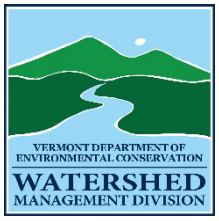
VERMONT AGENCY OF NATURAL RESOURCES

2021 Vermont Per- and Polyfluoroalkyl Substances (PFAS) Surface Water, Fish Tissue, and Wastewater Treatment Facility Effluent Monitoring Report

April 4, 2022



VERMONT
AGENCY OF NATURAL RESOURCES
Department of Environmental Conservation

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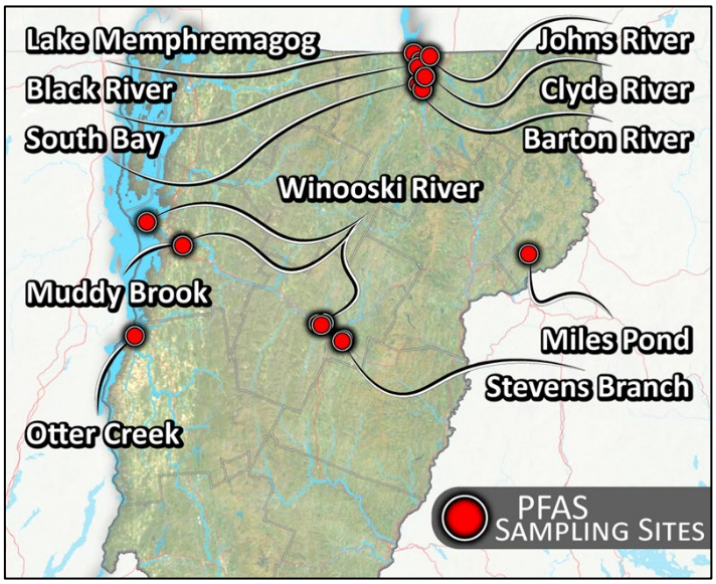

In 2021, the Vermont Department of Environmental Conservation (VT DEC), in cooperation with the Vermont Department of Fish & Wildlife (VT F&W), monitored for Per- and Polyfluoroalkyl Substances (PFAS) in lakes and rivers at a total of 19 sites in northern Vermont, including 10 sites in Lake Memphremagog and its watershed; in fish tissue at eight of the 19 sites; and in effluent at three wastewater treatment facilities (WWTFs). The purpose of the monitoring effort was to better understand the concentration of PFAS in surface waters and fish tissue.

PFAS are a large group of human-made chemicals that have been used in manufacturing; in many consumer products like non-stick cookware, waterproof clothing, and fast-food wrappers; and in some firefighting foams. Because of their widespread use, many PFAS have been found in our environment and are expected to be found in virtually every human. PFAS in surface water may originate from groundwater, stormwater runoff, or direct discharges, such as those from industrial facilities or WWTFs. PFAS can also be delivered by precipitation from sources near and far. Human exposure to PFAS in surface waters occurs primarily through use of the waterbody as a drinking water source or through fish consumption. Some PFAS are known to have toxic effects and pose health risks at very low levels.

Surface water analysis measures PFAS in parts per trillion (ppt). Fish tissue analysis measures PFAS in parts per billion (ppb). Some concentration values are so low that they are beyond the analytical capability of the laboratory instruments. The lowest value that can be used to assess PFAS concentration is considered the Reporting Limits (RL). The Vermont Department of Health has established a drinking water advisory of 20 ppt for the sum of five PFAS (PFHpA, PFHxS, PFOA, PFNA, PFOS). This value serves as a benchmark for assessing PFAS concentrations in surface waters in the absence of Vermont Water Quality Standards for PFAS.

The surface water PFAS results for the Lake Memphremagog sites and additional northern Vermont sites were all below the Vermont Drinking Water Advisory of 20 ppt for the sum of the five Vermont-Regulated PFAS. There were only two PFAS detected above the Reporting Limits within the Lake Memphremagog watershed and these detections were very low – in the single part per trillion. The highest surface water PFAS concentrations observed, though still low – in the single part per trillion – were from Muddy Brook and the Winooski River site downstream of Muddy Brook. The sum of the five Vermont-regulated PFAS at the Muddy Brook site was 14.8 ppt and in the Winooski River below Allen Brook was 10.7 ppt.

Fish tissue PFAS results from the eight sites sampled showed only one of the five Vermont-Regulated PFAS, PFOS, which is the most widely distributed and persistent PFAS, detected above the Reporting Limits. PFOS was detected in nearly all the fish tissue samples, with average PFOS concentrations of 2.4 ppb. Overall, PFAS concentrations were low. The sites with the highest PFAS concentrations were the mouth of the Winooski River and the mouth of Otter Creek. PFOS concentrations in fish tissue collected at these sites were 15.1 ppb and 9.82 ppb, respectively. The fish tissue data from this monitoring effort will be used by the Vermont Department of Health to determine if these levels pose any health risk to consumers.

The Newport City WWTF effluent had ten PFAS detected above the RL, with the sum of the five Vermont-regulated PFAS ranging from 17.0 ppt to 27.6 ppt. The Barre City WWTF effluent was very low in PFAS, with only four PFAS detected above the RL. The sum of the five Vermont-regulated PFAS was 2.53 ppt. The Montpelier City WWTF, which currently receives landfill leachate for treatment, had 12 PFAS detected above the RL, the sum of the five Vermont-Regulated PFAS was 79.7 ppt.

In summary, the 2021 PFAS surface water and fish tissue results show that occasionally there are PFAS present, but nearly all at low concentrations, reflective of background concentrations, with surface water concentrations in the single part per trillion and fish tissue concentrations in the single part per billion for individual compounds, with the exceptions noted above. All surface water results were below the Vermont Drinking Water Advisory of 20 ppt for the sum of the five Vermont-Regulated PFAS. Surface water, fish tissue, and WWTF effluent sampling will continue, targeting sites with known or suspected PFAS sources.

INTRODUCTION

The Vermont Department of Environmental Conservation (VT DEC) Watershed Management Division (WSMD), in cooperation with the Vermont Department of Fish & Wildlife (VT F&W), monitored for the presence of Per- and Polyfluoroalkyl Substances (PFAS) compounds in fish tissue and surface water in lakes and rivers. The sampling efforts will help develop a baseline of PFAS contamination within the state and identify areas requiring further assessment. Field sampling was performed by VT DEC and VT F&W between July 21, 2021 and October 21, 2021 at 19 sites in northern Vermont, including 11 sites in Lake Memphremagog and its watershed. This report describes the results of the surface water and fish tissue analysis and the field and laboratory activities utilized to assess surface water conditions.

Ambient water analysis measures PFAS in parts per trillion (ppt) while fish tissue analysis measures PFAS in parts per billion (ppb)[1]. VT DEC has not yet promulgated regulatory criteria for PFAS in fish tissue and surface waters[2]. The Vermont Department of Health has established drinking water advisories for five PFAS (PFHpA, PFHxS, PFOA, PFNA, PFOS). Vermont's Drinking Water Advisory for the sum of these five PFAS is 20 ppt in drinking water, which serves as a benchmark for assessing PFAS concentrations in surface waters in the absence of ambient Vermont Water Quality Standards.

BACKGROUND

PFAS are a large group of human-made chemicals that have been used in manufacturing; in many consumer products like non-stick cookware, waterproof clothing, and fast-food wrappers; and in some firefighting foams. Because of their widespread use, many PFAS have been found in our environment and are expected to be found in virtually every human. Some PFAS are known to have toxic effects and pose health risks at very low levels.

Since discovering PFOA in Bennington and North Bennington in 2016, VT DEC has partnered with other state and federal agencies to identify and clean up existing PFAS and mitigate current and future exposures. The additional work to identify and characterize PFAS contamination has identified numerous sources. These include industrial and manufacturing facilities, such as Teflon fabric coating facilities, wire coating facilities, semi-conductor manufacturers, battery manufacturers, electroplating facilities, carwashes, and tanneries. PFAS contamination has also been detected in our waste streams, including landfills, landfill leachate, Wastewater Treatment Facilities (WWTFs), and biosolids. VT DEC has investigated PFAS at 19 WWTFs, select industrial discharges, and landfill leachates.

PFAS in surface water may originate from groundwater, stormwater runoff, or direct discharges, such as those from industrial facilities or WWTFs. PFAS can also be delivered by atmospheric deposition from long range transport or from a local source. Human exposure to PFAS in surface waters occurs primarily through use of the waterbody as a drinking water source or fish

[1] Note: Surface water and effluent results are also reported in nanograms per liter (ng/L), which is equivalent to parts per trillion (ppt); fish tissue results are also reported in micrograms per kilogram (µg/kg), which is equivalent to parts per billion (ppb).

[2] Deriving Ambient Water Quality Standards for the Emerging Chemicals of Concern: Per- and Polyfluoroalkyl Substances (PFAS), Vermont Department of Environmental Conservation, February 2020, https://dec.vermont.gov/sites/dec/files/wsm/docs/VWQS-PFAS-Plan-Report-Final-20200204.pdf

consumption. Some PFAS, such as perfluorooctanesulfonic acid (PFOS), are known to accumulate in fish and are of concern because they are persistent and toxic.

Limited PFAS fish tissue samples have been collected in Vermont prior to the 2021 sampling effort, with the highest detection concentration of 5 ppb in fish fillet, which is considered a low background concentration. Nationally, contaminated sites have yielded PFAS fish tissue concentrations in the 100s ppb. Concentrations of PFOS are generally several orders of magnitude higher in fish than in surface waters due to bioconcentration factors.

MONITORING OBJECTIVES

The objective of this sampling effort is to investigate the occurrence and magnitude of PFAS in surface waters and the edible tissue from adult fish that are typically consumed by humans. The determination of levels of PFAS in fish tissue will provide preliminary species-specific data that can be used to evaluate the necessity of developing fish consumption advisories.

In 2021, surface water samples, WWTF effluent samples, and fish tissue samples were collected from several sites in northern Vermont, targeting sites with known and probable sources of PFAS. These sites were chosen based on state investigations at PFAS impacted sites conducted since 2016, summarized in the PFAS Status Report[3], VTANR PFAS Sampling Plan[4] and the PFAS WWTF and Landfill Leachate Report (Weston 2020)[5]. A reference site was also included to help characterize background levels of PFAS.

To help describe PFAS concentrations in surface waters and fish tissue, "paired" surface water and fish tissue samples were collected and analyzed. The surface water, fish tissue, and WWTF effluent were analyzed for 36 PFAS, including the five Vermont-regulated PFAS (PFHpA, PFHxS, PFOA, PFNA, PFOS). Refer to **Table 1** for a list of PFAS analytes, acronyms, number of carbon atoms, and Chemical Abstract Service (CAS) numbers.

DATA QUALITY OBJECTIVES

Data quality objectives (DQO) 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, effluent, and fish tissue samples and quality control samples followed protocols described in **Appendices D** and **E**.

The analytical methods for the 36 PFAS analytes relied on the use of Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS), based on EPA 537.1 Modified Isotope Dilution (ID) method, used for samples submitted to Alpha Analytical Laboratory in Westborough, Massachusetts.

[3] Vermont Department of Environmental Conservation Perfluoroalkyl Substances (PFAS) Contamination Status Report July 2018.
[4] Vermont Department of Environmental Conservation Perfluoroalkyl Substances (PFAS) Additional Sampling Plan July 2019.
[5] Weston Solutions, Inc. (WESTON) 2020. Poly- and Perfluoroalkyl Substances at Wastewater Treatment Facilities and Landfill Leachate January 30, 2020.

The isotope dilution method incorporates isotopically enriched forms of PFAS compounds into the sample analysis to greatly improve target compound quantitation and reduce uncertainty. The isotope dilution procedure incorporates the maximum number of commercially available extracted internal standards. Fish tissue detection limits for the 36 PFAS analytes range from 0.2 to 0.8 ppb, and surface water and wastewater detection limits range from 0.5 to 2.0 ppt. **Appendix A** provides specific quantitation limits for these analytes in surface water and fish tissue.

Performance acceptance criteria for data generated by Alpha Analytical Laboratory was based on principal data quality indicators, including precision, bias, representativeness, completeness, comparability, and sensitivity. The reporting detection limits (RLs) 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.

PFAS analyte values below the laboratory reporting limit are defined as non-detect (ND). Laboratories typically obtain PFAS analyte results below the laboratory reporting limit but still above the detection limit. These results, as defined in the US EPA Method 537.1, are intended for statistical determination of laboratory equipment precision, and not to produce "accurate quantitation" for the purposes of results reporting. Only results above the reporting limit are used to assess PFAS concentrations.

Table 1. PFAS Analytes (36) for Surface Water, Fish Tissue, and WWTF Effluent.

Analyte Description	Acronym	# 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
Perfluorotridecanoic acid	PFTriA	13	72629-94-8
Perfluorotetradecanoic acid	PFTeA	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	PFDoS	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

Note: The five Vermont-regulated PFAS (PFHpA, PFHxS, PFOA, PFNA, PFOS) are bolded.

SAMPLING LOCATIONS

Sites with known or suspected contamination were selected to describe PFAS concentrations in main exposure routes or to characterize baseline conditions in major waterbodies. In 2021, surface water was sampled at 19 sites, fish tissue was sampled at eight sites, and effluent was sampled at three WWTFs. The following sections describe the areas of focus in 2021.

Firefighting Activities

Due to the use of PFAS containing Aqueous Film-Forming Foams (AFFF) for firefighting, airports and firefighting academies have been investigated for PFAS contamination. The Burlington Air National Guard Base (ANGB) is one of these sites (Parsons 2020), and results indicate PFAS has been detected in adjacent surface waters, including the Winooski River. As part of this monitoring effort, the Winooski River, the largest tributary to Lake Champlain, was sampled at several locations above and below the ANGB site.

WWTF and Industrial Discharges

Waste streams are also prevalent PFAS sources. PFAS are present in landfill leachate, WWTF influent and effluent, and industrial discharges. Surface waters that receive these discharges may have elevated concentrations of PFAS. VT DEC has reviewed PFAS monitoring data from 19 WWTFs (Weston 2020) [6] statewide, including some industrial discharges.

Three WWTFs were sampled in 2021: the Montpelier WWTF, which discharges to the Winooski River and is currently receiving landfill leachate; the Newport City WWTF, which previously received landfill leachate prior to the moratorium; and the Barre WWTF, which is permitted to receive landfill leachate but has not been receiving leachate. In addition to effluent sampling, surface waters above and below these WWTFs outfalls were also sampled.

[6] Weston Solutions, Inc. (WESTON) 2020. Poly- and Perfluoroalkyl Substances at Wastewater Treatment Facilities and Landfill Leachate January 30, 2020.

Lake Memphremagog Watershed

In 2021, the Lake Memphremagog watershed was specifically targeted for PFAS surface water and fish tissue sampling to help provide PFAS data needed to address concerns relating to the NEWSVT Landfill in Coventry and the previous disposal of its landfill leachate at the Newport City WWTF. Surface water samples were collected at ten sites within the Lake Memphremagog watershed (**Table 2** and **Figure 1**), including three sites on the Main Lake: a US/Canada border site, a mid-lake site, and a southern site; South Bay; and four major tributaries: the Johns, Clyde, Black, and Barton Rivers were all sampled near the mouths of the river. The Clyde River had an additional site located upstream of the Newport City WWTF, and the Black River had an additional site located above the NEWSVT landfill. In addition to these sites, the Newport WWTF effluent was sampled and analyzed. The surface water and effluent sampling at these sites was conducted in July, August, and October 2021.

Fish tissue sampling was conducted August 16 and 17, 2021 at four sites within the Lake Memphremagog watershed by VT F&W. Two sites were on the Main Lake, one on South Bay, and one on the Clyde River near the mouth downstream of the Newport City WWTF. Fish species collected from each site included Yellow Perch (*Perca flavescens*), Largemouth Bass (*Micropterus salmoides*), and Brown Bullhead (*Ameiurus nebulosus*). Thirty fish tissue samples were analyzed for 36 PFAS compounds to provide baseline data for evaluation.

International Analysis and Reporting

To assist with the joint international effort to characterize PFAS within the Lake Memphremagog watershed, VT DEC and Saint-Francis Watershed Governance Council (COGESAF) collaborated on field sampling and interlaboratory PFAS analysis. Field quality control samples were analyzed during the first round of sampling in July 2021. Duplicate samples were collected at the US/Canada border site and Newport City WWTF and sent to Alpha Analytical Laboratory in the U.S. and analyzed for 36 PFAS compounds, and to Bureau Veritas in Ontario, Canada for analysis of 27 PFAS compounds. These paired duplicate samples measured field and analytical precision, assessed through the collection and analysis of field duplicates, and estimated by relative percent difference (RPD). Results of the interlaboratory analysis were good; laboratory detection limits, recovery percentages, and quality control practices met data quality objectives. A summary of this collaboration can be found in Appendix F. In addition to the quality control samples collected and analyzed at the two Vermont sites, COGESAF sampled several additional sites on Lake Memphremagog and tributaries in Quebec in 2021 (**Figure 6)**.

Additional Northern Vermont Sites

In addition to the ten Lake Memphremagog watershed sites sampled in 2021, nine additional sites in northern Vermont (**Figures 2-5**) were sampled for surface water, with fish tissue collected at four of these sites (**Table 3**). These sites targeted two of the largest rivers in Vermont, both tributaries to Lake Champlain, the Winooski River and Otter Creek. The Winooski River was sampled at four sites: one above the ANGB, one at the mouth of the river near the confluence with Lake Champlain, one above the Montpelier WWTF, and one below. Efforts to collect fish below the Montpelier WWTF were not successful due to the sampling technique used, which was not well-suited to site conditions. Otter Creek, which receives several

municipal and industrial discharges, was sampled for surface water and fish tissue near its mouth before entering Lake Champlain. Lastly, the Stevens Branch in Barre was sampled above and below the Barre WWTF, which is permitted to receive landfill leachate, but has not been receiving leachate for treatment. Fish were collected downstream of the Barre WWTF for PFAS analysis.

Reference Site

The sampling effort includes a reference site to help develop baseline PFAS data in areas outside the influence of known and/or suspected PFAS sources, such as municipal and industrial discharges and those found in urban areas. In 2021, Miles Pond in Concord (**Figure 5**) was sampled as a reference site.

Table 2. Lake Memphremagog Watershed Sites

Site Id	Site Name	Site Description	Town	Lat.	Long.
1	L. Memphremagog	US/Canada Border between west shore and Province Island	Newport Town	45.00500	72.24280
2	L. Memphremagog	STA 4 (1.0 km SW of Bell Island-mid Lake)	Newport Town	44.981800	72.216797
3	L. Memphremagog	STA 3 (0.5 km NE of Beacon-southern Lake)	Newport Town	44.966499	72.225601
4	Johns River	Final bridge over Johns R. at outlet to L. Memphremagog – abandon rail bridge	Derby	44.996498	72.180000
5	South Bay – L. Memphremagog	Center of South Bay (Lay monitoring Station #1)	Newport City	44.920300	72.209702
6	Black River	Located at mouth, outlet to South Bay, below NEWSVT Landfill	Newport City	44.92441	72.21294
7	Black River	Located above Airport Rd., above NEWSVT Landfill (alternate RT 5)	Coventry	44.91917	72.22578
8	Barton River	Located at mouth, outlet to South Bay	Coventry	44.90503	72.21004
9	Clyde River	Located above Gardner Park Rd., below Newport WWTF (near outlet to South Bay)	Newport City	44.93935	72.20470
10	Clyde River	Located above Western Ave., above Newport WWTF	Newport City	44.94013	72.19618
11	Newport City WWTF	Effluent samples	Newport City	44.93999	72.19927

Table 3. Additional Northern Vermont PFAS Sites Sampled in 2021

Site Id	Site Name	Site Description	Town	Lat.	Long.
STV-ABV	Stevens Branch-Abv	Above Barre WWTF	Barre	44.21053 N	72.51632W
STV-BLW	Stevens Branch-Blw	Below Barre WWTF	Barre	44.21520 N	72.51632 W
WIN-MONT-ABV	Winooski River-Abv	Above Montpelier WWTF	Montpelier	44.26002 N	72.59107 W

WIN-MONT-BLW	Winooski River-Blw	Below Montpelier WWTF	Montpelier	44.25823 N	72.61135 W
MONT WWTF	Montpelier WWTF	Effluent Sampled	Montpelier	44.25474 N	72.600744 W
BARRE WWTF	Barre WWTF	Effluent Sampled	Barre	44.21044 N	72.52113 W
MP	Miles Pond	Reference Site	Concord	44.44865 N	71.80270 W
OTC	Otter Creek -mouth	Sampled near mouth	Ferrisburgh	44.22189 N	73.31625 W
WIN-M	Winooski River - mouth	Sampled near mouth	Burlington	44.53650 N	73.27427 W
WIN-BLW ALLEN	Winooski River-blw Allen Brook	Sampled below Allen Brook	South Burlington	44.47520 N	73.13650 W
MB	Muddy Brook - mouth	Sampled near mouth	South Burlington	44.47259 N	73.13493 W

SURFACE WATER SAMPLING

All surface water samples were grab samples collected 15-30 cm below the surface to eliminate any surface debris at the 19 sites. PFAS are expected to accumulate at the surface water air interface, so samples taken at the surface are likely to result in high biased results and therefore not represent overall surface water concentration.

The surface water grab samples were collected with a stainless-steel telescopic dipper and then poured directly into two (2) 275 ml high density polyethylene (HDPE) pre-cleaned PFAS-free wide-mouth lab-prepared sample bottles (refer to **Appendix D** for Surface Water Sampling Procedures and Alpha Analytical PFAS Sampling Instructions for non-Drinking Water for EPA Method 537).

In addition to PFAS analysis, additional parameters were collected as supporting data for observed PFAS results. 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 dissolved organic carbon, total organic carbon, alkalinity, hardness, and total phosphorus (refer to **Appendix C** for results)**.**
These samples were submitted to the State of Vermont Agriculture and Environmental Laboratory (VAEL). The collection and analysis of these supporting parameters followed guidance provided in the Long-Term Water Quality and Biological Monitoring Project for Lake Champlain 2018-2023 Quality Assurance Plan for lakes (lentic waters) and the Ambient Biomonitoring Network Bioassessments of Flowing Waters in Vermont Quality Assurance Plan 2018 for rivers (lotic waters). The VAEL Quality Systems Manual Revision 26, 2021 provides details on Quality Assurance for chemistry analysis and reporting.

FIELD QUALITY CONTROL SAMPLES

Given the sensitivity of PFAS analyses, which are measured in parts per trillion (ppt) in surface water, and the potential for field contamination, field duplicates, duplicate blanks, and equipment blanks were collected and analyzed to assess the quality of laboratory analysis and to ensure that cross-contamination during sampling did not occur. Based on US EPA PFAS Method 537.1,

each PFAS analyte has a laboratory reporting limit, which is defined as the lowest analyte concentration that meets the Data Quality Objectives defined in the method. The laboratory reporting limit is 1.8 ppt for most forms of PFAS (refer to **Appendix A** for surface water and fish tissue PFAS quantification limits).

Field Duplicate

In addition to the primary samples, field duplicate samples were collected in the field and submitted to the laboratory as two 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.

Field Blank

A field blank is collected to verify that the sampling environment does not introduce PFAS and cross-contaminate samples during the sampling event. For the analysis of aqueous matrices, the field blank is collected by pouring PFAS-free reagent water that is stored in an acceptable sample container for PFAS sampling into an empty, clean sample container at the sampling site. The sample containers and supplies to process a field blank were prepared and provided by the laboratory prior to the sampling event. The field blank is treated the same throughout field and laboratory procedures. At least one field blank sample was collected per day or one per twenty samples, whichever was more frequent.

Equipment Blank

Equipment blank samples are collected by passing laboratory-verified PFAS-free water over or through decontaminated field sampling equipment before the collection of field samples to assess the adequacy of the decontamination process and/or to evaluate potential contamination from the equipment used during sampling. For sampling equipment that came in contact with aqueous samples only, rinsate or equipment blanks were collected. Equipment blanks were collected at a minimum frequency of one per day or one per twenty samples, whichever was more frequent.

WASTEWATER EFFLUENT SAMPLING

WWTF effluent samples were collected at as grab samples at the outfall location of three facilities: Newport City, Montpelier, and Barre. PFAS are expected to accumulate at the air/water interface; therefore, to obtain a sample that would be representative of the effluent overall, a stainless-steel telescopic dipper was used to collect these wastewater samples from below the surface, to the extent possible, and used to directly fill the sample bottles.

FISH SAMPLING

Target Species

Fish species chosen for these collections were legal species and sizes typically consumed by anglers. Target fish for collections 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*), rock bass (*Ambloplites rupestris*) and brown bullhead (*Ameiurus nebulosus*), though other species may be substituted based on quantities and availability of target species. These species are representative of different trophic levels and habitat (**Table 4**). A species that is highly mobile or exhibits seasonal migration may not be representative of conditions in the surface water. Fish were collected by Direct Current (DC) boat electrofishing by VT F&W staff, or electrofishing in wadeable rivers and streams by DEC staff.

A total of nine fish of legal and edible size were sampled and analyzed as individuals representing up to three target species at each location. Alternatively, when deemed necessary composite samples of fish may collected from each site representing up to three of the targeted species of fish if possible and consisting of three to five individuals for each fish species. For each fish retained for tissue analysis, it's weight, total length, and observed anomalies were recorded (**Appendix B).**

Single skin-off fillets of each fish or composite of target species were prepared from the right-side fillets. Alpha Analytical Laboratory performed the homogenization of fish tissue samples submitted. A minimum of 50 grams of sample was submitted for analysis. A total of 68 fish tissue samples representing eight species of fish were submitted to Alpha Laboratory for analysis from the eight fish collection sites (**Table 5**).

Table 4. Characteristics of fish species targeted

Species	Latin Name	Habitat	Trophic Level Descriptors	Trophic Level
Smallmouth Bass	*Micropterus dolomieu*	Pelagic	Top Carnivore	4
Largemouth Bass	*Micropterus salmoides*	Pelagic	Top Carnivore	4
Northern Pike	*Esox lucius*	Pelagic	Top Carnivore	4
Rainbow Trout	*Oncorhynchus mykiss*	Pelagic	Top Carnivore	4
Brown Trout	*Salmo trutta*	Pelagic	Top Carnivore	4
Yellow Perch	*Perca flavescens*	Pelagic	Lower-Level Insectivore/Piscivore	3
Brown Bullhead	*Ameiurus nebulosus*	Benthic	Benthic Insectivore	3
Bluegill Sunfish	*Lepomis macrochirus*	Pelagic /Benthic	Lower-Level Insectivore /Piscivore	3
Rock Bass	*Ambloplites reupestris*	Pelagic / Benthic	Lower-Level Insectivore/Piscivore	3

Table 5. Total fish counts and species by site

Site Name and Location	Largemouth Bass	Smallmouth Bass	Northern Pike	Yellow Perch	Brown Bullhead	Rock Bass	Rainbow Trout	Brown Trout	Total Fish by Site
South Bay	4 (D)	–	–	4	3	–	–	–	11
Clyde River (mouth)	3	–	–	–	3	3	–	–	9
Lake Memphremagog -North	3	–	–	3	3	–	–	–	9
Lake Memphremagog - South	2	–	–	3	2	–	–	–	7
Winooski River (mouth)	–	–	3	3	3	–	–	–	9
Otter Creek (mouth)	–	–	3	3	2	–	–	–	8
Miles Pond	3 (D)	1	–	3	2	–	–	–	9
Stevens Branch	–	–	–	–	–	–	3(D)	3	6
Fish Totals	**15**	**1**	**6**	**19**	**18**	**3**	**3**	**3**	**Total 68**

Notes:
D refers to duplicate.

Quality Assurance/Quality Control Measures

In addition to the primary samples, field duplicate samples and QA/QC samples were prepared. Field duplicate samples represented a minimum of 5% duplicate to primary sample ratio and were prepared from the left-side filets of the chosen fish specimens. The left-side filet was removed after the right-side filet and were skin-off filet tissue samples. The left-side skin-off filets were chosen at random and sent as field duplicate samples to the laboratory for PFAS analysis. Tissue samples were double bagged in a zip-seal bag and shipped frozen to the laboratory for PFAS analysis.

Equipment blanks were collected at a minimum of 5% with one rinsate blank collected on sample processing equipment for every 20 primary media samples. On every day that fish tissue samples were collected, prepared, and preserved for PFAS analysis, a field reagent blank sample was collected by pouring laboratory-supplied PFAS-free water into sample containers. All primary and QA/QC samples were analyzed for PFAS using modified U.S. Environmental Protection Agency (EPA) Method 537.1.Fish sampling and analysis procedures are further described in **Appendix E,** Fish Collection and Processing.

Sampling Schedule & Frequency

Field collection activities began in July 2021 and were completed late October 2021. Surface water samples in the Lake Memphremagog watershed were collected from the ten sites three times during the July – October 2021 period. Sampling events occurred in July, August, and October, likewise the wastewater effluent samples from Newport City WWTF were collected three times during the same period. Fish tissue sampling at the four Memphremagog sites was conducted in August 2021. The nine additional sites not part of the Lake Memphremagog watershed were sampled for effluent, surface water and fish tissue in early October, there was one sampling event for these sites.

SUMMARY OF ANALYTICAL RESULTS

Surface water results for the Lake Memphremagog watershed sites and the additional sites are presented in **Tables 6** and **7** respectively**,** WWTF effluent results are presented in **Table 8**, and

fish tissue analytical results are presented **in Tables 9 - 11**, ancillary water quality parameters are presented in **Appendix C**. Laboratory analytical data packages are available on request.

Surface Water Results

Lake Memphremagog Sites

The Lake Memphremagog watershed surface water results are presented in **Table 6**.
Of the 36 PFAS analyzed at the ten sites, which were sampled three times in 2021 (July, August, October), only two PFAS compounds were detected above the Reporting Limits. PFOS was detected once at mid-lake (site 2) at a concentration of 2.81 ppt, and Perfluorobutanoic acid (PFBA) was detected at four sites (Johns River, Clyde River, and both Black River sites). PFBA concentrations ranged from 1.84 ppt to 2.74 ppt. The concentrations of PFOS and PFBA observed are very low, less than 1 ppt above the Reporting Limits. PFAS concentrations on the Clyde River above and below the Newport WWTF outfall were all below the Reporting Limits except for PFBA (1.84 ppt) at the Clyde River (mouth) site.

Perfluorooctanesulfonic acid (PFOS)

PFOS is one of the most widely distributed and persistent PFAS and was produced in the largest amounts in the United States. PFOS is in AFFF (Aqueous Film Forming Foam) and can enter the environment during firefighting training activities and at crash sites. PFOS are detected in environmental media and biota worldwide, including oceans and the Arctic, indicating that long-range transport is possible. The estimated half-life of PFOS is hundreds to thousands of years. Detecting PFOS in surface waters in concentrations at least in the low part per trillion level is common in both developed and remote locations. Publicly available PFOS concentrations in surface waters across the United States and globally are often reported in the range of 1.0 to 3.0 ppt (Jarvis et al, 2021). Additional PFOS occurrence data in surface waters and other media is summarized in the ITRC PFAS Fact Sheet (April 2020).

Perfluorobutanoic acid (PFBA)

PFBA is a breakdown product of other PFAS used in stain-resistant fabrics, food packaging, and carpets. Nationally, PFBA is detected more frequently than other PFAS – it is commonly detected in rivers that are downstream of towns and cities. It has been detected in public drinking water sources up to 3,500 ppt nationally. For reference, the drinking water guidance value of 7,000 ppt is used by Minnesota Department of Health.

Additional Northern Vermont Sites

The additional surface water results are presented in **Table 7**. Of the 36 PFAS analyzed at the nine sites, there were only three sites that detected PFAS above the Reporting Limits (RLs). Eight PFAS (PFBS, PFBA, PFHpA, PFHxS, PFHxA, PFOS, PFOA and PFPeA) were detected at two sites (Muddy Brook and Winooski River below Allen Brook). The only other PFAS detection above the RL was for PFBA (1.98 ppt) at the Winooski River (mouth) site. There were no detections above the RLs at the balance of the six sites.

Muddy Brook (mouth) and the Winooski River (below Allen Brook) had the highest PFAS concentrations at 14.8 ppt and 10.7 ppt, respectively, for the sum of the five Vermont-regulated

PFAS. These sites are considered upstream from the ANGB PFAS sources (Parsons, 2020). Muddy Brook watershed has significant dense urban development; stormwater runoff from nonpoint sources may contribute to significant loads of PFAS to these surface waters (ITRC PFAS Fact Sheet, April 2020). PFAS concentrations in Muddy Brook were slightly higher than the PFAS concentrations detected in the Winooski River downstream below the confluence with Allen Brook. Much further downstream (approximately15 miles) by the mouth of the Winooski River (**Figure 3**), the sum of five Vermont Regulated PFAS was 4.3 ppt, and only PFBA was detected above the RL.

Table 6. Lake Memphremagog Watershed PFAS Surface Water Results

Site Name / Location	Field Sample Id	Sample Date	PFBS	PFBA	PFHpA	PFHxS	PFHxA	PFNA	FOSA	PFOS	PFOA	PFPeA
Field Samples - Surface Water (ng/L)												
Lake Memphremagog Watershed Sites												
Lake Memphremagog	Site 1	20-Jul-21	–	1.03 J	0.696 J	–	0.653 J	–	–	0.566 J	0.804 J	0.981 J
US/Canada border (VT)	Site 1D (FD)	20-Jul-21	–	1.01 J	0.661 J	–	0.618 J	–	–	0.540 J	0.742 J	0.821 J
	Site 1	20-Aug-21	0.254 J	0.932 J	0.709 J	–	0.663 J	–	–	0.822 J	0.762 J	0.788 J
	Site 1	19-Oct-21	0.469 J	0.620 J	0.517 J	0.462 J	–	–	–	0.477 J	0.627 J	0.587 J
	Site 1 (FB)	20-Jul-21	–	–	–	–	–	–	–	–	0.220 J	–
Lake Memphremagog	Site 2	20-Jul-21	0.284 J	1.01 J	0.646 J	–	0.594 J	–	–	**2.81**	0.812 J	0.713 J
Mid-Lake	Site 2	20-Aug-21	0.294 J	1.07 J	0.674 J	–	0.616 J	0.297 J	–	0.758 J	0.885 J	1.03 J
	Site 2	19-Oct-21	–	0.619 J	0.507 J	–	0.478 JF	–	–	–	0.637 J	0.543 J
Lake Memphremagog	Site 3	20-Jul-21	0.255 J	0.977 J	0.712 J	–	0.596 J	–	–	0.528 J	0.852 J	0.891 J
South Lake	Site 3	20-Aug-21	0.314 J	0.9721 J	0.665 J	–	0.665 J	0.296 J	–	0.658 J	0.795 J	0.776 J
	Site 3	19-Oct-21	0.336 J	0.538 J	0.508 J	–	0.466 J	–	–	–	0.664 J	0.572 J
Johns River (mouth)	Site 4	20-Jul-21	0.632 J	**2.22**	0.861 J	–	0.717 J	0.299 J	0.832 JF	1.80 J	1.41 J	1.24 J
	Site 4	20-Aug-21	0.482 J	1.51 J	0.601 J	–	0.630 J	0.315 J	–	0.775 J	0.953 J	1.03 J
	Site 4	19-Oct-21	0.634 J	**2.74**	0.867 J	–	0.848 J	0.306 J	–	0.610 J	0.940 J	1.03 J
South Bay (center)	Site 5	20-Jul-21	0.228 JF	0.907 J	0.478 J	–	0.482 J	–	–	0.691 J	0.691 J	0.896 J
	Site 5	20-Aug-21	–	0.876 J	0.545 J	–	0.581 J	–	–	0.775 J	0.731 J	0.852 J
	Site 5	19-Oct-21	–	1.20 J	0.625 J	–	0.481 JF	–	–	–	0.651 J	0.832 J
Black River (mouth)	Site 6	20-Jul-21	–	1.03 J	0.392 J	–	0.410 J	–	–	–	0.598 J	0.652 J
	Site 6	20-Aug-21	0.299 J	**1.86**	0.488 J	–	0.510 J	–	0.584 JF	1.19 J	0.747 J	1.14 J
	Site 6	19-Oct-21	0.299 J	1.66 J	0.756 J	–	0.624 J	–	–	–	0.724 J	0.938 J
	Site 6A (FD)	19-Oct-21	–	1.66 J	0.741 J	–	0.618 J	–	–	–	0.801 J	0.920 J
Black River (above)	Site 7	20-Jul-21	0.228 JF	1.28 J	0.504 J	–	0.511 J	–	–	0.573 J	0.670 J	0.964 J
Airport Rd	Site 7 (EB)	20-Jul-21	–	–	–	–	–	–	–	–	0.243 J	–
	Site 7	20-Aug-21	0.285 J	**2.48**	0.609 J	–	0.687 J	–	–	0.612 J	–	0.997 J
	Site 7	19-Oct-21	0.465 J	**2.47**	1.27 J	–	1.04 J	–	–	0.560 J	1.18 J	1.79 J
Barton River (mouth)	Site 8	20-Jul-21	0.415 JF	1.41 J	0.742 J	–	0.527 J	–	0.594 JF	0.649 J	0.824 J	0.946 J
	Site 8	20-Aug-21		1.12 J	0.436 J	–	0.440 J	–	–	0.572 J	0.757 J	0.772 J
	Site 8	19-Oct-21	0.348 J	1.12 J	0.580 J	–	0.455 JF	–	–	–	0.638 J	0.606 J
Clyde River (mouth)	Site 9	20-Jul-21	0.382 J	1.02 J	0.721 J	–	1.06 J	–	–	0.736 J	0.907 J	1.68 J
	Site 9	20-Aug-21	0.376 J	1.75 J	0.616 J	–	0.915 J	0.321 J	–	0.813 J	1.01 JF	1.62 J
	Site 9A (FD)	20-Aug-21	0.287 J	**1.84**	0.652 J	–	0.957 J	0.291 J	–	0.751 J	0.928 J	1.63 J
	Site 9	19-Oct-21	–	0.418 J	0.472 J	–	0.443 J	–	–	0.465 J	0.574 J	0.574 J
Clyde River												
(above WWTF)	Site 10	20-Jul-21	0.296 J	0.775 J	0.603 J	–	0.430 J	–	–	0.629 J	0.633 J	0.865 J
	Site 10	20-Aug-21	0.237 J	1.00 J	0.524 J	–	0.384 J	0.339 J	–	0.716 J	0.753 J	0.768 J
	Site 10	19-Oct-21	–	0.408 J	0.430 J	–	0.308 J	–	–	–	0.508 J	0.430 J
	Site 10 (EB)	20-Aug-21	–	–	–	–	–	–	–	–	0.219 J	–
	Site 10 (FB)	20-Aug-21	–	–	–	–	–	–	–	0.495 J	0.271 JF	–
	No. Detections abv. RL		0	6	0	0	0	0	0	1	0	0
	Mean		–	2.26	–	–	–	–	–	–	–	–
	Minimum		–	1.84	–	–	–	–	–	2.81	–	–
	Maximum		–	2.74	–	–	–	–	–	2.81	–	–

Notes:
Bolded values ≥ Reporting Limit (RL).
(5) VT Regulated PFAS highlighted green.
J – Estimated value. Analyte concentration below the quantitation limit (RL).
FD - Field Duplicate
FB - Field Blank
EB – Equipment Blank

Results from sampling above and below the WWTFs outfalls for the Montpelier and Barre WWTFs were very similar; the sum of the (5) Regulated PFAS above and below the Barre WWTF in the Stevens Branch (Figure 4) were 2.2 ppt and 2.45 ppt and for the Montpelier WWTF results were 1.88 ppt and 1.6 ppt for above and below in the Winooski River. The surface water sampling results for all Lake Memphremagog watershed and additional regional sites (n=19) were below the VT Drinking Water Advisory of 20 ppt for the sum of the five Vermont-Regulated PFAS.

Table 7. Additional Northern Vermont PFAS Surface Water Results

Site Name / Location	Field Sample Id	Sample Date	PFBS	PFBA	PFHpA	PFHxS	PFHxA	PFNA	PFOS	PFOA	PFPeS	PFPeA	Sum (5) PFAS
Field Samples - Surface Water (ng/L)													
Statewide Sites													
Stevens Branch Barre	STV_ABV WWTF	18-Oct-21	0.623 J	1.18 J	0.452 J	–	0.525 J	–	0.590 J	0.718 J	–	0.722 J	2.2 J
Stevens Branch Barre	STV_BLW WWTF	18-Oct-21	0.796 J	1.24 J	0.537 J	–	1.05 J	–	1.00 J	0.918 J	–	1.31 J	2.45 J
Winooski R. Montplelier	WIN_MONT_ABV_WWTF	18-Oct-21	0.496 J	1.54 J	0.637 J	–	0.681 J	–	0.482 J	0.768 J	–	0.927 J	1.88 J
Winooski R., Montplelier	WIN_MONT_BLW_WWTF	18-Oct-21	0.719 J	1.46 J	0.748 J	–	–	–	–	0.920 J	–	1.13 J	1.6 J
Winooski R. South Burlington	WIN_BLW_ALLEN	20-Oct-21	**1.99**	**3.38**	1.51 J	**4.22**	**3.09**	0.354 J	1.57 JB	–	0.917 J	**3.14**	10.7 J
Muddy Brook	Muddy Brook (mouth)	20-Oct-21	**2.52**	**4.63**	**2.17**	**5.72**	**4.99**	0.502 J	**2.03 F**	**4.43**	0.642 J	**5.11**	14.8 J
Muddy Brook	Muddy Brook (EB)	20-Oct-21	–	–	–	–	–	–	0.489 JB	–	–	–	–
Winooski R. Burlington	WIN_MOUTH	20-Oct-21	0.991 J	**1.98**	0.786 J	0.783 JF	1.38 J	0.344 J	1.13 JBF	1.27 J	–	1.48 J	4.3 J
Otter Creek, Ferrisburgh	Otter Creek (mouth)	20-Oct-21	0.428 J	1.22 J	0.590 J	–	0.778 J	–	0.484 J	0.894 J	–	1.14 J	1.96 J
Miles Pond, Concord	Miles Pond (Reference)	19-Oct-21	–	–	0.424 J	–	–	–	0.489 J	0.667 J	–	0.486 J	1.58 J
		No. Detections abv. RL	1	3	1	2	2	0	1	1	0	2	–
		Mean	2.25	3.33	–	4.97	4.04	–	–	–	–	4.12	4.60
		Minimum	1.99	4.63	2.17	4.22	3.09	–	2.03	4.43	–	3.14	1.58
		Maximum	2.52	1.98	2.17	5.72	4.99	–	2.03	4.43	–	5.11	14.80

Notes:
Bolded values ≥ Reporting Limit (RL).
Five Vermont-Regulated PFAS highlighted green.
J – Estimated value. Analyte concentration below the quantitation limit (RL).
EB – Equipment Blank

WWTF Effluent Results

Table 8 presents results of PFAS effluent analysis from three WWTFs: Newport City, Barre, and Montpelier, which currently receives landfill leachate for treatment. The Newport City WWTF

was sampled three times in 2021; the Barre and Montpelier facilities were sampled once in October 2021.

The Newport City WWTF effluent analysis show consistent results from the three sampling events. Ten PFAS analytes were detected above the RL, with the sum of the five Vermont-regulated PFAS ranging from 17.0 ppt to 27.6 ppt. Total PFAS at the Newport facility ranged from 67.3 ppt to 128.7 ppt.

The Barre City WWTF effluent was very low in PFAS, with only four PFAS detected above the RL. The sum of the five Vermont-regulated PFAS was 2.53 ppt and total PFAS was 36.8 ppt.

The Montpelier City WWTF, which currently receives landfill leachate for treatment, had 12 PFAS detected above the RL, the sum of the five Vermont-Regulated PFAS was 79.7 ppt and total PFAS was 377.8 ppt.

Table 8. WWTF PFAS Effluent Results

Site Name / Location	Field Sample Id	Sample Date	PFBS	PFBA	PFDA	PFHpA	PFHxS	PFHxA	PFNA	FOSA	PFOS	PFOA	PFPeA	NEtFOSSA	NMeFOSSA	6:2 FTS	Sum VT (5) PFAS	Sum PFAS
Field Samples - WWTF Effluent (ng/L)																		
Newport City WWTF	Site 11	20-Jul-21	**6.82 F**	**19.20**	**4.75**	**3.66**	0.459 J	**30.10**	**2.12**	1.34 JF	**5.35**	**11.40**	**41.10**	1.57 J	**4.22**	–	**22.50**	**128.70**
	Site 11 (FD)	20-Jul-21	**7.25 F**	**20.20**	**5.08**	**3.70**	0.359 J	**29.20**	**2.04**	1.43 JF	**5.84**	**11.10**	**38.80**	1.68 J	**4.15**	–	**22.60**	**127.30**
	Site 11	20-Aug-21	**4.38**	**12.60**	**4.24**	**6.06**	0.378 J	**31.50**	**1.91**	0.879 JF	**6.72**	**13.00**	**53.60**	1.45 JF	**3.50 F**	–	**27.69**	**137.50**
	Site 11	19-Oct-21	**4.57 F**	**8.12**	**1.92**	**5.52**	0.394 J	**13.8**	1.01 J	–	**4.38**	**7.19**	**15.7**	–	**2.00**	**4.14**	**17.00**	**67.30**
Barre City WWTF	Effluent	18-Oct-21	**4.19 F**	**5.52**	0.298 J	1.05 J	0.584 J	**10.5**	–	–	1.46 J	**2.53**	**14.1**	–	–	–	**2.53**	**36.80**
No. Detections abv. RL			5	5	4	4	0	5	3	0	4	5	5	–	4	1		
Mean			5.40	13.10	3.99	4.73	–	23.00	2.02	–	5.57	9.00	32.60	–	3.46	–		
Minimum			4.19	5.52	1.92	3.66	–	10.50	1.91	–	4.38	2.53	14.10	–	2.00	4.14		
Maximum			7.25	20.20	5.08	6.06	–	31.50	2.12	–	6.72	13.00	53.60	–	4.22	4.14		
Accepting Leachate																		
Montpelier WWTF	Effluent	18-Oct-21	**55.40**	**69.3**	**13.6**	**33.5**	**5.58**	**82.8**	**2.94**	–	**4.64**	**33.1**	**53.8**	–	**3.79**	**19.40**	**79.70**	**377.80**

Notes:
Bolded values ≥ Reporting Limit (RL).
Five Vermont-Regulated PFAS highlighted green.
J – Estimated value. Analyte concentration below the quantitation limit (RL).
F – Ratio of quantifier ion response to qualifier ion response falls outside of lab criteria, results are estimated maximum concentration.
EB – Equipment Blank

Fish Tissue Results

As presented in **Table 9**, of the 36 PFAS analyzed, there were only five PFAS detected in the fish tissue above the Reporting Limit (RL), shown in order of detections (PFOS > PFDA> PFUnA > PFDoA >PFTrDA). Perfluorooctanesulfonic acid (PFOS) was detected at all sites, Perfluorodecanoic acid (PFDA) was detected at six sites, Perfluoroundecanoic acid (PFUnA) was detected at five sites, and Perfluorododecanoic acid (PFDoA) and Perfluorotridecanoic acid (PFTrDA) were detected at only one site.

PFOS, one of the most ubiquitous and bioaccumulative PFAS, was detected above the RL in 54 (96%) of the fish tissue samples, PFDA was detected in 16 (28%) samples, PFUnA was detected in ten (17.8%) samples, and PFDoA and PFTrDA were detected in three (5.3%) and

two (3.5%) samples respectively. Of the five Vermont-regulated PFAS (PFHpA, PFHxS, PFOA, PFNA, PFOS), PFOS was the only one detected above the RL. Perfluorononanoic acid (PFNA) was detected in six samples, but all detections were below the RL and less than 0.1 ppb.

The potential for PFAS to bioaccumulate in fish tissue is related to the number of fluorinated carbons and the anionic group (carboxylate or sulfonate). In general, bioaccumulation of these PFAS is directly related to the length of the carbon chain, with sulfonates more bioaccumulative than carboxylates with the same length of carbon chain. PFOS is a sulfonate with eight carbons and has estimated bioaccumulation factor (BAF) of 1,000 to > 10,000 (Burkhard 2020). The other PFAS detected in fish tissue are within the carboxylate group (PFDA, PFUnA, PFDoA), and all are long-chain, with 10 – 13 carbons (**Table 1).** Shorter chain PFAS can bioaccumulate, but to a much lesser degree and would likely only be detected if water concentrations were very high. PFOS, PFDA, PFUnA, and PFDoA are the four most reported PFAS detected in fish tissue (Stahl et al., 2014).

The maximum PFAS fish tissue concentrations observed by site are shown in **Table 10.** PFOS was the predominant compound detected in all samples, with mean and median concentrations of 5.29 ppb and 3.22 ppb respectively, representing 70% of the PFAS detected across all samples. PFOS comprised more than 48% of the PFAS detected at each site and as much as 90% at two sites.

The highest concentrations of PFOS were detected in yellow perch samples from the Winooski River (15.1 ppb or 81% of total PFAS) and brown bullhead samples from Otter Creek (9.82 ppb or 90% of total PFAS). The lowest concentrations of PFOS were detected in samples from South Bay and the Clyde River at 1.98 ppb (brown bullhead) and 2.32 ppb (largemouth bass). The reference site Miles Pond had PFOS concentration of 2.67 ppb in a yellow perch sample.

The total PFAS detected in fish tissue by site ranged from 2.94 ppb at South Bay to 18.6 ppb at the Winooski River site. Otter Creek has the second highest value of total PFAS at 10.8 ppb. South Bay and the Clyde River site had the lowest PFOS concentrations and the lowest total PFAS values detected in fish tissue. The reference site, Miles Pond had the third lowest value for total PFAS at 3.51 ppb.

Table 9. Concentrations of PFAS in Fish Tissue Samples (µg/kg)

Site Name and Location	Field Sample Id	Species Collected	Sample Date	PFBA	PFDA	PFDoA	PFNA	FOSA	PFOS	PFPeA	PFTA	PFTrDA	PFUnA
Fish Tissue (µg/kg), wet weight													
South Bay	VT 1_SB1-YP1-2	Yellow Perch	16-Aug-21	–	0.140 J	–	–	–	**1.27 F**	–	–	–	0.184 J
	VT 2_SB2-YP1	Yellow Perch	16-Aug-21	–	0.072 J	–	–	–	**0.363 F**	–	–	–	0.108 J
	VT 3_SB1-BBH1	Brown Bullhead	16-Aug-21	–	–	–	–	–	**1.31 F**	–	–	–	0.109 J
	VT 4_SB1-BBH2	Brown Bullhead	16-Aug-21	–	–	–	–	–	**1.98 F**	–	–	–	–
	VT 5_SB2-BBH1	Brown Bullhead	16-Aug-21	–	–	–	–	–	**1.23 F**	–	0.056 J	–	0.100 J
	VT 6_SB1-LMB1	Largemouth Bass	16-Aug-21	0.029 J	0.216 J	0.107 J	–	–	**1.75 F**	–	0.067 J	0.185 J	0.327 J
	VT 7_SB1-LMB2	Largemouth Bass	16-Aug-21	0.027 J	0.094 J	0.103 J	–	–	**1.21 F**	–	0.065 J	–	0.213 J
	VT 8_SB1-LMB2A	Largemouth Bass	16-Aug-21	–	0.107J	0.132 J	–	–	**1.59 F**	–	0.075 JF	0.189 J	0.283 J
	VT 9_SB2-LMB1	Largemouth Bass	16-Aug-21	–	0.149 J	0.083 J	–	–	**1.13**	–	–	–	0.240 J
Clyde River	VT 10_CLY-RB1-2-3	Rock Bass	16-Aug-21	–	0.216 J	0.142 J	–	–	**1.08 F**	–	0.070 J	–	0.231 J
	VT 11_CLY-LMB1	Largemouth Bass	16-Aug-21	–	0.222 J	0.168 JF	–	–	**1.06**	–	0.113 J	0.201 J	0.283 J
	VT 12_CLY-LMB2	Largemouth Bass	16-Aug-21	–	**0.428**	0.241 J	–	–	**2.32**	–	0.104 J	0.251 J	**0.549**
	VT 13_CLY-LMB3	Largemouth Bass	16-Aug-21	–	0.200 J	0.120 J	–	–	**1.16**	–	0.062 J	–	0.266 J
	VT 14_CLY-BBH1-2	Brown Bullhead	16-Aug-21	–	0.091 J	0.073 J	–	–	**1.68 F**	–	0.061 J	–	0.157 J
	VT 15_CLY-BBH3	Brown Bullhead	16-Aug-21	–	0.065 J	0.194 JF	–	–	**0.346**	–	0.246 J	0.314 J	0.163 J
Lake Memphremagog	VT 16_MLN-YP1-2	Yellow Perch	17-Aug-21	–	**0.596**	0.423 J	0.079 J	–	**2.83 F**	–	0.149 J	0.392 J	**0.839**
North	VT 17_MLN-YP3	Yellow Perch	17-Aug-21	–	0.118 J	0.129 J	–	–	**1.32 F**	–	0.109 J	0.261 J	0.214 J
	VT 18_MLN-BBH1	Brown Bullhead	17-Aug-21	–	–	0.137 JF	–	–	**0.347 F**	0.043 J	0.102 J	0.237 J	0.170 J

	VT 19_MLN-BBH2	Brown Bullhead	17-Aug-21	–	0.094 J	0.163 J	–	–	**0.942 F**	–	0.064 JF	–	0.270 J
	VT 20_MLN-BBH3	Brown Bullhead	17-Aug-21	–	0.172 J	0.163 J	–	–	**0.700 F**	–	0.085 J	0.234 J	0.422 J
	VT 21_MLN-LMB1	Largemouth Bass	17-Aug-21	–	**0.712**	0.358 J	–	–	**3.22 F**	–	0.182 J	0.472 J	**0.82**
	VT 22_MLN-LMB2	Largemouth Bass	17-Aug-21	–	**0.24**	0.178 J	–	–	**0.997**	–	0.146 J	0.318 J	0.373 J
	VT 23_MLN-LMB3	Largemouth Bass	17-Aug-21	–	**0.31**	0.147 J	–	–	**1.57 F**	–	0.140 J	0.345 J	0.435 J
Lake Memphremagog	VT 24_MLS-YP1	Yellow Perch	17-Aug-21	–	0.147 J	0.147 J	–	–	**0.762 F**	–	0.103 J	0.215 J	0.209 J
South	VT 25_MLS-YP2-3	Yellow Perch	17-Aug-21	–	0.175 J	0.121 J	–	–	**0.962 F**	–	0.080 JF	0.184 J	0.245 J
	VT 26_MLS-BBH2	Brown Bullhead	17-Aug-21	–	**0.346**	0.176 J	–	–	**1.47 F**	–	0.144 J	0.340 J	0.381 J
	VT 27_MLS-BBH3	Brown Bullhead	17-Aug-21	–	0.086 J	0.142 J	–	–	**1.61 F**	–	0.124 J	0.242 J	0.184 J
	VT 28_MLS-LMB1	Largemouth Bass	17-Aug-21	–	**0.58**	0.317 J	0.079 J	–	**4.93 F**	–	0.154 J	0.350 J	**0.683**
	VT 29_MLS-LMB3	Largemouth Bass	17-Aug-21	–	**0.23**	0.204 JF	–	–	**1.69 F**	–	0.108 J	0.226 J	0.416 J
Winooski River	VT30_WN_YP1	Yellow Perch	6-Oct-21	–	**0.582**	**0.599**	–	–	**15.1**	–	0.097 J	–	**0.81**
	VT31_WN_YP2-3	Yellow Perch	6-Oct-21	–	**0.44**	0.44 J	–	–	**10.9 F**	–	0.82 J	0.232 J	**0.613**
	VT32_WN_NP1	Northern Pike	6-Oct-21	–	**0.541**	**0.598**	0.091 J	0.236 JF	**4.48**	–	0.091 J	0.315 J	**0.718**
	VT33_WN_NP2	Northern Pike	6-Oct-21	–	**0.276**	0.406 J	–	0.098 JF	**2.28 F**	–	0.078 J	0.277 J	0.384 J
	VT34_WN_NP3	Northern Pike	6-Oct-21	–	**0.425**	0.422 J	0.094 J	0.182 J	**3.83**	–	0.074 J	0.258 J	**0.526**
	VT35_WN_BBH1	Brown Bullhead	6-Oct-21	–	**0.36**	**0.546**	–	–	**1.63 F**	–	0.120 J	0.342 J	**0.691**
	VT36_WN_BBH2-3	Brown Bullhead	6-Oct-21	–	0.174 J	0.417 J	–	–	**7.73 F**	–	0.135 J	0.332 J	0.403 J
Otter Creek	VT37_OTC_NP1	Northern Pike	6-Oct-21	–	0.219 J	0.116 J	0.074 J	0.099 J	**2.84**	–	–	–	0.220 J
	VT 38_OTC_NP2	Northern Pike	6-Oct-21	–	0.140 J		–	0.146 J	**1.68**	–	–	–	0.119 J
	VT 39_OTC_NP3	Northern Pike	6-Oct-21	–	**0.272**	0.127 J	0.094 J	0.100 JF	**2.04**	–	0.057 JF	–	**0.294**

	VT 40_OTC_YLP1	Yellow Perch	6-Oct-21	–	0.065 J	–	–	–	**1.29 F**	–	–	–	0.078 J
	VT 41_OTC_YLP2	Yellow Perch	6-Oct-21	–	–	–	–	–	**1.05 F**	–	–	–	0.064 J
	VT 42_OTC_YLP3	Yellow Perch	6-Oct-21	–	0.064 J	–	–	–	**0.616 F**	–	–	–	0.065 J
	VT 43_OTC_BBH1	Brown Bullhead	6-Oct-21	–	–	–	–	–	**9.82**	–	–	–	0.069 J
	VT 44_OTC_BBH2	Brown Bullhead	6-Oct-21	–	–	–	–	–	**2.76 F**	–	–	–	0.105 J
Miles Pond	VT 46_MP_SMB1	Smallmouth Bass	8-Oct-21	0.052 J	**0.25**	0.279 J	–	–	**2.18 F**	–	0.199 J	**0.467**	0.571
	VT 47_MP_LMB1	Largemouth Bass	8-Oct-21	–	0.115 J	0.119 JF	–	–	**0.779**	0.046 J	0.077 J	0.206 J	0.281 J
	VT 48_MP-LMB1A	Largemouth Bass	8-Oct-21	–	0.123 J	0.165 JF	–	–	**0.849**	–	0.090 J	0.232 J	0.268 J
	VT 49_MP-LMB2	Largemouth Bass	8-Oct-21	–	0.177 J	0.257 J	–	–	**0.92**	–	0.243 J	**0.582**	0.470 J
	VT 50_MP_YP1-2-3	Yellow Perch	8-Oct-21	–	0.122 J	0.148 J	–	–	**2.67 F**	0.044 J	0.121 J	0.317 J	0.24 J
	VT 51_MP_BBH1	Brown Bullhead	8-Oct-21	0.059 J	0.098 J	0.237 J	–	–	**1.96 F**	0.087 J	0.146 J	0.469 J	0.392 J
	VT 52_MP_BBH2	Brown Bullhead	8-Oct-21	–	–	0.083 J	–	–	**0.277 F**	0.056 J	0.068 JF	–	0.168 J
Stevens Branch	VT 53_STV_RBT1	Rainbow Trout	11-Oct-21	–	–	–	–	–	0.186 J	–	–	–	–
	VT 54_STV_RBT1A	Rainbow Trout	11-Oct-21	–	–	–	–	0.092 J	0.144 J	–	–	–	–
	VT 55_STV_RBT2	Rainbow Trout	11-Oct-21	0.023 J	–	–	–	–	**1.45 F**	0.051 J	–	–	0.044 J
	VT 56_STV_BRT1	Brown Trout	11-Oct-21	–	0.178 J	0.112 J	–	–	**1.68 F**	–	0.070 J	–	0.155 J
	VT 57_STV_BRT2-3	Brown Trout	11-Oct-21	–	0.136 J	0.088 J	–	–	**6.36 F**	0.044 J	0.051 J	–	0.092 J
No. Detects (%)				5 (8.9)	45 (80)	42 (7.5)	6 (1.0)	7 (1.2)	56 (100)	7 (1.2)	41 (73)	30 (53)	53 (94)
No. Detects abv RL (%)				0	16 (28)	3 (5.3)	0	0	54 (96)	0	0	2 (3.5)	10 (17.8)
Total 56													

Notes:
Bolded values ≥ Reporting Limit (RL).
Vermont-regulated PFAS highlighted green.
J – Estimated value. Analyte concentration below the quantitation limit (RL).
F – Ratio of quantifier ion response to qualifier ion response falls outside of lab criteria, results are estimated maximum concentration.

Table 10. Maximum Fish Tissue Concentrations by Site

	Maximum Fish Tissue Concentration												
Site Name and Location	**PFBA**	**PFDA**	**PFDoA**	**PFHxA**	**PFNA**	**FOSA**	**PFOS**	**PFPeA**	**PFTA**	**PFTrDA**	**PFUnA**	**Total PFAS (µg/kg)**	**% PFOS vs Total PFAS**
Fish Tissue (ug/kg), wet weight													
L. Memphremagog-North	–	**0.712**	0.423 J	–	0.079 J	–	**3.22 F**	0.043 J	0.182 J	0.472 J	**0.839**	6.6	48%
L. Memphremagog- South	–	**0.58**	0.317 J	–	0.079 J	–	**4.93 F**	–	**0.154**	0.350 J	**0.683**	7.09	69%
South Bay	0.029 J	0.216 J	0.132 J	–	–	–	**1.98 F**	–	0.075 JF	0.189 J	0.327 J	2.94	67%
Clyde River-Mouth	–	**0.428**	0.241 J	–	–	–	**2.32**	–	0.246 J	–	0.283 J	3.51	66%
Winooski River -Mouth	–	**0.582**	**0.599**	0.080 JF	0.094 J	0.236 JF	**15.1**	–	0.82 J	0.342 J	**0.81**	18.6	81%
Otter Creek-Mouth	–	**0.272**	0.127 J	–	0.094 J	0.146 J	**9.82**	–	0.057 JF	–	**0.294**	10.8	90%
Miles Pond (Reference)	0.052 J	**0.25**	0.279 J	–	–	–	**2.67 F**	–	0.243 J	**0.582**	**0.571**	4.64	57%
Stevens Branch-Blw WWTF	0.023 J	0.178 J	0.112 J	–	–	0.092 J	**6.36 F**	0.051 J	0.070 J	–	0.155 J	7.04	90%
Mean	*0.03*	*0.374*	*0.257*		*0.086*	*0.158*	*5.29*	*0.047*	*0.211*	*0.387*	*0.466*	*6.99*	*70.8*
Median	*0.029*	*0.272*	*0.241*		*0.086*	*0.146*	*3.22*	*0.047*	*0.154*	*0.35*	*0.327*	*6.6*	*69*
Minimum	*0.023*	*0.149*	*0.083*	*0.08*	*0.079*	*0.092*	*1.23*	*0.043*	*0.056*	*0.189*	*0.155*	*2.94*	*48*
Maximum	*0.052*	*0.712*	*0.599*	*0.08*	*0.094*	*0.236*	*15.1*	*0.051*	*0.82*	*0.58*	*0.83*	*18.6*	*90*

Notes:
Bolded values ≥ Reporting Limit (RL).
Vermont-regulated PFAS highlighted green.
J – Estimated value. Analyte concentration below the quantitation limit (RL).
F – Ratio of quantifier ion response to qualifier ion response falls outside of lab criteria, results are estimated maximum concentration.

Table 11 shows the summary of PFAS detections by site with the average, minimum, and maximum PFAS concentrations shown for the five PFAS detected above the Reporting Limits. Except for PFOS, the maximum concentration for all other PFAS analytes detected was < 1.0 ppb.

Table 8. Summary of PFAS detections in fish tissue from all sites

Compound	Number of Sites Detected (n=8)	Number of Samples Detected (n = 56)	Average Concentration (µg/kg)	Minimum Concentration (µg/kg)	Maximum concentration (µg/kg)
PFOS	8	54	2.4	0.34	15.1
PFDA	6	16	0.41	0.23	0.712
PFUnA	5	10	0.71	0.29	0.83
PFDoA	1	3	0.58	0.54	0.59
PFTrDA	1	2	0.52	0.46	0.58

Notes:
Vermont-regulated PFAS highlighted green.

PFOS concentrations by fish species with average, minimum, and maximum values are presented in Table **9.** Brown trout (n=2) had the highest average PFOS concentration (4.02 ppb), followed by yellow perch (n=12) at 3.26 ppb. Yellow perch and brown bullhead had the highest PFOS concentrations reported at 15.1 ppb and 9.82 ppb respectively. These maximum PFOS concentrations observed in lower trophic fish species help illustrate that PFOS do not

bioaccumulate in fish tissue in the same manner as other contaminants (e.g., PCBs); the higher trophic level fish do not necessarily have higher levels of PFAS contamination.

Other factors that may play a role in observed tissue concentrations are age and size of fish as well as habitat (e.g., benthic, pelagic) and potential exposure. **Appendix B** provides fish metric data including length, weight, anomalies, and PFOS concentration.

The highest PFOS concentrations observed in brown bullhead, largemouth bass, and yellow perch did not correspond to the largest fish for each of these species within the same sites. Fish anomalies included two brown bullheads from South Bay and Lake Memphremagog with "coal tar" type lesions; PFOS levels in these fish were 0.34 ppb and 1.31 ppb respectively. High incidence of similar lesions has been reported in brown bullhead collected from South Bay and other southern Lake Memphremagog locations (Blazer et al., 2020).

Table 11. PFOS Concentrations Detected by Fish Species

Species	No. of samples	Average PFOS Concentration (µg/kg)	Minimum PFOS Concentration (µg/kg)	Maximum PFOS Concentration (µg/kg)
Brown Bullhead	16	2.1	0.34	9.82
Largemouth Bass	15	1.67	1	4.93
Smallmouth Bass	1	2.18	2.18	2.18
Northern Pike	6	2.85	1.68	4.48
Yellow Perch	12	3.26	0.363	15.1
Brown Trout	2	4.02	2	6.36
Rainbow Trout	3	0.59 J	0.144	1.45
Rock Bass	3 (composite)	1.08	1.08	1.08

Fish Tissue Comparability

The fish tissue PFAS concentrations observed during this monitoring effort are low compared to national fish tissue studies conducted in lakes and rivers (Stahl et al., 2014). EPA national fish tissue study collected fish from randomly selected locations (164 urban river sites, 157 nearshore Great Lakes sites). Results showed that PFOS dominated in frequency of occurrence, with maximum PFOS concentrations of 127 ppb and 80 ppb in urban river samples and Great Lakes samples, respectively. PFOS median concentrations were 15.2 ppb and 10.7 ppb for Great Lake and urban river samples, respectively. The median PFOS concentration observed during this monitoring effort was 3.22 ppb for all river and lake sites.

Regional fish tissue studies (Maine DEP, 2014) indicate PFOS concentrations in freshwater species at reference sites (rivers, lakes) were in the range of 1.0 – 4.0 ppb, which is consistent with this study's PFOS results. A recent New Hampshire Department of Environmental Services (NHDES) PFAS Baseline study included sampling and analysis of surface water, sediment, and fish tissue at 14 lakes in southern New Hampshire. Results from this study indicated mean and

median PFOS values were 7.96 ppb and 5.99 ppb and maximum PFOS value reported was 18.30 ppb (Weston Solutions, 2021). Additional PFAS fish tissue occurrence data are summarized in the ITRC PFAS Fact Sheet (April 2020). ITRC summary data indicates PFOS has been reported in fish tissue (muscle) at 225 ppb below WWTFs, 2,000 ppb below industrial sites, and 6,160 ppb at AFFF spill sites.

CONCLUSIONS

All surface water PFAS results for the Lake Memphremagog sites and additional sites (n=19), were below the Vermont Drinking Water Advisory of 20 ppt for the sum of the five Vermont-Regulated PFAS. There were only two PFAS detected above the analytical Reporting Limits within the Lake Memphremagog watershed and these detections were still very low – in the single part per trillion.

The highest PFAS concentrations observed were from Muddy Brook and the Winooski River site downstream of Muddy Brook. The Muddy Brook watershed may be receiving PFAS loading from nonpoint source stormwater discharges. This watershed, and similar surface waters, merit additional investigation and sampling, though the PFAS detections were very low – in the single part per trillion. For reference, nationally, PFAS have been detected in the hundreds parts per trillion (ITRC September 2020).

Fish tissue PFAS results from the eight sites sampled showed only one of the five Vermont-Regulated PFAS, PFOS, which is the most widely distributed and persistent PFAS, detected above the Reporting Limits. PFOS is also one of the most bioaccumulative PFAS, and it was detected in 96 percent of the fish tissue samples. Average PFOS concentrations observed were 2.4 ppb. These PFAS detections were low – PFOS fish tissue concentrations were in the single part per billion (ppb) at all sites except the Winooski site, which had two detections above ten parts per billion. Compared to national fish tissue studies, these results are considered low. Nationally, PFAS have been detected in the hundreds parts per billion (ITRC September 2020)

The highest PFAS concentrations were detected in fish from the lower Winooski River and Otter Creek. These watersheds are large, have numerous municipal and industrial discharges, and land use ranges from forested to urban. The fish tissue data from this study is currently under review by the Vermont Department of Health to determine if these levels pose any health risk to consumers.

In summary, the additional PFAS surface water and fish tissue results show that a few PFAS compounds are present, reflective of low background concentrations at most sites, with surface water in the single digits parts per trillion and fish tissue in the single digits parts per billion. However, the environmental occurrence and persistence, bioaccumulation, and potential adverse effects of PFAS on humans and other species remain a potential cause for concern and continued monitoring. Surface water, fish tissue, WWTF effluent sampling will continue, targeting sites with known or suspected PFAS sources.

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FIGURE 1

LAKE MEMPHREMAGOG PFAS SAMPLING SITES

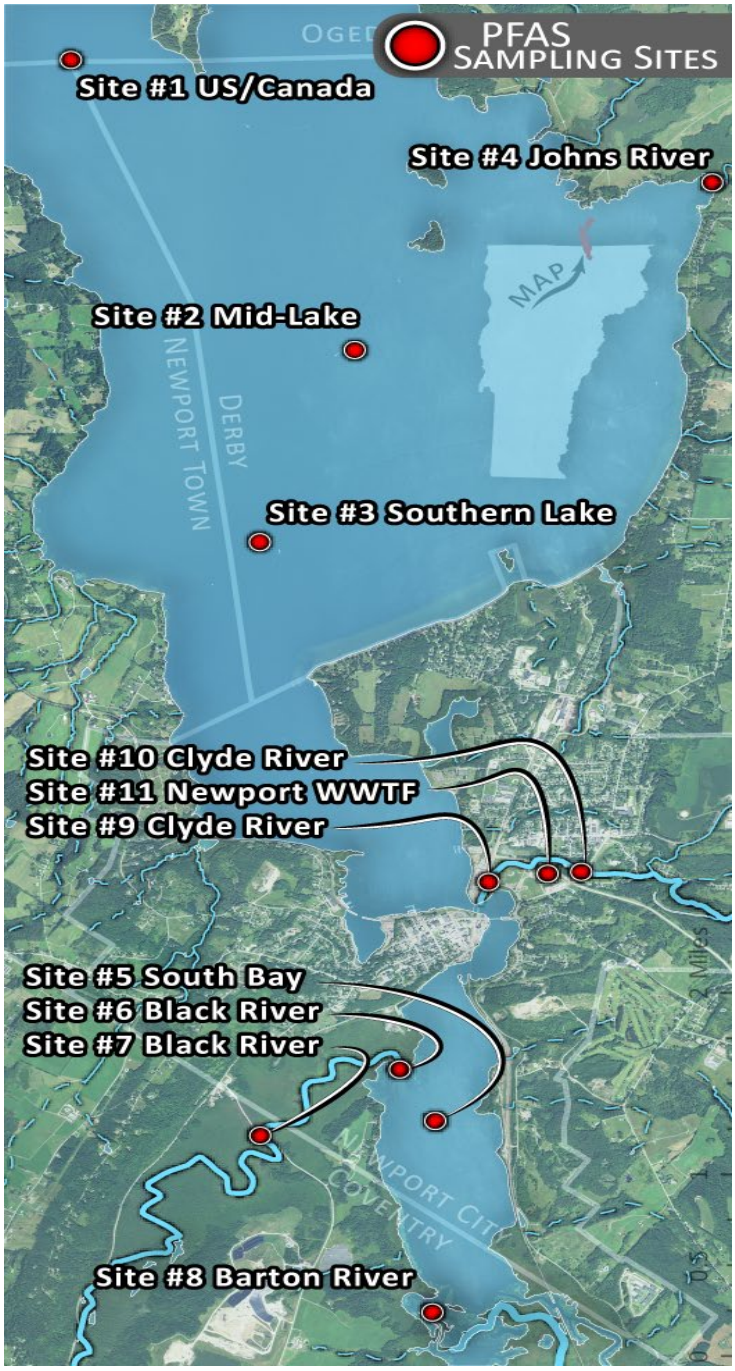


FIGURE 2

ADDITIONAL NORTHERN VERMONT PFAS SAMPLING SITES

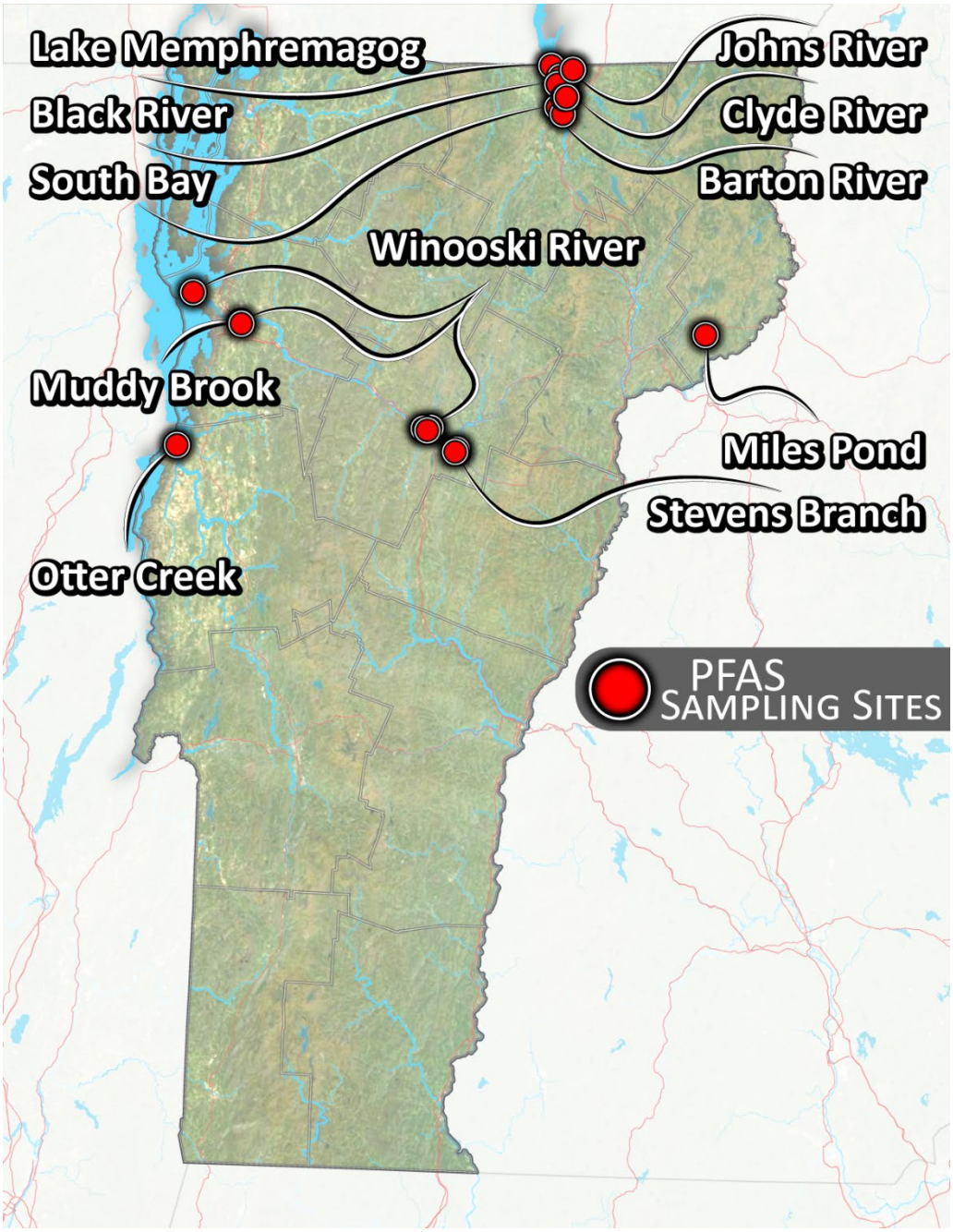


FIGURE 3

WINOOSKI RIVER & OTTER CREEK PFAS SAMPLING SITES

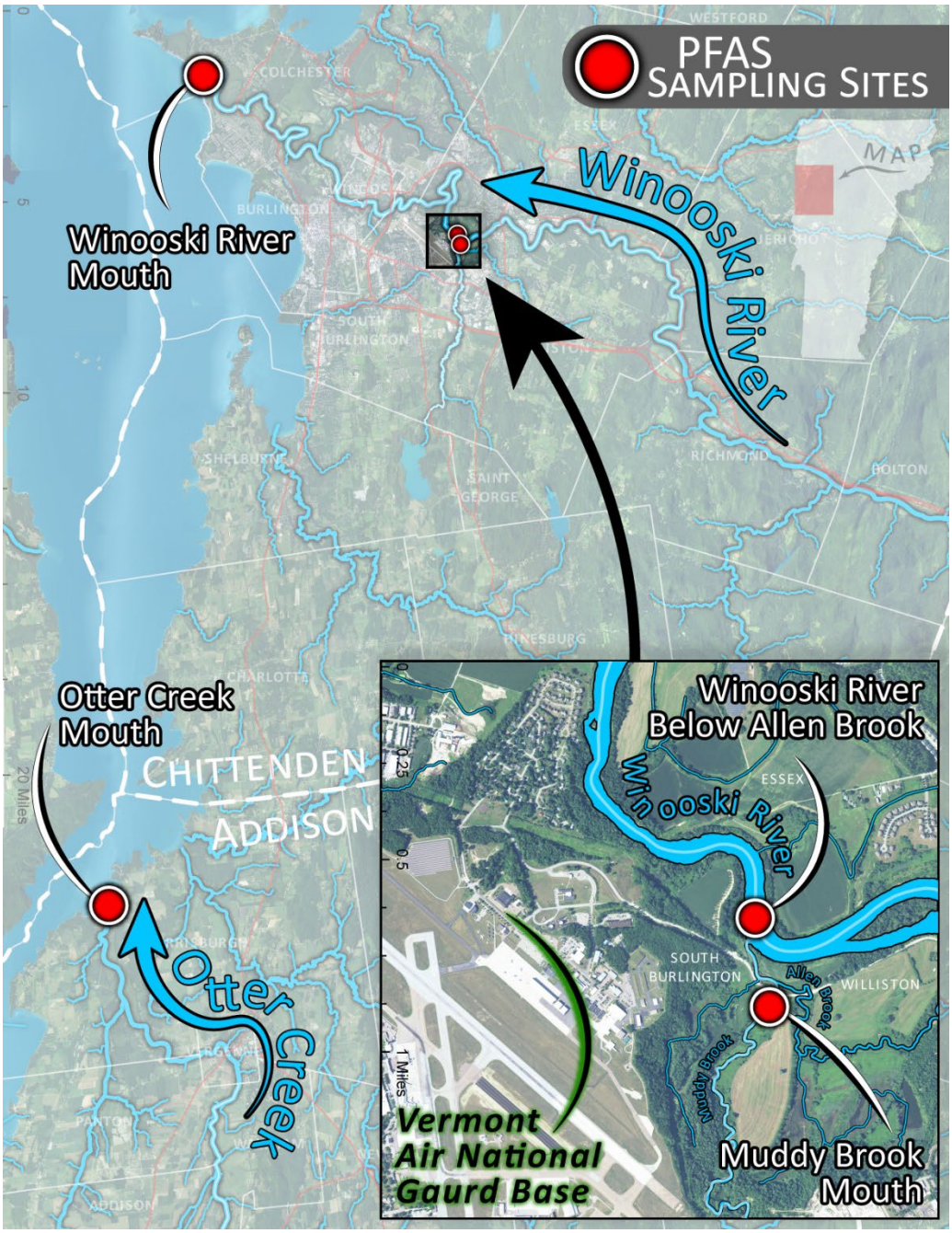


FIGURE 4

MONTPELIER & BARRE PFAS SAMPLING SITES

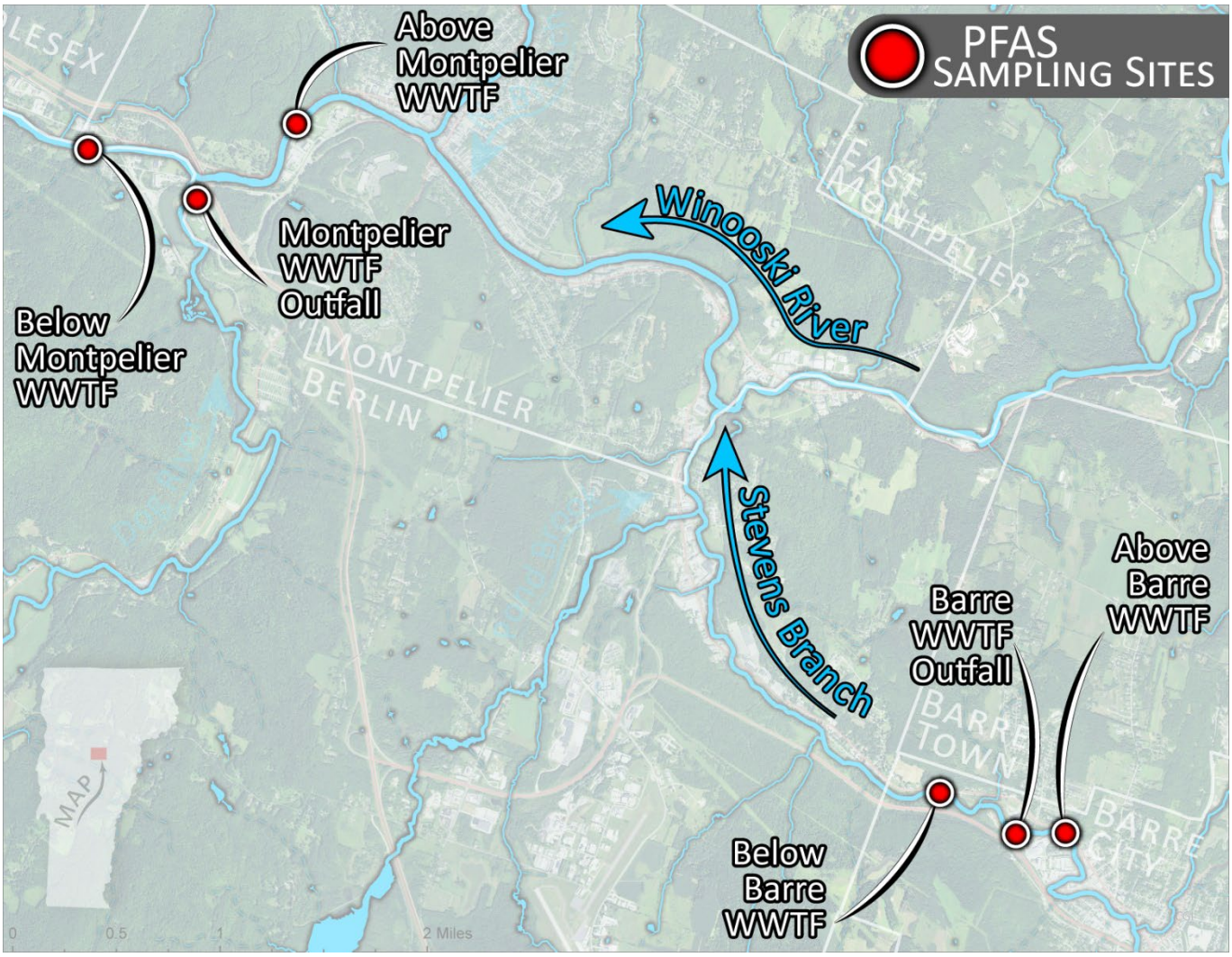


FIGURE 5

MILES POND (REFERENCE) PFAS SAMPLING SITE

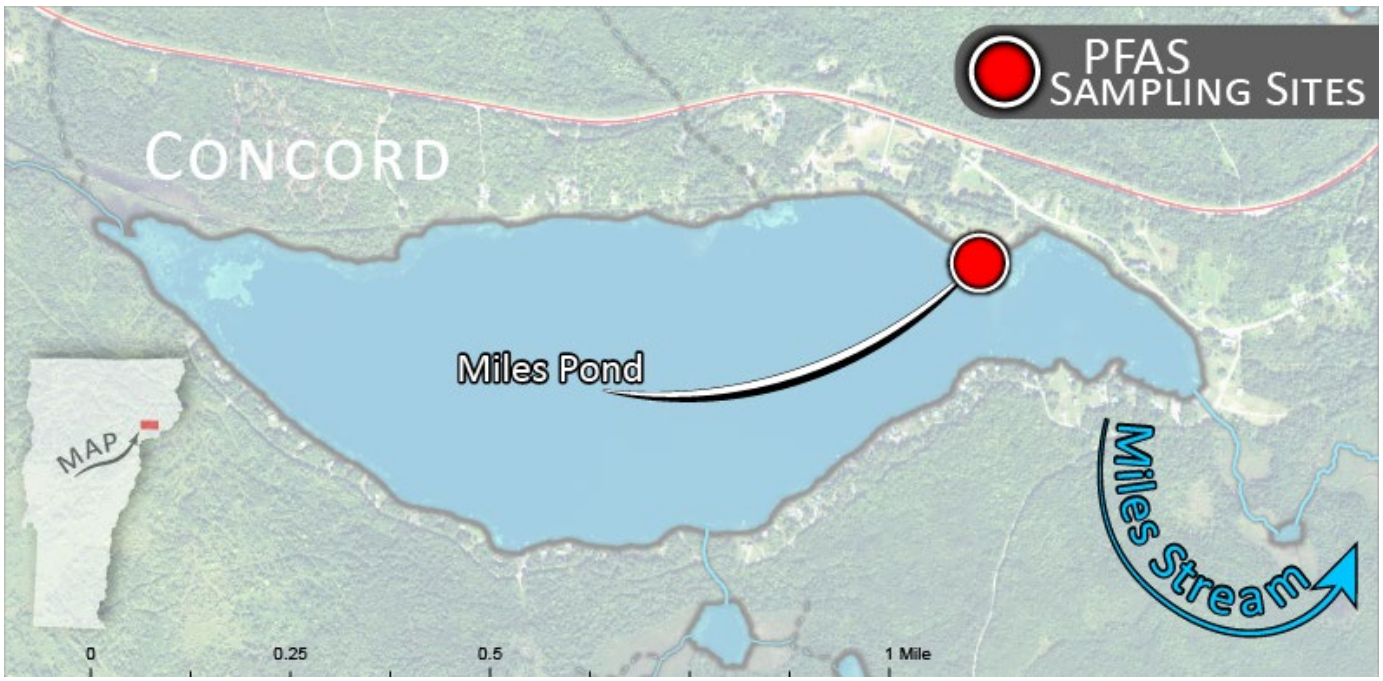
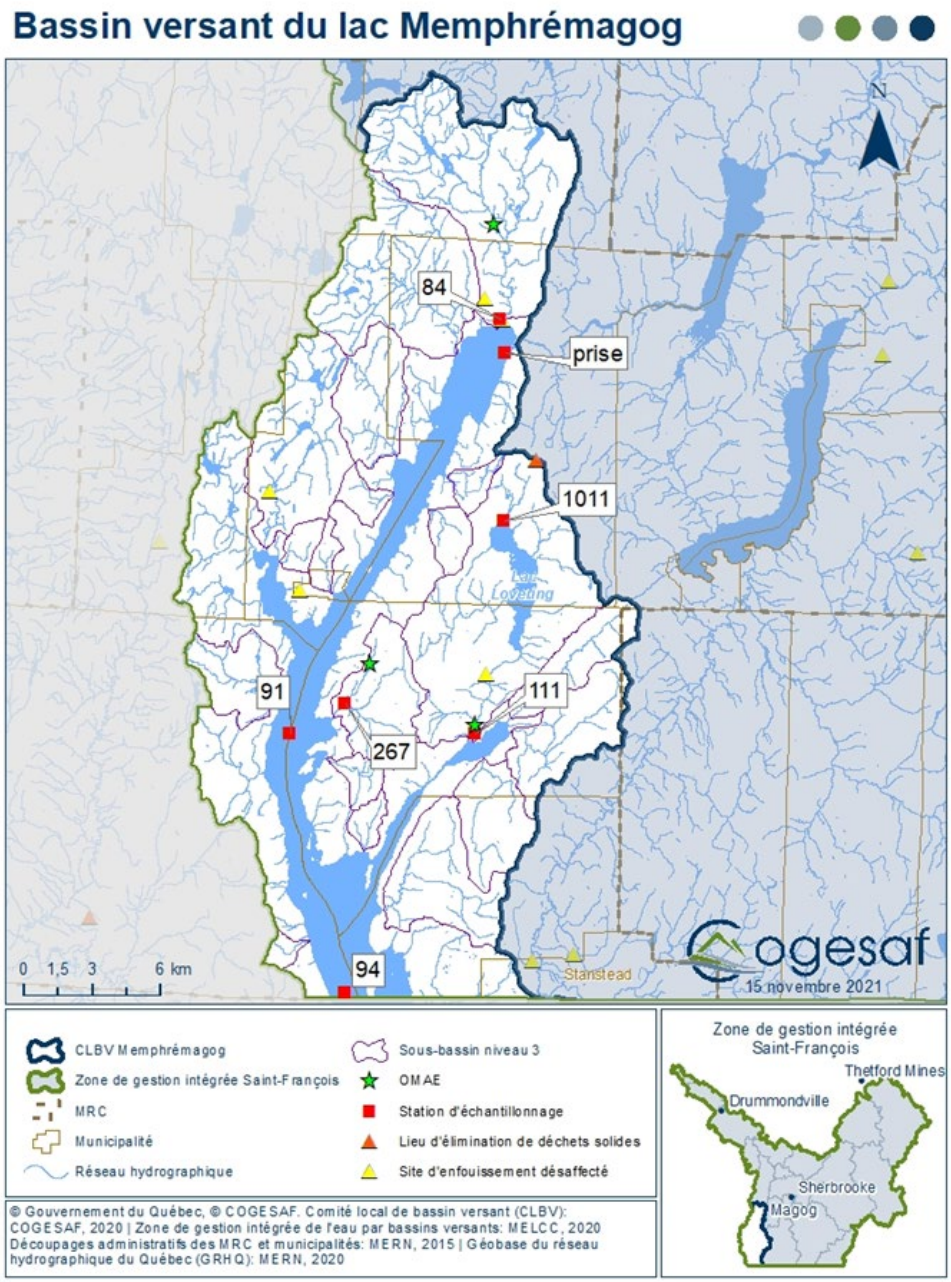


FIGURE 6
COGESAF PFAS SAMPLING SITES



APPENDIX A
LABORATORY PFAS QUANTITATION INFORMATION

APPENDIX A: LIMITS OF PFAS QUANTITATION FOR SURFACE WATER

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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 (NMeFOSA	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]-P	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	85-154	30	85-154	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-PF	756426-58-1	2	0.2768	ng/l	55-158	30	55-158	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11C	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	*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)

APPENDIX A

LIMITS OF PFAS QUANTITATION OF SURFACE WATER (continued)

Date Created: 06/17/21
Created By: Michael Chang
File: PM10726-1
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,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2	*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,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2	*NONE*									*10-162*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid	*NONE*									*24-116*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA	*NONE*									*55-137*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*10-112*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (	*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]-1	*NONE*									*10-165*		
Perfluoro[13C2]Hexadecanoic Acid (M2PFHxDA)	*NONE*									*10-206*		
1H,1H,2H,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-o	*1265205-95-5*									*10-189*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (	*NONE*									*10-187*		

APPENDIX A: LIMITS OF PFAS QUANTITATION FISH TISSUE

Date Created: 06/17/21
Created By: Michael Chang
File: PM10727-1
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 (NMeFOSA	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]-P	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	68-143	30	68-143	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	82-160	30	82-160	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-PF	756426-58-1	1	0.0374	ng/g	69-139	30	67-139	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11C	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	*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)

APPENDIX A: LIMITS OF PFAS QUANTITATION OF FISH TISSUE (continued)

Date Created: 06/17/21
Created By: Michael Chang
File: PM10727-1
Page: 2

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	*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	*NONE*									*19-175*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid	*NONE*									*31-134*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA	*NONE*									*61-155*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*10-117*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (	*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]-1	*NONE*									*10-203*		
Perfluoro[13C2]Hexadecanoic Acid (M2PFHxDA)	*NONE*									*10-145*		
1H,1H,2H,2H-Perfluorododecane Sulfonate (M2D4-10:2FT	*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-o	*1265205-95-5*									*10-146*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol	*NONE*									*10-129*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. (Soil/Solids only)

APPENDIX B
FISH TISSUE METRICS

APPENDIX B

FISH TISSUE METRICS

Site Name and Location	Field Sample Id	Species Collected	Fish No.	Total Weight (grams)	Total Length (millimeter)	Sample Date	Comments	PFOS
Fish Tissue (ug/kg), wet weight								
South Bay	VT 1_SB1-YP1-2	Yellow Perch	1	266/126	285 / 196	16-Aug-21	composite (2)	**1.27 F**
	VT 2_SB2-YP1	Yellow Perch	2	126	257	16-Aug-21		**0.363 F**
	VT 3_SB1-BBH1	Brown Bullhead	3	240	241	16-Aug-21	Lesions	**1.31 F**
	VT 4_SB1-BBH2	Brown Bullhead	4	278	260	16-Aug-21		**1.98 F**
	VT 5_SB2-BBH1	Brown Bullhead	5	283	259	16-Aug-21		**1.23 F**
	VT 6_SB1-LMB1	Largemouth Bass	6	915	361	16-Aug-21		**1.75 F**
	VT 7_SB1-LMB2	Largemouth Bass	7	770	343	16-Aug-21		**1.21 F**
	VT 8_SB1-LMB2A	Largemouth Bass	8	770	343	16-Aug-21		**1.59 F**
	VT 9_SB2-LMB1	Largemouth Bass	9	969	358	16-Aug-21		**1.13**
Clyde River	VT 10_CLY-RB1-2-3	Rock Bass	10	308/247/286	220 /198 /210	16-Aug-21	composite (3)	**1.08 F**
	VT 11_CLY-LMB1	Largemouth Bass	11	793	368	16-Aug-21		**1.06**
	VT 12_CLY-LMB2	Largemouth Bass	12	562	324	16-Aug-21		**2.32**
	VT 13_CLY-LMB3	Largemouth Bass	13	957	381	16-Aug-21		**1.16**
	VT 14_CLY-BBH1-2	Brown Bullhead	14	199/240	259	16-Aug-21	composite (2)	**1.68 F**
	VT 15_CLY-BBH3	Brown Bullhead	15	297	284	16-Aug-21		**0.346**
Lake Memphremagog	VT 16_MLN-YP1-2	Yellow Perch	16	142/134	226 /241	17-Aug-21	composite (2)	**2.83 F**
North	VT 17_MLN-YP3	Yellow Perch	17	165	236	17-Aug-21		**1.32 F**
	VT 18_MLN-BBH1	Brown Bullhead	18	362	307	17-Aug-21	Lesions	**0.347 F**
	VT 19_MLN-BBH2	Brown Bullhead	19	315	295	17-Aug-21		**0.942 F**
	VT 20_MLN-BBH3	Brown Bullhead	20	209	254	17-Aug-21		**0.700 F**
	VT 21_MLN-LMB1	Largemouth Bass	21	1334	411	17-Aug-21		**3.22 F**
	VT 22_MLN-LMB2	Largemouth Bass	22	1201	414	17-Aug-21		**0.997**
	VT 23_MLN-LMB3	Largemouth Bass	23	1384	447	17-Aug-21		**1.57 F**
Lake Memphremagog	VT 24_MLS-YP1	Yellow Perch	24	276	284	17-Aug-21		**0.762 F**
South	VT 25_MLS-YP2-3	Yellow Perch	25	249/137	272	17-Aug-21	composite (2)	**0.962 F**
	VT 26_MLS-BBH2	Brown Bullhead	26	268	272	17-Aug-21		**1.47 F**
	VT 27_MLS-BBH3	Brown Bullhead	27	609	330	17-Aug-21		**1.61 F**
	VT 28_MLS-LMB1	Largemouth Bass	28	686	335	17-Aug-21		**4.93 F**
	VT 29_MLS-LMB3	Largemouth Bass	29	636	351	17-Aug-21		**1.69 F**
Winooski River	VT30_WN_YP1	Yellow Perch	30	150	247	6-Oct-21		**15.1**
	VT31_WN_YP2-3	Yellow Perch	31	136/114	215 / 190	6-Oct-21	composite (2)	**10.9 F**
	VT32_WN_NP1	Northern Pike	32	1984	800	6-Oct-21		**4.48**
	VT33_WN_NP2	Northern Pike	33	715	513	6-Oct-21		**2.28 F**
	VT34_WN_NP3	Northern Pike	34	1026	596	6-Oct-21		**3.83**
	VT35_WN_BBH1	Brown Bullhead	35	192	241	6-Oct-21		**1.63 F**
	VT36_WN_BBH2-3	Brown Bullhead	36	161/137	215/196	6-Oct-21	composite (2)	**7.73 F**
Otter Creek	VT37_OTC_NP1	Northern Pike	37	1560	635	6-Oct-21		**2.84**
	VT 38_OTC_NP2	Northern Pike	38	1420	622	6-Oct-21		**1.68**
	VT 39_OTC_NP3	Northern Pike	39	730	615	6-Oct-21		**2.04**
	VT 40_OTC_YLP1	Yellow Perch	40	175	228	6-Oct-21		**1.29 F**
	VT 41_OTC_YLP2	Yellow Perch	41	180	222	6-Oct-21		**1.05 F**
	VT 42_OTC_YLP3	Yellow Perch	42	178	241	6-Oct-21		**0.616 F**
	VT 43_OTC_BBH1	Brown Bullhead	43	216	241	6-Oct-21		**9.82**
	VT 44_OTC_BBH2	Brown Bullhead	44	195	235	6-Oct-21		**2.76 F**
Miles Pond	VT 46_MP_SMB1	Smallmouth Bass	46	622	323	8-Oct-21		**2.18 F**
	VT 47_MP_LMB1	Largemouth Bass	47	2140	488	8-Oct-21		**0.779**
	VT 48_MP-LMB1A	Largemouth Bass	48	2140	488	8-Oct-21		**0.849**
	VT 49_MP-LMB2	Largemouth Bass	49	1140	425	8-Oct-21		**0.92**
	VT 50_MP_YP1-2-3	Yellow Perch	50	150/136/114	247 /215 /190	8-Oct-21	composite (3)	**2.67 F**
	VT 51_MP_BBH1	Brown Bullhead	51	372	292	8-Oct-21		**1.96 F**
	VT 52_MP_BBH2	Brown Bullhead	52	330	273	8-Oct-21		**0.277 F**
Stevens Branch	VT 53_STV_RBT1	Rainbow Trout	53	902	419	11-Oct-21		0.186 J
	VT 54_STV_RBT1A	Rainbow Trout	54	902	419	11-Oct-21		0.144 J
	VT 55_STV_RBT2	Rainbow Trout	55	550	360	11-Oct-21		**1.45 F**
	VT 56_STV_BRT1	Brown Trout	56	205	266	11-Oct-21		**1.68 F**
	VT 57_STV_BRT2-3	Brown Trout	57	123/89	234 /209	11-Oct-21	composite (2)	**6.36 F**

APPENDIX C
ANCILLARY WATER CHEMISTRY DATA

APPENDIX C

ANCILLARY WATER CHEMISTRY DATA

Site Name / Location	Field Sample Id	Sample Date	Alkalinity	TOC	NPOC	TP	Conductivity	Temp	pH
Field Samples - Surface Water			CaCO3	Total Inorganic Carbon	Organic Carbon	Total Phosphorus	umho/cm	C°	units
Lake Memphremagog Watershed Sites		Units	mg/L	mg/L	mg/L	µg/L			
Lake Memphremagog	Site 1	20-Jul-21	56.50	13.70	3.10	52.80	129.00	21.46	8.03
US/Canada	Site 1	19-Oct-21	59.30	14.5	3.00	19.2	155.00	14.90	7.43
Lake Memphremagog	Site 2	20-Jul-21	56.90	13.80	3.10	13.10	131.80	22.90	8.16
Mid-Lake	Site 2	20-Aug-21	–	14.00	3.00	12.70	129.00	21.60	8.23
	Site 2	19-Oct-21	62.20	14.4	2.9	17.00	155.00	15.30	7.65
Lake Memphremagog	Site 3	20-Jul-21	57.50	14.00	3.00	14.90	131.00	22.90	8.07
South Lake	Site 3	20-Aug-21	–	14.00	3.00	11.70	135.00	21.40	7.60
	Site 3	19-Oct-21	59.40	14.6	2.9	16.80	145	13.60	7.20
Johns River (mouth)	Site 4	20-Jul-21	172.00	43.70	5.10	39.20	385.00	23.24	7.68
	Site 4	20-Aug-21	–	20.10	3.50	19.60	365.00	21.50	7.42
	Site 4	19-Oct-21	81.70	22.9	3.8	27.50	–	12.90	7.37
South Bay (center)	Site 5	20-Jul-21	93.50	21.60	3.50	30.00	182.00	19.26	7.60
	Site 5	20-Aug-21	–	21.20	3.70	20.30	–	–	–
	Site 5	19-Oct-21	92.90	24	4.6	28.00	–	–	7.82
Black River (mouth)	Site 6	20-Jul-21	102.00	25.00	3.20	35.30	222.00	21.70	8.12
	Site 6	20-Aug-21	–	27.00	3.60	22.60		22.60	–
	Site 6	19-Oct-21		22.3	5.2	36.20	239	11.08	7.35
Black River (above)	Site 7	20-Jul-21	99.90	24.00	4.00	50.90	–	21.70	7.80
Airport	Site 7	20-Aug-21	102.00	26.4	3.5	27.00	252	20.00	–
	Site 7	19-Oct-21	60.50	15.4	7.9	36.90	159	13.30	7.57
Barton River (mouth)	Site 8	20-Jul-21	86.30	20.70	4.30	22.10	199	22.50	8.53
	Site 8	20-Aug-21		22.1	2.7	17.20	213	21.00	–
	Site 8	19-Oct-21	76.40	19.2	7.4	21.80	196	11.08	–
Clyde River (mouth)	Site 9	20-Jul-21	60.50	14.60	3.50	51.70	–	22.50	8.21
	Site 9	20-Aug-21	63.10	15.4	3.2	16.80	192	21.5	
	Site 9	19-Oct-21	64.90	15.6	3.2	16.50	185	9.00	7.89
Clyde River (above)	Site 10	20-Jul-21	57.90	13.90	3.40	12.80	–	21.00	7.95
	Site 10	20-Aug-21	61.50	15.10	3.20	12.20	–	–	–
	Site 10	19-Oct-21	63.70	14.60	3.10	15.80	–	13.40	8.07

ANCILLARY WATER CHEMISTRY DATA (continued)

Site Name / Location	Field Sample Id	Sample Date	Alkalinity	TOC	NPOC	TP	Temp	pH
Field Samples - Surface Water			CaCO3	Total Inorganic Carbon	Organic Carbon	Total Phosphorus	C°	units
Statewide Sites		Units	mg/L	mg/L	mg/L	µg/L		
Stevens Branch Barre	STV_ABV WWTF	18-Oct-21	133	30.9	3.60	13.5	11.70	8.29
Stevens Branch Barre	STV_BLW WWTF	18-Oct-21	137	32.6	3.60	23.5	12.20	8.16
Winooski R. Montplelier	WIN_MONT_ABV_WWTF	18-Oct-21	79.4	18.6	4.80	16.1	13.10	8.24
Winooski R., Montplelier	WIN_MONT_BLW_WWTF	18-Oct-21	66.8	15.5	4.00	15.40	12.90	8.40
Winooski R. South Burlington	WIN_BLW_ALLEN	20-Oct-21	134	31.7	6.1	46.9	14.2	7.82
Muddy Brook	Muddy Brook (mouth)	20-Oct-21	154	36.4	7.2	70.2	13.2	8.21
Winooski R. Burlington	WIN_MOUTH	20-Oct-21	50.3	12	3.5	19.1	14.2	8.00
Otter Creek, Ferrisburgh	Otter Creek (mouth)	20-Oct-21	94.4	23.5	5.40	62.3	16.50	7.75
Miles Pond, Concord	Miles Pond (Reference)	19-Oct-21	14.60	4	4.70	15.20	12.60	7.08

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 filet 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 filet 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
    - Filet weight
    - Physical exam including deformities, erosions, lesions, and tumors.

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

Filet Sample Processing

The following procedures will be used for fileting 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 filet 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 filet by rinsing with deionized water.

After a filet 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 filets for the composite and weigh to the nearest gram. Minimum sample size is 30.0 grams (g) of tissue, confirm with laboratory. Individual filet 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

Filet 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 filet) will be collected every 20 samples from specimens large enough to produce the minimum required sample mass (approximately
30 g) per filet.

APPENDIX F

LAKE MEMPHREMAGOG INTERNATIONAL ANALYSIS AND REPORTING

Introduction

On July 20, 2021, water quality monitoring experts from the Vermont Department of Environmental Conservation (DEC) and from COGESAF, the Saint-Francis watershed governance council, collected water samples from sites in Lake Memphremagog, its tributaries, and in adjacent wastewater effluent. These samples were then analyzed for 36 forms of Per- and Polyfluorinated Alkyl Substances (PFAS) at an accredited laboratory in the United States, including the five VT Regulated PFAS (PFHpA, PFHxS, PFOA, PFNA, PFOS), and 27 forms of PFAS at an accredited laboratory in Ontario, Canada[7].

PFAS Surface Water & Effluent Sample Collection Sites

DEC collected surface water samples from ten sites within the Lake Memphremagog watershed (Figure 1) including three sites on the Main Lake, including a US/Canada border location, a mid-lake site and southern site. South Bay and four major tributaries (Johns, Clyde, Black and Barton Rivers) and the Newport City Wastewater Treatment Facility (WWTF) effluent were also sampled. COGESAF collected samples from three sites in Lake Memphremagog on the Canadian side of the border, with duplicates taken at the northern end of the lake adjacent to the Sherbrooke and Magog Water Intake, for a total of four samples. To ensure complementarity between laboratory results, COGESAF also analyzed two samples taken by the VT DEC Team, one from the border and one effluent sample taken at the Newport WWTF. See Figures 1 and 2 below for maps of the respective sampling sites in USA and Canada.

PFAS Laboratory Analysis Information

Given the sensitivity of PFAS analyses, which are measured in parts per trillion, and potential for field contamination, duplicate samples from two sites in VT were also sent to the Canadian Laboratory to assess complementarity between the two laboratories. Based on US EPA Method 537.1, each PFAS analyte has a **laboratory reporting limit**, which is defined as the lowest analyte concentration that meets the Data Quality Objectives defined in the method. The laboratory reporting limit is 1.8 nanograms per liter (ng/L or parts per trillion) for most forms of PFAS in the USA and 2.0 ng/L for most forms of PFAS in Canada. PFAS analyte values below the laboratory reporting limit are defined as "**ND**" or non-detect in the tables below.

[7] USA Lab is Alpha Analytical in Massachusetts and the Canadian Lab is Bureau Veritas in Ontario.

Laboratories typically obtain PFAS analyte results below the laboratory reporting limit but still above a detection limit, but these results, as defined in the US EPA Method 537.1, are intended for statistical determination of laboratory equipment precision, and not to produce "accurate quantitation" for the purposes of results reporting. Therefore, VT DEC received some PFAS results for samples above the detection limit but below the laboratory reporting limit, and the results presented below are only results above the laboratory reporting limits as per EPA guidelines.

Lake and Tributary Preliminary Results

Lake and Tributary water samples analyzed for PFAS show concentrations below detection limits for all sites samples, with two exceptions, a value of 2.81 ng/L for PFOS in the main lake (USA) and a value of 2.22 ng/L for PFBA at the mouth of the John's River. See Tables 1 and 2 below for results from the USA and Table 3 for results from Canada. These very low concentrations are consistent with PFAS surface water concentrations found in remote areas worldwide, and concentrations found in atmospheric precipitation. The analysis of duplicates taken at the border by the VTDEC Team resulted in identical results (Table 4), suggesting adequate lab complementarity for surface water samples. These values are well below the VT drinking water guidance of 20 ng/L (sum of five analytes).

Table 1. Surface Water PFAS concentrations (ng/L) for the five Vermont-regulated PFAS at Vermont Lake Memphremagog sites, collected 7/20/2021

Site	Main Lake - Border	Main Lake - Mid	Main Lake - South	Johns R. - mouth	South Bay - Center	Black R. - mouth	Black R. - above	Barton R. - mouth	Clyde R. - mouth	Clyde R. - above
Analytes	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
PHFpA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFOA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFOS	ND	2.81	ND	ND	ND	ND	ND	ND	ND	ND

Table 2. Surface Water PFAS detections (ng/L) for the 36 PFAS compounds at VT Lake Memphremagog sites, collected 7/20/2021 (NB: if an analyte is not shown, the value is non-detect or ND)

Site	Main Lake - Border	Main Lake - Mid	Main Lake - South	Johns R. - mouth	South Bay - Center	Black R. - mouth	Black R. - above	Barton R. - mouth	Clyde R. - mouth	Clyde R. - above
Analytes	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
PHFpA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFOA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFOS	ND	2.81	ND	ND	ND	ND	ND	ND	ND	ND
PFBA	ND	ND	ND	2.22	ND	ND	ND	ND	ND	ND
PFPeA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFBS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NMeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NEtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 3. Surface Water PFAS detections (ng/L) for the 27 PFAS compounds at Quebec Lake Memphremagog sites, collected 7/20/2021

Site	Main Lake - Border	Main Lake - Central	Main Lake North #1	Main Lake - North #2
Analytes	Site 94	Site 91	Prise #1	Prise #2
EtFOSAA	ND	ND	ND	ND
Perfluorobutanoic Acid (PFBA)	ND	ND	ND	ND
Perfluoropentanoic Acid (PFPeA)	ND	ND	ND	ND
Perfluorohexanoic Acid (PFHxA)	ND	ND	ND	ND
Perfluoroheptanoic Acid (PFHpA)	ND	ND	ND	ND
Perfluorooctanoic Acid (PFOA)	ND	ND	ND	ND
Perfluorononanoic Acid (PFNA)	ND	ND	ND	ND
Perfluorodecanoic Acid (PFDA)	ND	ND	ND	ND
Perfluoroundecanoic Acid (PFUnA)	ND	ND	ND	ND
Perfluorododecanoic Acid (PFDoA)	ND	ND	ND	ND
Perfluorotridecanoic Acid (PFTrDA)	ND	ND	ND	ND
Perfluorotetradecanoic Acid(PFTeDA)	ND	ND	ND	ND
Perfluorobutanesulfonic acid (PFBS)	ND	ND	ND	ND
Perfluoropentanesulfonic acid PFPes	ND	ND	ND	ND
Perfluorohexanesulfonic acid(PFHxS)	ND	ND	ND	ND
Perfluoroheptanesulfonic acid(PFHp)	ND	ND	ND	ND
Perfluorooctanesulfonic acid (PFOS)	ND	ND	ND	ND

Perfluorononanesulfonic acid (PFNS)	ND	ND	ND	ND
Perfluorodecanesulfonic acid (PFDS)	ND	ND	ND	ND
Perfluorooctane Sulfonamide (PFOSA)	ND	ND	ND	ND
MeFOSAA	ND	ND	ND	ND
4:2 Fluorotelomer sulfonic acid	ND	ND	ND	ND
6:2 Fluorotelomer sulfonic acid	ND	ND	ND	ND
8:2 Fluorotelomer sulfonic acid	ND	ND	ND	ND
Hexafluoropropyleneoxide Dimer Acid	ND	ND	ND	ND
4,8-Dioxa-3H-Perfluorononanoic Acid	ND	ND	ND	ND
9Cl-PF3ONS (F-53B Major)	ND	ND	ND	ND
11Cl-PF3OUdS (F-53B Minor)	ND	ND	ND	ND

Table 4. US / Canada Lab results for (5) VT Regulated PFAS (ng/L) for duplicate lake samples

Site	Main Lake - Border - USA Lab	Main Lake - Border - Canadian Lab
Analytes	Duplicate 1	Duplicate 2
PHFpA	ND	ND
PFHxS	ND	ND
PFOA	ND	ND
PFNA	ND	ND
PFOS	ND	ND

WWTF Effluent Results

DEC collected wastewater effluent samples from the Newport WWTF, and duplicates samples were analyzed at both USA and Canadian labs to assess complementarity.

A total of ten PFAS analytes were detected in the Newport City WWTF effluent by the USA laboratory and a total of seven PFAS analytes were detected by the Canadian Laboratory. Comparison of wastewater effluent results shows one result where inter-laboratory complementarity is below expectations; specifically, the PFOS results show a value of 5.35 ng/L from the USA laboratory and a ND result from the Canadian laboratory.

Table 5. Effluent PFAS detections (ng/L) for the 36 PFAS compounds at Newport WWTF, collected 7/20/2021, with results from both the USA and Canada laboratories

Analytes	Newport WWTF Effluent - US LAB	Newport WWTF Effluent- Canadian Lab
	Site 11	Site 11
PHFpA	3.66	3.4
PFHxS	ND	ND
PFOA	11.4	9.8
PFNA	2.12	ND
PFOS	5.35	ND
PFBA	19.2	9.1
PFPeA	41.1	35
PFBS	6.82	3.4
PFHxA	30.1	23
FOSA	ND	ND
PFDA	4.75	4
NMeFOSAA	4.22	ND
NEtFOSAA	ND	ND

Figure 1. Eleven USA PFAS Sampling Sites

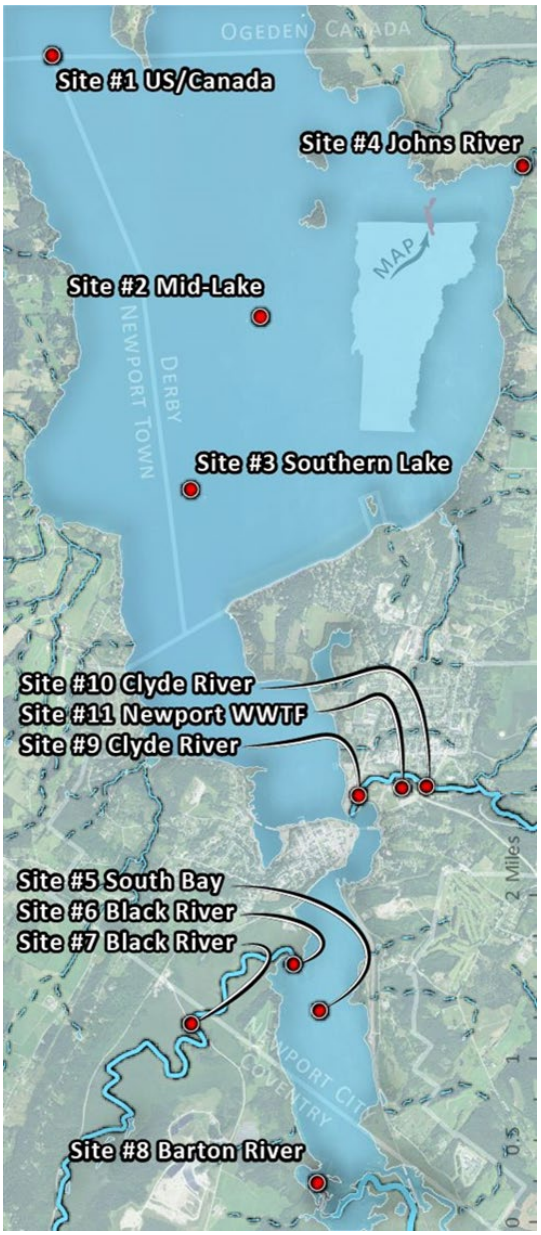

Figure 2. Three Canadian PFAS Sampling Sites.