizes all surface water PFAS detections. PFAS were found at all ten monitoring sites, with 13 unique compounds detected in total. There were detections above laboratory reporting limits at three sites, all in the Winooski River. PFAS concentrations at Salmon Hole and the Winooski River mouth were significantly higher than those of any other monitoring sites.

Table 6. Summary of Surface Water Detections (ppt)[1]

Site	Sample Date	PFBA	PFPeA	PFBS	PFHxA	PFPeS	PFHpA	PFHxS	PFOA	6:2FTS	PFNA	PFOS	PFDA	PFHxDA	Sum of all PFAS[2]
Winooski River: Above Montpelier WWTF	12/12/2022	0.448J	0.427J	ND	ND	ND	0.251J	ND	0.406J	ND	ND	ND	ND	ND	0
Winooski River: Below Montpelier WWTF	12/12/2022	0.396J	0.525J	ND	ND	ND	0.229J	ND	0.414J	ND	ND	ND	ND	1.24JF	0
Winooski River: Above Global Foundries	12/10/2022	ND	0.426J	ND	ND	ND	0.227J	ND	0.474J	ND	ND	ND	ND	1.18JF	0
Winooski River: Essex 19 Dam	12/14/2022	0.916J	0.691J	0.481J	0.537JF	ND	0.316J	ND	0.523J	**1.76**	ND	ND	ND	1.16J	**1.76**
Winooski River: Salmon Hole	8/10/2022	**5.84**	**3.86**	**2.81**	**3.22**	0.470J	1.33J	**3.83**	**2.61**	ND	0.518J	**4.19**	0.303JF	ND	**26.36**
Winooski River: Mouth	8/10/2022	**5.87**	**3.86**	**2.88**	**3.57**	0.510JF	1.51J	**3.87**	**3.08**	ND	0.641J	**5.75**	ND	ND	**28.88**
Otter Creek: Vergennes	9/16/2022	1.47J	1.00J	0.501J	0.727J	ND	0.731J	ND	0.939J	ND	ND	0.602J	ND	ND	0
Otter Creek: Mouth	9/28/2022	0.875J	0.507J	0.344J	0.472J	ND	0.434J	ND	0.656J	ND	ND	0.521J	ND	ND	0
Missisquoi River: Above Mill	12/10/2022	ND	0.477J	ND	ND	ND	0.226J	ND	0.399J	ND	ND	ND	ND	1.16J	0
Missisquoi River: Below Mill	12/10/2022	0.377J	0.472J	ND	ND	ND	ND	ND	0.328J	ND	ND	ND	ND	ND	0

Footnote:
[1]Detections above laboratory reporting limit are in bold
[2]Sum includes only results above laboratory reporting limit

Abbreviations:
ND = Compound not detected in sample
J = Estimated value, compound was detected in sample below laboratory reporting limit
F = Estimated maximum concentration

In general, shorter chain (seven or fewer carbon atoms) perfluoroalkyl carboxylic acids were detected most frequently in surface water analyses, along with the longer chain PFOA and PFOS, which were historically two of the most widely used PFAS (U.S. EPA 2022).

The results of monitoring at the four Winooski River sites in the Champlain Valley show a pattern of increasing PFAS further downstream. There were no surface water detections above laboratory reporting limits upstream of the Global Foundries discharge, one detection at the Essex 19 dam, and seven detections each at Salmon Hole and the Winooski River mouth. Moreover, the total observed PFAS concentration increased sharply between the Essex 19 dam and Salmon Hole monitoring locations. The total PFAS concentration was slightly higher at the river mouth than at Salmon Hole.

In contrast, the Otter Creek monitoring results did not show a significant increase in PFAS between the Vergennes site and the mouth of the Creek. There were no surface water detections above laboratory reporting limits in either location.

No significant difference was observed in surface water PFAS concentrations above and below the two wastewater discharges investigated (Montpelier WWTF and WestRock paperboard mill), and no compounds were detected above laboratory reporting limits at either location.

Surface water results at all sites were below U.S. EPA's draft water column criteria for the protection of aquatic life. All results were also below Vermont's drinking water MCL and U.S. EPA's proposed drinking water MCLs for PFOA and the mixture of HFPO-DA, PFBS, PFNA, and PFHxS. Results at Salmon Hole and the Winooski River mouth exceeded U.S. EPA's proposed drinking water MCL for PFOS, although no public water systems use the lower Winooski River as a drinking water source and, moreover, the drinking water MCLs apply after treatment and are therefore not directly comparable to surface water results. The MCLs are used as benchmarks here for context due to the lack of human health-based surface water PFAS criteria in Vermont.

Fish Tissue

Maximum observed PFAS concentrations in each species at the four fish tissue monitoring locations are summarized in **Table 7**. Twelve unique compounds were detected, six of those above laboratory reporting limits. The highest total PFAS concentrations observed were in smallmouth bass at Salmon Hole and were significantly above the next highest concentrations, observed in largemouth bass and yellow perch at the Winooski River mouth. Notably, however, several of the Salmon Hole smallmouth bass results are estimated maximum concentrations (see quality control discussion below).

Table 7. Maximum PFAS Detections in Fish Tissue (ppb)[1]

Site	Fish Species	Fish Count	PFBA	PFHxS	PFNA	PFOS	PFDA	PFUnA	PFDS	PFDoA	PFTrDA	PFTA	FOSA	NMeFOSE	Sum of all PFAS Above RL[2]
Winooski River: Salmon Hole	Smallmouth Bass	3	0.058JF	ND	ND	**15.4F**	**1.16F**	**2.04F**	0.184JF	**1.90F**	**1.23F**	ND	0.151JF	ND	21.71
	Yellow Perch	1	ND	0.068J	ND	**4.38**	**0.344**	**0.718**	ND	**0.679**	**0.515**	0.160J	ND	ND	6.636
Winooski River: Mouth	Largemouth Bass	2	ND	ND	ND	**8.19**	**0.532**	**0.951**	ND	0.429JF	0.371JF	0.257JF	ND	ND	9.673
	Northern Pike	3	ND	0.097J	ND	**5.50**	**0.590**	**0.790**	ND	**0.466**	0.347JF	0.069JF	0.142JF	ND	7.346
	Yellow Perch	3	ND	0.059J	ND	**6.90**	**0.486F**	**0.789**	ND	**0.565**	**0.588F**	0.200JF	ND	ND	9.246
Otter Creek: Vergennes	Northern Pike	3	ND	ND	0.108J	**2.20**	**2.20**	0.280J	0.137J	0.159JF	0.257J	0.121J	**0.688**	0.509J	3.124
	Smallmouth Bass	3	0.023J	ND	ND	**2.51**	**0.242**	0.445J	ND	0.231J	0.289J	0.158J	0.105J	ND	2.752
	Yellow Perch	3	ND	ND	ND	**1.38F**	0.157J	0.208J	ND	0.138JF	0.268JF	0.128J	ND	ND	1.38
Otter Creek: Mouth	Northern Pike	3	ND	ND	ND	**2.90**	0.230J	0.220J	ND	0.109J	ND	ND	0.162J	ND	2.90
	Smallmouth Bass	3	ND	ND	ND	**2.64F**	**0.234**	0.329JF	ND	0.141JF	ND	0.077JF	ND	ND	2.874
	Yellow Perch	3	ND	ND	ND	**0.945F**	0.075JF	0.122J	ND	0.072JF	ND	ND	ND	ND	0.945

Footnotes:
[1]Detections above laboratory reporting limit are in bold
[2]Maximum single-sample result, including estimated maximum values (F flag)

Abbreviations:
ND = Compound not detected in sample
J = Estimated value, compound was detected in sample below laboratory reporting limit
F = Estimated maximum concentration

PFOS was detected above laboratory reporting limits in all samples. Aside from PFOS, most PFAS detected in fish tissue samples were perfluoroalkyl carboxylic acids with ten or more carbon atoms. **Table 8** summarizes the compounds detected above laboratory reporting limits and their detection frequency.

Table 8. Compounds Detected in Fish Tissue above Laboratory Reporting Limits

Compound	Number of Detections Above RL	Average of Detections above RL (ppb)	Maximum (ppb)
PFOS	30	4.81	15.4
PFDA	15	0.724	2.2
PFUnA	6	1.06	2.04
PFDoA	4	0.903	1.90
PFTrDA	6	0.778	1.23
FOSA	1	0.688	0.688

Unlike the surface water results, fish tissue concentrations at Salmon Hole and the Winooski River mouth did not demonstrate a clear upstream versus downstream pattern. The only species collected in both locations, yellow perch, had a slightly higher maximum total PFAS concentration at the mouth of the river, but the average total concentrations were similar (refer to full results in **Appendix G**).

The Otter Creek fish tissue sampling found roughly equal concentrations of PFAS above and below the Vergennes dam (and WWTF) across all three species monitored in both locations.

All fish tissue results were below U.S. EPA's draft PFOA and PFOS criteria for the protection of aquatic life. The results also show similar trends in compounds detected and detection frequency to the recently released 2018-2019 National Rivers and Streams Assessment, which sampled for 33 PFAS in 290 samples across the United States (U.S. EPA, 2023a).

As part of the quality control process, VT DEC staff collected equipment blank samples on each date that fish tissue samples were processed prior to laboratory analysis. Results from the equipment blank collected on 12/15/2022 showed detections of 11 compounds, several at significantly higher concentrations than observed in any surface water field samples. Follow-up testing did not replicate these results and VT DEC was not able to identify a source of the detections. Although the data from fish tissue processed on that date appear within reasonable ranges and not all compounds detected in the blank sample were observed in tissue samples, the results from the 10/28/2022 Salmon Hole monitoring event have been adjusted to account for potential sample contamination following guidance from the New York State Department of Environmental Conservation (NYSDEC, 2023).

DISCUSSION

Comparison to 2021 Results

The 2022 monitoring effort included sampling certain locations (Winooski River mouth and Otter Creek mouth) that were also monitored in 2021, providing an opportunity for data comparison. The PFAS concentrations observed in both fish tissue and surface water were generally similar from 2021 to 2022, with the exception of certain results from the Winooski River mouth. The surface water results at that location were significantly higher in 2022, whereas the 2022 fish tissue concentrations were roughly unchanged in northern pike and were lower in yellow perch.

As in 2021, the lower Winooski River showed elevated PFAS concentrations in both fish and water, as compared to other sample locations.

Data Representativeness

As with all environmental sampling, there is uncertainty associated with both PFAS surface water and fish tissue results. Surface water conditions may vary day to day depending on a variety of factors including runoff, wastewater discharges, and river flow characteristics. While fish tissue may be a more representative measure of waterbody conditions over time, tissue concentrations are also dependent on fish age and the predominant location within the waterbody that the fish resides. Although dams serve as definitive fish barriers, it is otherwise impossible to assess the precise conditions experienced by the fish prior to sample collection.

Despite these sources of uncertainty, the relative consistency of the results from 2021 to 2022 indicates that PFAS levels tend to be higher in the lower Winooski River than in the lower Otter Creek. This may be due to the presence of more urban inputs, including runoff and direct discharges, to the Winooski River and is a potential focus of future monitoring.

CONCLUSIONS

In summary, the 2022 fish tissue and surface water monitoring found that:

- PFAS were detected above laboratory reporting limits at three of the ten surface water monitoring sites, all in the Winooski River,
- PFAS were detected above laboratory reporting limits at all four fish tissue monitoring sites, with PFOS as the most significant contributor,
- Surface water PFAS levels increased further downstream in the Winooski River, but not in the Otter Creek,
- There was no measurable increase in surface water PFAS levels downstream of either the Montpelier WWTF or the WestRock paperboard mill discharge, and
- All results were below U.S. EPA's proposed aquatic life-based regulatory criteria for PFOA and PFOS, which are currently the only available benchmarks directly applicable to surface water and fish tissue data. U.S. EPA expects to release human health-based ambient water quality criteria for PFAS in Fall 2024.

VT DEC plans to continue its study of PFAS impacts to surface waters through targeted monitoring near sites with known or suspected sources of contamination. Future monitoring locations may be identified through results of the ongoing statewide PFAS WWTF effluent monitoring study, or through discussions with local and state partners.

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FIGURES

Figure 1. All 2022 PFAS monitoring locations.

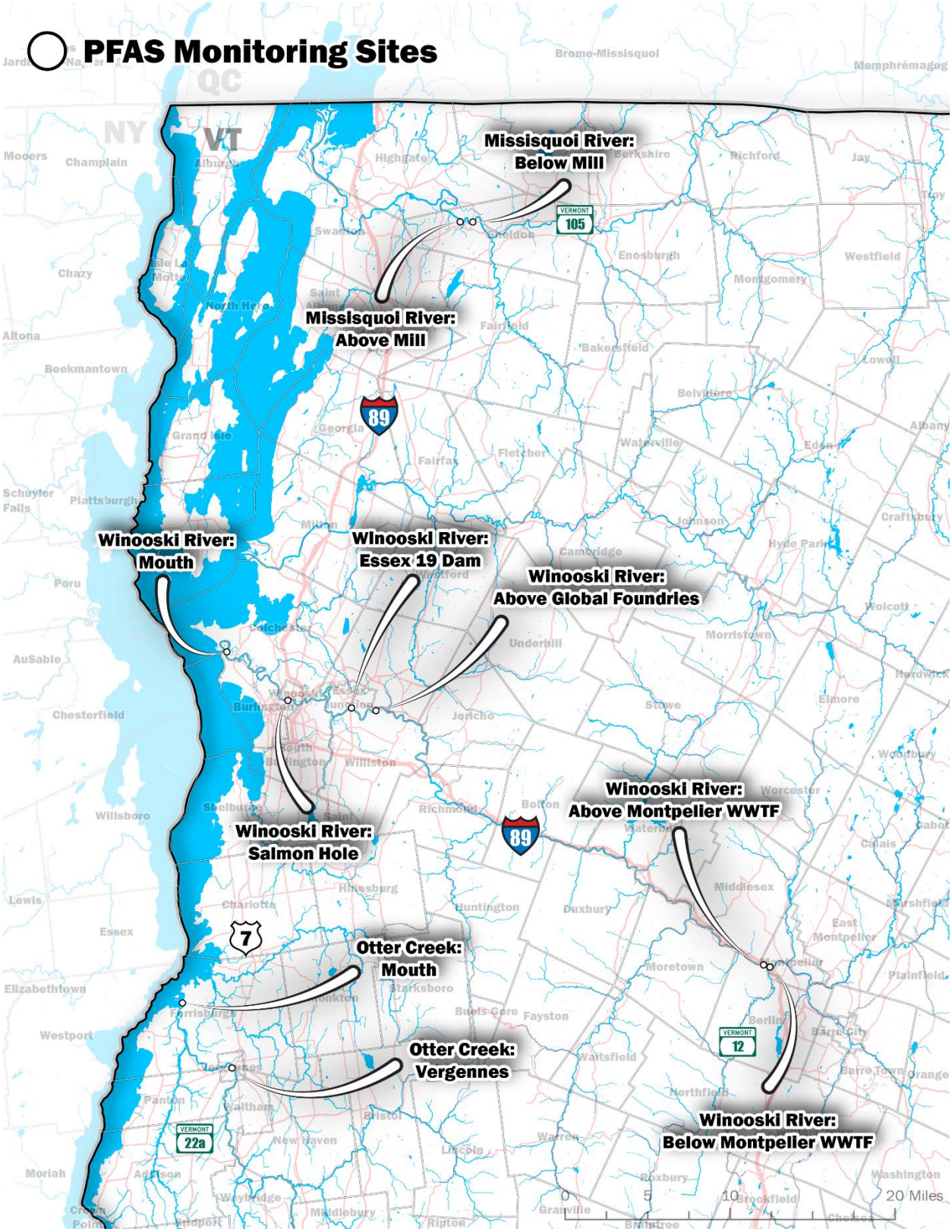


Figure 2. 2022 Otter Creek monitoring locations.

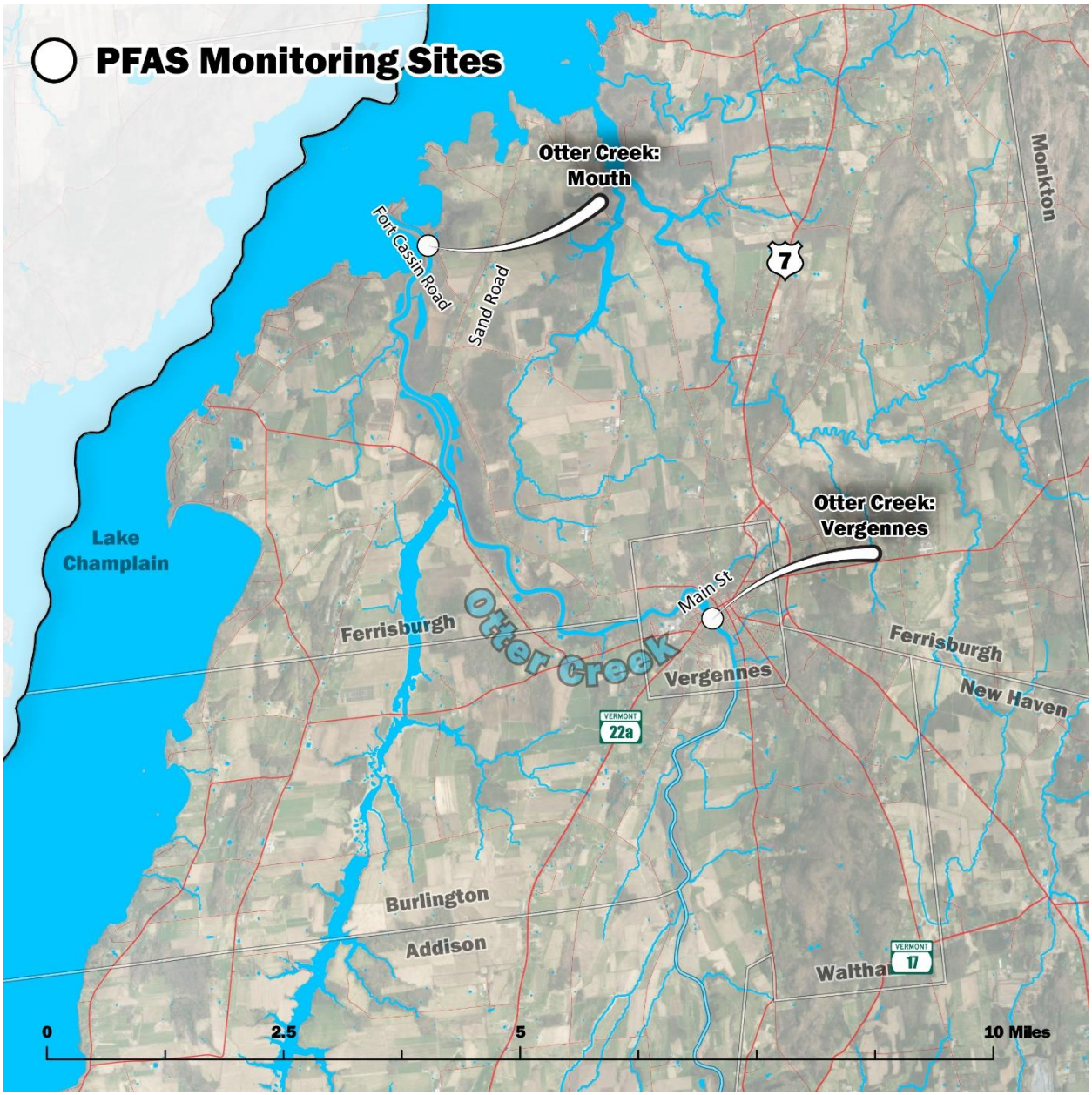
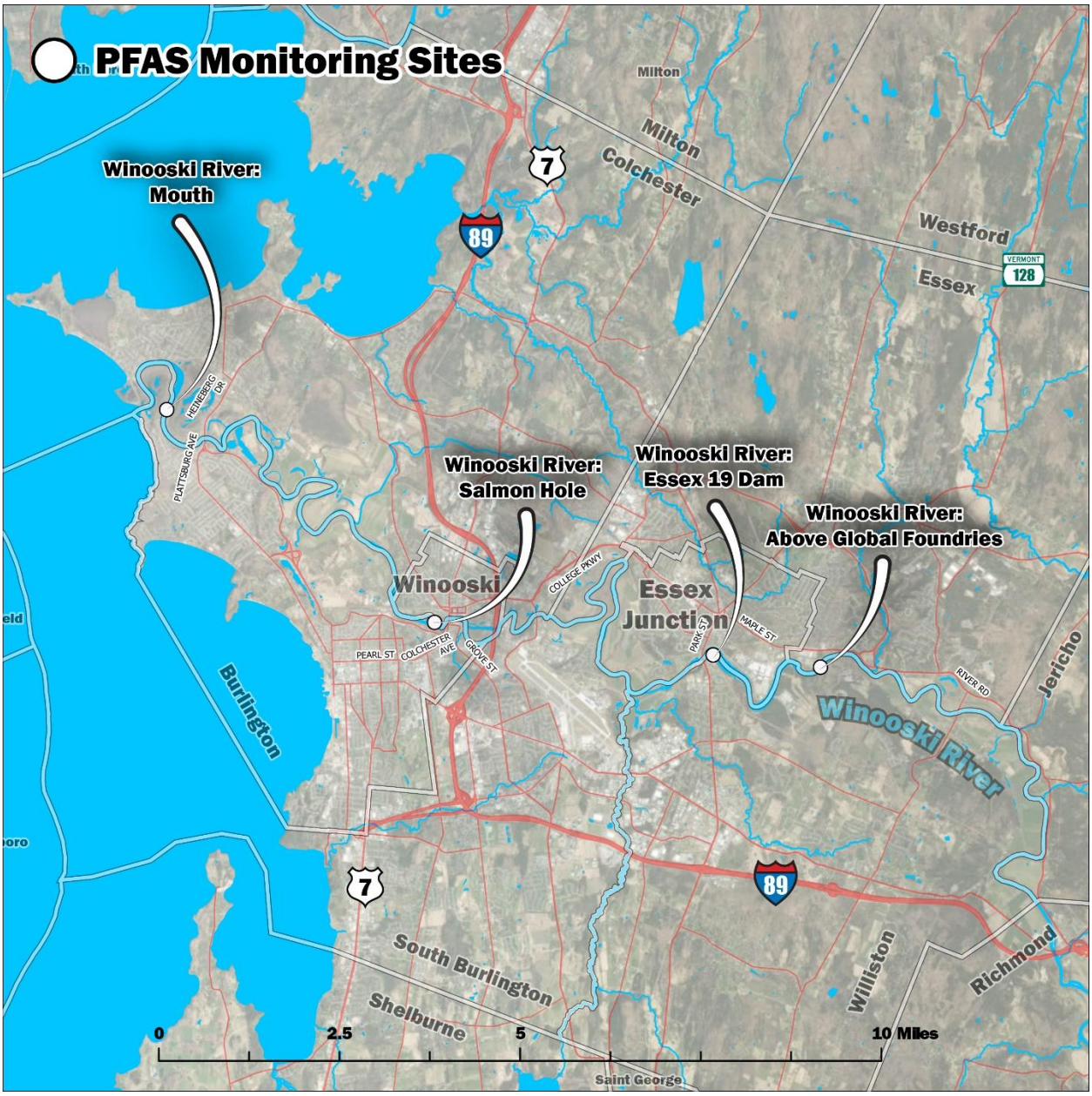


Figure 3. 2022 Winooski River monitoring locations within the Champlain Valley.



APPENDIX A: LABORATORY PFAS QUANTITATION LIMITS

Table A-1. Surface Water Analysis Method Reporting Limits (RLs) and Method Detection Limits (MDLs)

Date Created: 07/07/22
Created By: Michael Chang
File: PM12752-1
Page: 1

PFAAs via LCMSMS-Isotope Dilution (WATER)

Holding Time: 14 days
Container/Sample Preservation: 1 - 2 Plastic/1 Plastic/1 H20 Plastic

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria
Perfluorobutanoic Acid (PFBA)	375-22-4	2	0.408	ng/l	67-148	30	67-148	30	30	
Perfluoropentanoic Acid (PFPeA)	2706-90-3	2	0.396	ng/l	63-161	30	63-161	30	30	
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	2	0.238	ng/l	65-157	30	65-157	30	30	
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	2	0.452	ng/l	37-219	30	37-219	30	30	
Perfluorohexanoic Acid (PFHxA)	307-24-4	2	0.328	ng/l	69-168	30	69-168	30	30	
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	2	0.2452	ng/l	52-156	30	52-156	30	30	
Perfluoroheptanoic Acid (PFHpA)	375-85-9	2	0.2252	ng/l	58-159	30	58-159	30	30	
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	2	0.376	ng/l	69-177	30	69-177	30	30	
Perfluorooctanoic Acid (PFOA)	335-67-1	2	0.236	ng/l	63-159	30	63-159	30	30	
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	2	1.332	ng/l	49-187	30	49-187	30	30	
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	2	0.688	ng/l	61-179	30	61-179	30	30	
Perfluorononanoic Acid (PFNA)	375-95-1	2	0.312	ng/l	68-171	30	68-171	30	30	
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	2	0.504	ng/l	52-151	30	52-151	30	30	
Perfluorodecanoic Acid (PFDA)	335-76-2	2	0.304	ng/l	63-171	30	63-171	30	30	
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	2	1.212	ng/l	56-173	30	56-173	30	30	
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	2	1.12	ng/l	48-150	30	48-150	30	30	
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	2355-31-9	2	0.648	ng/l	60-166	30	60-166	30	30	
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	2	0.26	ng/l	60-153	30	60-153	30	30	
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	2	0.98	ng/l	38-156	30	38-156	30	30	
Perfluorooctanesulfonamide (FOSA)	754-91-6	2	0.58	ng/l	46-170	30	46-170	30	30	
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	2	0.804	ng/l	45-170	30	45-170	30	30	
Perfluorododecanoic Acid (PFDoA)	307-55-1	2	0.372	ng/l	67-153	30	67-153	30	30	
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	2	0.3272	ng/l	48-158	30	48-158	30	30	
Perfluorotetradecanoic Acid (PFTA)	376-06-7	2	0.248	ng/l	59-182	30	59-182	30	30	
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Propanoic Acid (HFPO-DA)	13252-13-6	50	22.7	ng/l	57-162	30	57-162	30	30	
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	2	0.336	ng/l	69-143	30	69-143	30	30	
Perfluorohexadecanoic Acid (PFHxDA)	67905-19-5	4	1.24	ng/l	40-167	30	40-167	30	30	
Perfluorooctadecanoic Acid (PFODA)	16517-11-6	4	1.148	ng/l	10-119	30	10-119	30	30	
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	2	0.616	ng/l	69-141	30	69-141	30	30	
1H,1H,2H,2H-Perfluorododecanesulfonic Acid (10:2FTS)	120226-60-0	5	2.02	ng/l	81-188	30	81-188	30	30	
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	756426-58-1	2	0.2768	ng/l	55-158	30	55-158	30	30	
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	763051-92-9	2	0.2932	ng/l	52-156	30	52-156	30	30	
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	20	7.36	ng/l	10-185	30	10-185	30	30	
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	20	6.64	ng/l	10-202	30	10-202	30	30	
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	50	22.2	ng/l	10-209	30	10-209	30	30	
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	50	22.52	ng/l	66-176	30	66-176	30	30	
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*58-132*
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*62-163*
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*70-131*
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-4:2FTS)	*NONE*									*12-142*
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*57-129*
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*60-129*

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
Please Note that the information provided in this table is subject to change at anytime at the discretion of Alpha Analytical, Inc.

Date Created: 07/07/22
Created By: Michael Chang
File: PM12752-1
Page: 2

PFAAs via LCMSMS-Isotope Dilution (WATER)

Holding Time: 14 days
Container/Sample Preservation: 1 - 2 Plastic/1 Plastic/1 H20 Plastic

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*71-134*
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*62-129*
1H,1H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-6:2FTS)	*NONE*									*14-147*
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*59-139*
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*69-131*
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*62-124*
1H,1H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-8:2FTS)	*NONE*									*10-162*
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid (d3-NMeFOSAA)	*NONE*									*24-116*
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*55-137*
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*5-112*
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (d5-NEtFOSAA)	*NONE*									*27-126*
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*48-131*
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*22-136*
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-13C3-Propanoic Acid (M3HFPO-DA)	*NONE*									*10-165*
Perfluoro[13C2]Hexadecanoic Acid (M2PFHxDA)	*NONE*									*10-206*
1H,1H,2H-Perfluorododecane Sulfonate (M2D4-10:2FTS)	*NONE*									*50-150*
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA)	*NONE*									*10-161*
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*10-160*
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (d7-NMeFOSE)	*1265205-95-5*									*10-189*
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (d9-NEtFOSE)	*NONE*									*10-187*

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. *(Soil/Solids only)*
Please Note that the information provided in this table is subject to change at anytime at the discretion of Alpha Analytical, Inc.

Table A-2. Fish Tissue Analysis Method Reporting Limits (RLs) and Method Detection Limits (MDLs)

Date Created: 07/07/22
Created By: Michael Chang
File: PM12753-1
Page: 1

PFAAs via LCMSMS-Isotope Dilution (TISSUE)

Holding Time: 28 days
Container/Sample Preservation: 1 - Plastic 8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria
Perfluorobutanoic Acid (PFBA)	375-22-4	0.5	0.0227	ng/g	71-135	30	71-135	30	30	
Perfluoropentanoic Acid (PFPeA)	2706-90-3	0.5	0.046	ng/g	69-132	30	69-132	30	30	
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	0.25	0.039	ng/g	72-128	30	72-128	30	30	
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	1	0.0645	ng/g	62-145	30	62-145	30	30	
Perfluorohexanoic Acid (PFHxA)	307-24-4	0.5	0.0525	ng/g	70-132	30	70-132	30	30	
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	1	0.0835	ng/g	73-123	30	73-123	30	30	
Perfluoroheptanoic Acid (PFHpA)	375-85-9	0.25	0.0451	ng/g	71-131	30	71-131	30	30	
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	0.25	0.0605	ng/g	67-130	30	67-130	30	30	
Perfluorooctanoic Acid (PFOA)	335-67-1	0.25	0.0419	ng/g	69-133	30	69-133	30	30	
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	0.5	0.1795	ng/g	64-140	30	64-140	30	30	
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	0.5	0.1365	ng/g	70-132	30	70-132	30	30	
Perfluorononanoic Acid (PFNA)	375-95-1	0.25	0.075	ng/g	72-129	30	72-129	30	30	
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	0.25	0.13	ng/g	68-136	30	68-136	30	30	
Perfluorodecanoic Acid (PFDA)	335-76-2	0.25	0.067	ng/g	69-133	30	69-133	30	30	
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	0.5	0.287	ng/g	65-137	30	65-137	30	30	
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	1	0.299	ng/g	69-125	30	69-125	30	30	
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	2355-31-9	0.5	0.2015	ng/g	63-144	30	63-144	30	30	
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	0.5	0.0468	ng/g	64-136	30	64-136	30	30	
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	0.5	0.153	ng/g	59-134	30	59-134	30	30	
Perfluorooctanesulfonamide (FOSA)	754-91-6	0.5	0.098	ng/g	67-137	30	67-137	30	30	
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	0.5	0.0845	ng/g	61-139	30	61-139	30	30	
Perfluorododecanoic Acid (PFDoA)	307-55-1	0.5	0.07	ng/g	69-135	30	69-135	30	30	
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	0.5	0.2045	ng/g	66-139	30	66-139	30	30	
Perfluorotetradecanoic Acid (PFTA)	376-06-7	0.5	0.054	ng/g	69-133	30	69-133	30	30	
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Propanoic Acid (HFPO-DA)	13252-13-6	10	3.81	ng/g	41-165	30	41-165	30	30	
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	1	0.0413	ng/g	61-135	30	61-135	30	30	
Perfluorohexadecanoic Acid (PFHxDA)	67905-19-5	2.5	0.12	ng/g	18-191	30	18-191	30	30	
Perfluorooctadecanoic Acid (PFODA)	16517-11-6	2.5	0.171	ng/g	10-123	30	10-123	30	30	
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	1	0.086	ng/g	50-150	30	50-150	30	30	
1H,1H,2H,2H-Perfluorododecanesulfonic Acid (10:2FTS)	120226-60-0	1	0.275	ng/g	37-261	30	37-261	30	30	
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	756426-58-1	1	0.0374	ng/g	69-139	30	67-139	30	30	
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	763051-92-9	1	0.0388	ng/g	51-155	30	51-155	30	30	
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	1	0.379	ng/g	62-149	30	62-149	30	30	
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	1	0.407	ng/g	71-156	30	71-156	30	30	
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	2	0.52	ng/g	10-239	30	10-239	30	30	
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	2	0.73	ng/g	10-275	30	10-275	30	30	
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*61-135*
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*58-150*
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*74-139*
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-4:2FTS)	*NONE*									*14-167*
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*66-128*
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*71-129*

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
Please Note that the information provided in this table is subject to change at anytime at the discretion of Alpha Analytical, Inc.

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PFAAs via LCMSMS-Isotope Dilution (TISSUE)

Holding Time: 28 days
Container/Sample Preservation: 1 - Plastic 8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*78-139*
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*75-130*
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-6:2FTS)	*NONE*									*20-154*
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*72-140*
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*79-136*
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*75-130*
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-8:2FTS)	*NONE*									*19-175*
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid (d3-NMeFOSAA)	*NONE*									*31-134*
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*61-155*
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*5-117*
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (d5-NEtFOSAA)	*NONE*									*34-137*
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*54-150*
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*24-159*
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-13C3-Propanoic Acid (M3HFPO-DA)	*NONE*									*10-203*
Perfluoro[13C2]Hexadecanoic Acid (M2PFHxDA)	*NONE*									*10-145*
1H,1H,2H,2H-Perfluorododecane Sulfonate (M2D4-10:2FTS)	*NONE*									*50-150*
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA)	*NONE*									*10-146*
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*10-145*
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (d7-NMeFOSE)	*1265205-95-5*									*10-146*
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (d9-NEtFOSE)	*NONE*									*10-129*

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
Please Note that the information provided in this table is subject to change at anytime at the discretion of Alpha Analytical, Inc.

APPENDIX B: FISH TISSUE METRICS

Table B-1. 2022 PFAS in Fish Tissue Sample Metrics

Sample Number	Sample Date	Site	Fish Number	Species	Length (millimeters)	Sample weight (grams)	Comments
1	8/10/2022	Winooski River: Salmon Hole	1	Yellow Perch	152	53	Composite
	8/10/2022	Winooski River: Salmon Hole	2	Yellow Perch	165		
	8/10/2022	Winooski River: Salmon Hole	3	Yellow Perch	178		
	8/10/2022	Winooski River: Salmon Hole	4	Yellow Perch	165		
2	8/10/2022	Winooski River: Mouth	5	Northern Pike	546	115	
3	8/10/2022	Winooski River: Mouth	6	Northern Pike	673	293	
4	8/10/2022	Winooski River: Mouth	7	Northern Pike	571	177	
5	8/10/2022	Winooski River: Mouth	8	Largemouth Bass	508	249	
6	8/10/2022	Winooski River: Mouth	9	Largemouth Bass	438	229	
7	8/10/2022	Winooski River: Mouth	10	Yellow Perch	203	52	Composite
	8/10/2022	Winooski River: Mouth	11	Yellow Perch	216		
	8/10/2022	Winooski River: Mouth	12	Yellow Perch	165		
8	8/10/2022	Winooski River: Mouth	13	Yellow Perch	165	50	Composite, left and right fillets
	8/10/2022	Winooski River: Mouth	14	Yellow Perch	165		
9	8/10/2022	Winooski River: Mouth	15	Yellow Perch	178	45	Left and right fillet
10	9/16/2022	Otter Creek: Vergennes	16	Yellow Perch	240	50	Composite, left-side fillets used for duplicate sample
	9/16/2022	Otter Creek: Vergennes	17	Yellow Perch	230		
11	9/16/2022	Otter Creek: Vergennes	18	Yellow Perch	270	78	Composite
	9/16/2022	Otter Creek: Vergennes	19	Yellow Perch	240		
12	9/16/2022	Otter Creek: Vergennes	20	Yellow Perch	235	53	Composite
	9/16/2022	Otter Creek: Vergennes	21	Yellow Perch	235		
13	9/16/2022	Otter Creek: Vergennes	22	Smallmouth Bass	370	94	
14	9/16/2022	Otter Creek: Vergennes	23	Smallmouth Bass	270	73	Left and right fillet
15	9/16/2022	Otter Creek: Vergennes	24	Smallmouth Bass	440	156	

Sample Number	Sample Date	Site	Fish Number	Species	Length (millimeters)	Sample weight (grams)	Comments
16	9/16/2022	Otter Creek: Vergennes	25	Northern Pike	535	74	
17	9/16/2022	Otter Creek: Vergennes	26	Northern Pike	480	92	
18	9/16/2022	Otter Creek: Vergennes	27	Northern Pike	315	68	Left and right fillet
19	9/27/2022	Otter Creek: Mouth	28	Smallmouth Bass	330	59	
20	9/27/2022	Otter Creek: Mouth	29	Smallmouth Bass	290	59	
21	9/27/2022	Otter Creek: Mouth	30	Smallmouth Bass	340	90	
22	9/27/2022	Otter Creek: Mouth	31	Northern Pike	600	115	
23	9/27/2022	Otter Creek: Mouth	32	Northern Pike	590	106	
24	9/27/2022	Otter Creek: Mouth	33	Northern Pike	620	68	
25	9/27/2022	Otter Creek: Mouth	34	Yellow Perch	250	51	Composite
	9/27/2022	Otter Creek: Mouth	35	Yellow Perch	200		
26	9/27/2022	Otter Creek: Mouth	36	Yellow Perch	220	56	Composite
	9/27/2022	Otter Creek: Mouth	37	Yellow Perch	210		
	9/27/2022	Otter Creek: Mouth	38	Yellow Perch	220		
27	9/27/2022	Otter Creek: Mouth	39	Yellow Perch	240	54	Composite
	9/27/2022	Otter Creek: Mouth	40	Yellow Perch	230		
28	10/28/2022	Winooski River: Salmon Hole	41	Smallmouth Bass	380	125	Collected from Winooski Dam fish lift, blotch bass virus present
29	10/28/2022	Winooski River: Salmon Hole	42	Smallmouth Bass	290	60	Collected from Winooski Dam fish lift, blotch bass virus present
30	10/28/2022	Winooski River: Salmon Hole	43	Smallmouth Bass	340	86	Collected from Winooski Dam fish lift

APPENDIX C: ANCILLARY WATER QUALITY DATA

Table C-1. Ancillary Water Chemistry Data at PFAS Monitoring Sites

Visit Date	Site	Alkalinity (mg/L-$CaCO_3$)	Conductivity at 25˚C (µmho/cm)	Dissolved Non-Purgeable Organic Carbon (mg/L)	Dissolved Oxygen (mg/L)	pH (s.u.)	Temperature (˚C)	Total Phosphorus (µg/L)
12/12/2022	Winooski River: Above Montpelier WWTF	57.2	201	3.4		7.63		14.6
12/12/2022	Winooski River: Below Montpelier WWTF	58.6	204	3.4	19.11	7.66	1.1	14.5
12/10/2022	Winooski River: Above Global Foundries	30.7	116	3	13.6	7.12	1.5	12.2
12/14/2022	Winooski River: Essex 19 Dam	40.6	84.2	2.7	14.85	7.33	0.1	13
8/10/2022	Winooski River: Salmon Hole	67.9	329	2.4	7.69	7.97	25.2	14.1
8/10/2022	Winooski River: Mouth	74	359	2.6	6.76	7.48	25.7	15.6
9/16/2022	Otter Creek: Vergennes	75.6	226	5.6	7.75		18.9	41.6
9/28/2022	Otter Creek: Mouth	65.6	191	5	8.63	7.73	14.9	32.2
12/10/2022	Missisquoi River: Above Mill	21.1	67.7	4.9	13.38	7.17	1.2	21.5
12/10/2022	Missisquoi River: Below Mill	22.1	69.2	4.3	14.96	7.18	1.1	25

Abbreviations:
mg/L = milligrams per liter
mg/L-$CaCO_3$ = milligrams per liter as calcium carbonate
˚C = degrees Celsius
µmho/cm = microsiemens per centimeter
s.u. = standard pH units
µg/L = micrograms per liter

APPENDIX D: SURFACE WATER SAMPLING STANDARD OPERATING PROCEDURE

SURFACE WATER SAMPLING
STANDARD OPERATING PROCEDURE

General

The objective of this protocol is to give general guidelines for the collection of surface water samples for PFAS analysis.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory. Samples must be collected in two (2) 275-ml high density polyethylene (HDPE) containers with an unlined plastic screw cap. Fill sample bottles to the neck. Samples do not need to be collected headspace free. After collecting the sample, cap the bottle, and keep it sealed from time of collection until extraction.

The sample handler must wash their hands before sampling and wear nitrile gloves while filling and sealing the sample bottles. PFAS contamination during sampling can occur from a number of common sources, such as food packaging and certain foods and beverages. Proper hand washing and wearing nitrile gloves will aid in minimizing this type of accidental contamination of the samples. Michigan Department of Environmental Quality (MDEQ) PFAS Sampling Quick Reference Guide provides guidance on prohibited and allowable materials for sampling.

Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °C when the samples are received at the laboratory. Samples stored in the lab must be held at or below 6 °C until extraction but should not be frozen.

Water samples should be extracted as soon as possible but must be extracted within 14 days. Soil samples should be extracted within 14 days. Extracts are stored at < 10 C and analyzed within 28 days after extraction. Complete instructions are provided by Alpha Analytical can be found at this link: Alpha Analytical PFAS Sampling Instructions for non-Drinking Water for EPA Method 537.

Equipment

Acceptable materials for sampling include: stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if tested to be PFAS free through laboratory analysis.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel cup
- stainless steel telescopic dipper

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Where conditions permit, (e.g., river, lake) grab samples collected from 15 – 30 cm below the surface of the water directly into the PFAS-free plastic wide mouth lab-prepared sample bottle, if grab samples are not possible, a stainless-steel telescopic dipper will be used to collect water samples and directly fill the sample bottles. Sampling devices (e.g., stainless steel cup) should be rinsed with site medium to be sampled prior to collection of the sample. At this point the sample can be collected and poured into the sample container.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice.
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 10 samples. The duplicate shall consist of an additional sample at a given location.
- Collect one equipment blank every day that sampling is conducted and minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS- free water and passing the water over or through the sampling device and into laboratory provided sample containers.
- Request appropriate data deliverable (Category II) and an electronic data deliverable.

Documentation

A sample log shall document the location of the sample, sampling equipment, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g., waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

APPENDIX E: FISH COLLECTION AND PROCESSING STANDARD OPERATING PROCEDURE

FISH COLLECTION AND PROCESSING
STANDARD OPERATING PROCEDURE

Scope and Application

This Standard Operating Procedure (SOP) is applicable to the collection and processing of fish for chemical analysis from Vermont lakes and rivers and includes procedures for fish tissue processing for per- and polyfluoroalkyl substances (PFAS) analysis.

Summary of Method

This SOP presents the method(s) by which fish will be collected.

- Boat-mounted electrofishing (lakes, rivers)
- Back-pack electrofishing equipment (wadeable streams)

Boat-mounted electrofishing will be used for all lake sites, wadeable river sections may utilize back-pack electrofishing equipment.

Health and Safety Issues

Health and safety issues associated with fish collection effort including the use of all equipment as well as fish processing are addressed in VT F&W and DEC site specific plans.

- When working with potentially hazardous materials, follow United States Environmental Protection Agency (EPA), Occupational Safety and Health Administration, and specific health and safety procedures as documented.
- When conducting sampling from a boat in an impoundment or flowing waters, follow appropriate boating safety procedures.

Interferences

Primary potential interferences with fish sampling include the availability of sufficient numbers of target species fish for collection and cross- contamination of samples during sample processing.

- The availability of adequate numbers of target fish may be a potential issue that will be addressed by substituting another target species.
- Cross-contamination issues will be eliminated or minimized by the implementation of decontamination procedures associated with fish processing.

Sampling for PFAS requires special procedures including the type of equipment used and handling procedures. The precautions to be applied are as follows:

- Nitrile gloves should be worn at all times when handling fish processing equipment and preparing and packaging fillet tissue samples.
- Teflon treated equipment should not be used for sampling activities. Sample containers should also be free of Teflon liners or seals.

- Disposable sampling materials and equipment should be used to the extent feasible to avoid potential cross-contamination between samples and sampling locations.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

Personnel Qualifications

All fish collection and field processing will be performed by VT F&W or VT DEC personnel. All field samplers are trained according to the Departments Health & Safety Plans.

Equipment and Supplies

Equipment for Collecting Fish

- Fish capture field notebook
- Waterproof ink pens
- Detailed maps of each sample location
- Hand-held Global Positioning System unit
- Cellular phone
- Meter measuring board
- Electrofishing boat and motor (gas and oil), oars (2), boat hook, anchor, rope
- Boat(s) and Boat trailer(s) with working lights
- Generator (check gas, oil, and connections)
- Electrofishing unit – Smith-Root VI-A and/or Smith-Root 1.5KVA
- Electrodes (anode and cathode)
- Foot pedal, dead-man switches (one for each person netting)
- Insulated, short and long-handled dip nets
- Electrically insulated footwear (all crew members)
- Electrically insulated gloves (5,000 V minimum)
- Personnel flotation devices (all crew members)
- Thermometer
- First aid kit
- Tool box
- Depth sounder

Additional Equipment for Processing Fish Samples (as needed)

- Fish health assessment field notebook
- Waterproof ink pens
- Meter measuring board with 1 mm divisions
- Portable electronic balance for fish weight and tissue weights
- Polypropylene cutting boards
- Stainless steel fillet knives
- Quart and Gallon heavy duty Ziploc™ freezer bags

- PFAS-free water (for decontamination of tools)
- Wash bottles, non-Teflon, and laboratory supplied PFAS-free water (for decontamination)
- Wash basin (for non-disposable used dissection tools)
- Disposable nitrile gloves (several sizes, 2 pairs per fish)
- Kimwipes
- Prelabeled self-adhesive sample
- Clear packing tape (for securing sample labels and sealing shipping containers)
- Chain-of-custody forms
- Plastic bags (for protecting chain of custody forms)
- Custody seals (for sealing containers for chain of custody)
- Paper towels

Sample Collection Procedures

The electrofishing must be conducted in accordance with the health and safety requirements described in the VT F&W Safety Plan and in accordance with applicable collection permits of the State of Vermont.

Begin shocking the selected area using a pulse DC setting and voltage appropriate for the conditions (to be determined by the fish collection supervisor).

Net any target fish that may be are of legal size and/or longer than 20 cm (approximately 8 in.) in total length.

Identify any target species and potential surrogate species. If the species is one of the target species for that location, retain and measure the total length of the fish accordingly.

Target Species (other species can be included):

- Smallmouth Bass (*Micropterus dolomieu*)
- Largemouth Bass (*Micropterus salmoides*)
- Northern Pike *(Esox lucius*)Rainbow Trout (*Oncorhynchus mykiss*)
- Brown Trout (Salmo trutta)
- Yellow Perch (*Perca flavescens*)
- Brown Bullhead (*Ameiurus nebulosus*)

If the fish falls within the target length for that species and the target sample number for that species has not yet been collected from that sampling location, retain the specimen for processing and analysis.

Special procedures for PFAS

Unlike legacy contaminants such as PCBs, which are rarely found in day-to-day life, PFAS are widely used and frequently encountered. Practices that avoid sample contamination are

therefore necessary. The following practices should be used for collections when fish are to be analyzed for PFAS:

- No materials containing Teflon, no Post-it notes.
- No ice packs; only water ice or dry ice.
- Any gloves worn must be powder free nitrile.
- No Gore-Tex or similar materials (Gore-Tex is a PFC with PFOA used in its manufacture). No stain repellent or waterproof treated clothing; these are likely to contain PFCs.
- Avoid plastic materials, other than HDPE, including clipboards and waterproof notebooks. Wash hands after handling any food containers or packages as these may contain PFCs.
- Keep pre-wrapped food containers and wrappers isolated from fish handling.
- Wear clothing washed at least six times since purchase. Wear clothing washed without fabric softener.
- Staff should avoid cosmetics, moisturizers, hand creams and similar products on the day of sampling as many of these products contain PFCs. Sunscreen or insect repellent should not contain ingredients with "fluor" in their name. Apply any sunscreen or insect repellent well downwind from all materials. Hands must be washed after touching any of these products.

Fish Processing and Preparation for Tissue Analysis

Initial Processing

Fish will be collected in accordance with the methods identified by location and retained in coolers until sample processing is initiated.

Fish containers will be labeled with capture location information. All fish retained for potential sample analysis will be enumerated and separated by species and size class.

The following metrics will be recorded for each individual fish included in any sample:

- Total length
- Total weight
- Fillet weight
- Physical exam, including deformities, erosions, lesions, and tumors.

Upon completion of collection of metrics, fish samples will be processed and submitted for fillet analysis.

Fillet Sample Processing

The following procedures will be used for filleting fish. An initial cut should be made from the dorsal fin to the pelvic fin, just behind the opercular flap. Run the tip of the knife along the dorsal side of the fish, from the initial cut to the caudal fin. Continue making successively deeper cuts, running the knife blade as close to the neural spines and ribs as

possible. Place fillet skin-side down on the cutting board and remove the skin by running the knife parallel to the cutting board. Remove any debris from the fillet by rinsing with deionized water.

After a fillet is cleaned, place the sample in a pre-weighed decontaminated tray and record the weight to the nearest gram. For composite samples, obtain all the fillets for the composite and weigh to the nearest gram. Minimum sample size is 30.0 grams (g) of tissue, confirm with laboratory. Individual fillet samples will be placed in a zip sealing polyethylene bag that will be placed inside a second zip sealing bag along with a sample label. Fish samples will be shipped on dry ice to the laboratory for further processing.

Tissue Analysis

Fillet tissue samples will be analyzed for PFAS by modified EPA Method 537 in accordance with the respective laboratory's analytical methods.

Data and Records Management

All sample documentation will follow project specific SOPs for field sample ID, data sheet, chain-of-custody, and custody seal procedures. All data and information will be documented in field data logbooks with permanent ink.

Decontamination

All dissection equipment will be decontaminated between samples with phosphate-free laboratory grade detergent, and PFAS-free water rinse.

Field Quality Assurance/Quality Control Samples

All field QA/QC procedures will be followed in accordance with those outlined in the Work Plan. One duplicate sample (left side fillet) will be collected every 20 samples from specimens large enough to produce the minimum required sample mass (approximately 30 g) per fillet.

APPENDIX F: COMPARISON OF DATA 2021-2022

Table F-1. Comparison of 2021 to 2022 PFAS Detections in Surface Water (ppt)[1]

Analyte	Winooski River: Above Montpelier WWTF		Winooski River: Below Montpelier WWTF		Winooski River: Mouth		Otter Creek: Mouth	
	10/18/2021	12/12/2022	10/18/2021	12/12/2022	10/20/2021	8/10/2022	10/20/2021	9/28/2022
PFBA	1.54J	0.448J	1.46J	0.396J	**1.98**	**5.87**	1.22J	0.875J
PFPeA	0.927J	0.427J	1.13J	0.525J	1.48J	**3.86**	0.486J	0.507J
PFBS	0.496J	ND	0.719J	ND	0.991J	**2.88**	0.428J	0.344J
PFHxA	0.681J	ND	ND	ND	1.38J	**3.57**	0.778J	0.472J
PFPeS	ND	ND	ND	ND	ND	0.510JF	ND	ND
PFHpA	0.637J	0.251J	0.748J	0.229J	0.786J	1.51J	0.590J	0.434J
PFHxS	ND	ND	ND	ND	0.783JF	**3.87**	ND	ND
PFOA	0.768J	0.406J	0.920J	0.414J	1.27J	**3.08**	0.894J	0.656J
PFNA	ND	ND	ND	ND	0.344J	0.641J	ND	ND
PFOS	0.482J	ND	ND	ND	1.13JF	**5.75**	0.484J	0.521J
PFHxDA	ND	ND	ND	1.24JF	ND	ND	ND	ND
Sum (excluding estimated values)	0	0	0	0	1.98	28.88	0	0
Sum (including estimated values)	5.531	1.532	4.977	2.804	10.144	31.541	4.88	3.809

Footnotes:
[1]Detections above laboratory reporting limit are in bold

Abbreviations:
ND = Compound not detected in sample
J = Estimated value, compound was detected in sample below laboratory reporting limit
F = Estimated maximum concentration

Table F-2a. Comparison of 2021 to 2022 PFAS in Fish Tissue Analytical Data (ppb)[1]

Analyte	Yellow Perch, Winooski River Mouth					Northern Pike, Winooski River Mouth					
	10/6/2021		8/10/2022			10/6/2021			9/27/2022		
	YP1	YP2	YP1	YP2	YP3	NP1	NP2	NP3	NP1	NP2	NP3
PFHxA	ND	ND	ND	ND	ND	ND	ND	0.080 JF	ND	ND	ND
PFHxS	ND	ND	0.059J	ND	ND	ND	ND	ND	ND	0.054J	0.097J
PFNA	ND	ND	ND	ND	ND	0.091 J	ND	0.094 J	ND	ND	ND
PFOS	**15.1**	**10.9 F**	**5.67**	**4.13**	**6.90**	**4.48**	**2.28 F**	**3.83**	**2.25**	**4.33**	**5.50**
PFDA	**0.582**	**0.44**	**0.486F**	**0.247F**	**0.455**	**0.541**	**0.276**	**0.425**	0.127J	**0.269**	**0.590**
PFUnA	**0.81**	**0.613**	**0.789**	0.362JF	**0.738**	**0.718**	0.384 J	**0.526**	0.272JF	0.383J	**0.790**
PFDoA	**0.599**	0.44 J	**0.499**	0.295JF	**0.565**	**0.598**	0.406 J	0.422 J	0.146JF	0.285JF	**0.466**
PFTrDA	ND	0.232 J	**0.514F**	0.281J	**0.588F**	0.315 J	0.277 J	0.258 J	ND	0.193JF	0.347JF
PFTA	0.097 J	0.82 J	0.200JF	0.130JF	0.066JF	0.091 J	0.078 J	0.074 J	ND	0.051JF	0.069JF
FOSA	ND	ND	ND	ND	ND	0.236 JF	0.098 JF	0.182 J	0.107JF	0.142JF	0.113JF
Sum (excluding values below RL)	17.091	11.953	7.958	4.377	9.246	6.337	2.556	4.781	2.25	4.599	7.346
Sum (including estimated values)	17.188	13.445	8.217	5.445	9.312	7.07	3.799	5.891	2.902	5.707	7.972

Footnote:
[1]Detections above laboratory reporting limit are in bold

Abbreviations:
ND = Compound not detected in sample
J = Estimated value, compound was detected in sample below laboratory reporting limit
F = Estimated maximum concentration

Table F-2b. Comparison of 2021 to 2022 PFAS in Fish Tissue Analytical Data, continued (ppb)[1]

Analyte	Yellow Perch, Otter Creek Mouth						Northern Pike, Otter Creek Mouth					
	10/6/2021			8/10/2022			10/6/2021			9/27/2022		
	YP1	YP2	YP3	YP1	YP2	YP3	NP1	NP2	NP3	NP1	NP2	NP3
PFNA	ND	ND	ND	ND	ND	ND	0.074 J	ND	0.094 J	ND	ND	ND
PFOS	**1.29 F**	**1.05 F**	**0.616 F**	**0.773F**	**0.945F**	**0.746F**	**2.84**	**1.68**	**2.04**	**0.819**	**1.22**	**2.90**
PFDA	0.065 J	ND	0.064 J	0.072JF	0.063JF	0.075JF	0.219 J	0.140 J	**0.272**	0.063J	0.080J	0.230J
PFUnA	0.078 J	0.064 J	0.065 J	0.056J	0.064J	0.122J	0.220 J	0.119 J	**0.294**	0.059JF	0.074J	0.220J
PFDoA	ND	ND	ND	0.072JF	ND	0.064J	0.116 J	ND	0.127 J	ND	ND	0.109J
PFTA	ND	ND	ND	ND	ND	ND	ND	ND	0.057 JF	ND	ND	ND
FOSA	ND	ND	ND	ND	ND	ND	0.099 J	0.146 J	0.100 JF	0.111J	ND	0.162J
Sum (excluding values below RL)	1.29	1.05	0.616	0.773	0.945	0.746	2.84	1.68	2.606	0.819	1.22	2.90
Sum (including estimated values)	1.433	1.114	0.745	0.973	1.072	1.007	3.568	2.085	2.984	1.052	1.374	3.621

Footnote:
[1]Detections above laboratory reporting limit are in bold

Abbreviations:
ND = Compound not detected in sample
J = Estimated value, compound was detected in sample below laboratory reporting limit
F = Estimated maximum concentration

APPENDIX G: ALL SURFACE WATER AND FISH TISSUE DATA

Table G-1. PFAS in Surface Water Analytical Data (ppt)[1]

Analyte	Winooski River: Above Montpelier WWTF	Winooski River: Below Montpelier WWTF	Winooski River: Above Global Foundries	Winooski River: Essex 19 Dam	Winooski River: Salmon Hole	Winooski River: Mouth	Otter Creek: Vergennes	Otter Creek: Mouth	Missisquoi River: Above Mill	Missisquoi River: Below Mill
	12/12/2022	12/12/2022	12/10/2022	12/14/2022	8/10/2022	8/10/2022	9/16/2022	9/28/2022	12/10/2022	12/10/2022
PFBA	0.448J	0.396J	ND	0.916J	**5.84**	**5.87**	1.47J	0.875J	ND	0.377J
PFPeA	0.427J	0.525J	0.426J	0.691J	**3.86**	**3.86**	1.00J	0.507J	0.477J	0.472J
PFBS	ND	ND	ND	0.481J	**2.81**	**2.88**	0.501J	0.344J	ND	ND
4:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxA	ND	ND	ND	0.537JF	**3.22**	**3.57**	0.727J	0.472J	ND	ND
PFPeS	ND	ND	ND	ND	0.470J	0.510JF	ND	ND	ND	ND
PFHpA	0.251J	0.229J	0.227J	0.316J	1.33J	1.51J	0.731J	0.434J	0.226J	ND
PFHxS	ND	ND	ND	ND	**3.83**	**3.87**	ND	ND	ND	ND
PFOA	0.406J	0.414J	0.474J	0.523J	**2.61**	**3.08**	0.939J	0.656J	0.399J	0.328J
6:2FTS	ND	ND	ND	**1.76**	ND	ND	ND	ND	ND	ND
PFHpS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNA	ND	ND	ND	ND	0.518J	0.641J	ND	ND	ND	ND
PFOS	ND	ND	ND	ND	**4.19**	**5.75**	0.602J	0.521J	ND	ND
PFDA	ND	ND	ND	ND	0.303JF	ND	ND	ND	ND	ND
8:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFUnA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTrDA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Analyte	Winooski River: Above Montpelier WWTF	Winooski River: Below Montpelier WWTF	Winooski River: Above Global Foundries	Winooski River: Essex 19 Dam	Winooski River: Salmon Hole	Winooski River: Mouth	Otter Creek: Vergennes	Otter Creek: Mouth	Missisquoi River: Above Mill	Missisquoi River: Below Mill
	12/12/2022	12/12/2022	12/10/2022	12/14/2022	8/10/2022	8/10/2022	9/16/2022	9/28/2022	12/10/2022	12/10/2022
ADONA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxDA	ND	1.24JF	1.18JF	1.16J	ND	ND	ND	ND	1.16J	ND
PFODA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoDS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum (excluding estimated values)	0	0	0	1.76	26.36	28.88	0	0	0	0
Sum (including estimated values)	1.532	2.804	2.307	6.384	28.981	31.541	5.97	3.809	2.262	1.177
VT-regulated sum[2,3]	0	0	0	0	10.63	12.7	0	0	0	0
Proposed EPA Hazard Index[2,4]	0	0	0	0	0.43	0.43	0	0	0	0

Footnotes:

[1]Detections above laboratory reporting limit are in bold

[2]Sum includes only results above laboratory reporting limit

[3]Sum of PFOA, PFOS, PFHxS, PFNA, PFHpA

[4]Hazard index = $\frac{[\text{GenX}]}{10\text{ ppt}} + \frac{[\text{PFBS}]}{2{,}000\text{ ppt}} + \frac{[\text{PFNA}]}{10\text{ ppt}} + \frac{[\text{PFHxS}]}{9.0\text{ ppt}}$

Abbreviations:

ND = Compound not detected in sample

J = Estimated value, compound was detected in sample below laboratory reporting limit

F = Estimated maximum concentration

Table G-2a. PFAS in Fish Tissue Analytical Data (ppb)[1]

Analyte	Winooski River: Salmon Hole				Winooski River: Mouth								Otter Creek: Vergennes		
	YP1 (Composite)	SMB1	SMB2	SMB3	LMB1	LMB2	NP1	NP2	NP3	YP1 (Composite)	YP2 (Composite)	YP3 (Composite)	NP1	NP2	NP3 (Left and right fillet)
	8/10/2022	10/28/2022	10/28/2022	10/28/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	9/16/2022	9/16/2022	9/16/2022
PFBA	ND	ND	0.024JF[2]	0.058JF[2]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFPeA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFBS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxA	ND	ND	ND	ND[2]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFPeS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHpA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxS	0.068J	ND	ND	ND	ND	ND	ND	0.054J	0.097J	0.059J	ND	ND	ND	ND	ND
PFOA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHpS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.108J	0.075J	ND
PFOS	**4.38**	**12.0F[2]**	**14.4F[2]**	**15.4F[2]**	**8.19**	**7.94**	**2.25**	**4.33**	**5.50**	**5.67**	**4.13**	**6.90**	**2.02**	**2.20**	**0.576F**
PFDA	**0.344**	**0.967F[2]**	**1.16F[2]**	**1.14F[2]**	**0.532**	**0.349F**	0.127J	**0.269**	**0.590**	**0.486F**	**0.247F**	**0.455**	**0.264**	**0.236**	0.078J
8:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFUnA	**0.718**	**1.63F**	**1.48F**	**2.04F**	**0.951**	**0.553**	0.272JF	0.383J	**0.790**	**0.789**	0.362JF	**0.738**	0.263J	0.280J	0.077J
PFDS	ND	ND	ND	0.184JF	ND	ND	ND	ND	ND	ND	ND	ND	0.137J	ND	ND
NEtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoA	**0.679**	**1.58F[2]**	**1.06F[2]**	**1.90F[2]**	0.413J	0.429JF	0.146JF	0.285JF	**0.466**	**0.499**	0.295JF	**0.565**	0.123J	0.159JF	ND
PFTrDA	**0.515**	**1.06F[2]**	**0.750F[2]**	**1.23F[2]**	0.271JF	0.371JF	ND	0.193JF	0.347JF	**0.514F**	0.281J	**0.588F**	ND	0.257J	ND
PFTA	0.160J	ND[2]	ND[2]	ND[2]	0.089JF	0.257JF	ND	0.051JF	0.069JF	0.200JF	0.130JF	0.066JF	0.069J	0.121J	ND
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADONA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Analyte	Winooski River: Salmon Hole				Winooski River: Mouth								Otter Creek: Vergennes		
	YP1 (Composite)	SMB1	SMB2	SMB3	LMB1	LMB2	NP1	NP2	NP3	YP1 (Composite)	YP2 (Composite)	YP3 (Composite)	NP1	NP2	NP3 (Left and right fillet)
	8/10/2022	10/28/2022	10/28/2022	10/28/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/10/2022	9/16/2022	9/16/2022	9/16/2022
PFHxDA	ND	ND[2]	ND[2]	ND[2]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFODA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoDS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FOSA	ND	0.123J	0.122J	0.151JF	ND	ND	0.107JF	0.142JF	0.113JF	ND	ND	ND	0.126J	**0.688**	ND
NMeFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.509J	ND
NEtFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PFAS (excluding values below RL)	6.636	17.237	18.85	21.71	9.673	8.842	2.25	4.599	7.346	7.958	4.377	9.246	3.11	4.525	0.731
Total PFAS (including estimated values)	6.864	17.36	18.996	22.103	10.446	9.899	2.902	5.707	7.972	8.217	5.445	9.312	0.264	3.124	0.576

Footnote:
[1]Detections above laboratory reporting limit are in bold
[2]Result was adjusted during quality control review

Abbreviations:
ND = Compound not detected in sample
J = Estimated value, compound was detected in sample below laboratory reporting limit
F = Estimated maximum concentration

Table G-2b. PFAS in Fish Tissue Analytical Data, continued[1] (ppb)

Analyte	Otter Creek: Vergennes						Otter Creek: Mouth								
	SMB1	SMB2 (Left and right fillet)	SMB3	YP1 (Composite)	YP2 (Composite)	YP3	NP1	NP2	NP3	SMB1	SMB2	SMB3	YP1	YP2	YP3
	9/16/2022	9/16/2022	9/16/2022	9/16/2022	9/16/2022	9/16/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022
PFBA	ND	0.023J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFPeA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFBS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFPeS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHpA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFOA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHpS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFOS	**1.20F**	**1.18F**	**2.51**	**1.09F**	**1.27F**	**1.38F**	**0.819**	**1.22**	**2.90**	**2.64F**	**1.45F**	**2.27F**	**0.773F**	**0.945F**	**0.746F**
PFDA	0.150J	0.140J	**0.242**	0.147J	0.148J	0.157J	0.063J	0.080J	0.230J	**0.234**	0.175J	0.209J	0.072JF	0.063JF	0.075JF
8:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFUnA	0.297J	0.233J	0.445J	0.197J	0.166J	0.208J	0.059JF	0.074J	0.220J	0.310J	0.248J	0.329JF	0.056J	0.064J	0.122J
PFDS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoA	0.179J	0.132J	0.231J	0.092JF	0.111J	0.138JF	ND	ND	0.109J	0.141JF	0.125J	0.122J	0.072JF	ND	0.064J
PFTrDA	0.258J	ND	0.289J	ND	0.211JF	0.268JF	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTA	0.131J	0.089J	0.158J	0.087J	0.115J	0.128J	ND	ND	ND	0.077JF	0.053JF	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADONA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Analyte	Otter Creek: Vergennes						Otter Creek: Mouth								
	SMB1	SMB2 (Left and right fillet)	SMB3	YP1 (Composite)	YP2 (Composite)	YP3	NP1	NP2	NP3	SMB1	SMB2	SMB3	YP1	YP2	YP3
	9/16/2022	9/16/2022	9/16/2022	9/16/2022	9/16/2022	9/16/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022	9/27/2022
PFHxDA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFODA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoDS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FOSA	ND	0.105J	ND	ND	ND	ND	0.111J	ND	0.162J	ND	ND	ND	ND	ND	ND
NMeFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PFAS (excluding values below RL)	1.2	1.18	2.752	1.09	1.27	1.38	0.819	1.22	2.9	2.874	1.45	2.27	0.773	0.945	0.746
Total PFAS (including estimated values)	2.215	1.902	3.875	1.613	2.021	2.279	1.052	1.374	3.621	3.402	2.051	2.93	0.973	1.072	1.007

Footnote:
[1]Detections above laboratory reporting limit are in bold

Abbreviations:
ND = Compound not detected in sample
J = Estimated value, compound was detected in sample below laboratory reporting limit
F = Estimated maximum concentration