Evaluating Kentucky Source Waters for Per- & Poly-Fluoroalkyl Substances

Department for Environmental Protection

Division of Water

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Contents

Links to Appendices:

    Appendix A: PFAS Sampling SOP

    Appendix B: Quality Assurance Project Plan (QAPP)

    Appendix C: PFAS Chain of Custody

    Appendix D: PFAS Source Water Sample Results

    Appendix E: DEPS Lab PFAS Data Quality Assessment

Tables

Figures

Executive Summary

In an effort to expand our knowledge of per- and poly-fluoroalkyl substances (PFAS) occurrence in Kentucky, 40 surface water monitoring stations were each sampled one time during the summer of 2020. This project was designed as an extension of the previous year's drinking water PFAS study. Monitoring station locations were selected to fill data gaps and represent each of the major river basins in the state. Catchment areas for these monitoring stations ranged from 0.8 mi^2 to 4288 mi^2

PFAS were detected at 36 of the 40 monitoring stations. The most frequently detected PFAS was PFOS, which was found at 34 monitoring stations. This was followed closely by PFOA, which was detected at 31 stations. The highest single concentration was PFOS, which was found at 249 ng/L (or parts per trillion (ppt)) at a station in Christian County. This is considered a cursory study for the presence of PFAS, and due to the limited number of samples care must be taken when attempting to draw conclusions.

Introduction and Background

PFAS have been identified as contaminants of emerging concern. These compounds are ubiquitous and have been used since the 1940s for their ability to resist heat, oil, grease, and water. The most common uses have been stain resistance for carpets, non-stick cookware, and aqueous film-forming foam (AFFF). These chemicals are persistent in the environment and can bioaccumulate in organisms. There is evidence that exposure to PFAS chemicals may impact reproductive and developmental health, increase the risk for cancer, disrupt thyroid hormones, and affect the immune system (USEPA, 2018). The United States Environmental Protection Agency (USEPA) and many states have assessed the need to establish Maximum Contaminant Levels (MCLs) for PFAS exposure in drinking water and take further regulatory actions regarding PFAS.

The chemical characteristics of PFAS are also key to each compound's environmental transport and fate. These molecules form carbon chains with fluorine atoms inhabiting some or all of the potential bonding sites, and a non-fluorine charged *head* on one end (ITRC, 2018). The carbon-fluorine bond is one of the strongest known in organic chemistry (Lemal, 2004). This strong bond create a molecule that is unreactive and resistant to chemical and biological breakdown (deSilva, 2019). Therefore, standard remediation technologies and biological activity have little to no effect on these molecules. Major known PFAS sources include fire training and response sites, industrial sites, landfills, and wastewater treatment plant effluent. Point source discharges and atmospheric transport (non-point sources) both contribute to PFAS distribution in the environment (ITRC, 2018).

The USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3) examined the occurrence of six different PFAS in drinking water nationwide. The finished water from all community water systems in the United States serving more than 10,000 people, and a

representative sample of 800 systems serving less than 10,000 people, were sampled. In Kentucky, 121 water systems with 165 drinking water sources were monitored under this rule for the occurrence of PFAS. Nationally, 4% of public water systems reported detections of PFAS while Kentucky had detections in 1.82% of sampled sources. Nationally, detections in drinking water were associated with numerous potential sources of PFAS, including industrial sites, areas where fire training with AFFF occurred, and wastewater treatment facilities (ITRC, 2018).

On May 19, 2016, the USEPA issued drinking water lifetime health advisories (HA) for two PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). The HA level is 0.07 µg/L for PFOA, and 0.07 µg/L for PFOS (or 70 ng/L). EPA further recommends that when these two chemicals co-occur at the same time and location in a drinking water source, a conservative and health-protective approach would be to compare the sum of the concentrations ([PFOA] + [PFOS]) to the HA (0.07 µg/L). Lifetime health advisories are not drinking water standards (MCLs or Treatment Technology) but may be used for developing local standards. In addition, the HA is being utilized as a screening level of public and private drinking water. USEPA is also proposing to use the HA as a remediation goal for PFAS-contaminated groundwater being used for consumptive purposes. The USEPA has not established health advisories for the other PFAS at this time.

Previous Research in Kentucky

The Department for Environmental Protection (Department) conducted an examination of the occurrence of PFAS in a representative sample of Kentucky's public drinking water in 2019. Samples of finished (treated) water were collected and analyzed from 81 community public drinking water treatment plants (WTPs), representing 74 public drinking water systems. Sampling sites were chosen to represent surface water (43 WTPs) and groundwater (38 WTPs) supplies, urban and rural land-use influence, and varying sizes of populations served. Source waters for the WTPs sampled include each of Kentucky's major river basins, the main stem of the Ohio River, and major aquifers in the state. Table 1 summarizes the PFAS analyzed in that study.

Table 1. PFAS Analyzed in the 2019 Drinking Water Study

Analyte	Acronym	CAS Number
Perfluorobutanesulfonic acid*	PFBS	375-73-5
Perfluoroheptanoic acid*	PFHpA	375-85-9
Perfluorohexanesulfonic acid*	PFHxS	355-46-4
Perfluorononanoic acid*	PFNA	375-95-1
Perfluorooctanesulfonic acid*#	PFOS	1763-23-1
Perfluorooctanoic acid*#	PFOA	335-67-1
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6

*Indicates PFAS analyzed in UCMR3.

#Indicates PFAS for which EPA has issued a Health Advisory

PFAS were detected at 41 of the 81 water treatment plants, the majority of which represent surface water sources. All detections of PFAS were below the EPA Health Advisory of 70 ng/L. One or more PFAS were detected at 31 surface WTPs (72%) and 10 groundwater WTPs (26%). Drinking water systems that utilize surface water from the Ohio River manifested the highest PFAS detection rate and those in the Kentucky River Basin had the second highest detection rate. Surface water systems in the Big Sandy, Cumberland, Green, Licking and Salt river basins had very few or no PFAS detections. Drinking water systems using groundwater from the Ohio River alluvial aquifer as their source had the highest detection rate for systems using groundwater. Only one PFAS detection was found in drinking water systems utilizing the Mississippi Embayment aquifers. No PFAS were detected in groundwater systems using Pennsylvanian Sandstone or the Tennessee River alluvial aquifers.

The most frequently detected analyte was PFOS, which was identified in 33 of 81 (41%) samples. This was followed by PFOA, which was detected in 24 of 81 (30%) samples. The highest concentration of any PFAS detected was HFPO-DA at 29.7 ng/L. ADONA was not detected in any samples. All samples were collected by Department staff and were analyzed by the Department's Division of Environmental Program Support (DEPS) laboratory. The map in Figure 1 shows results for the WTPs sampled in the previous study.
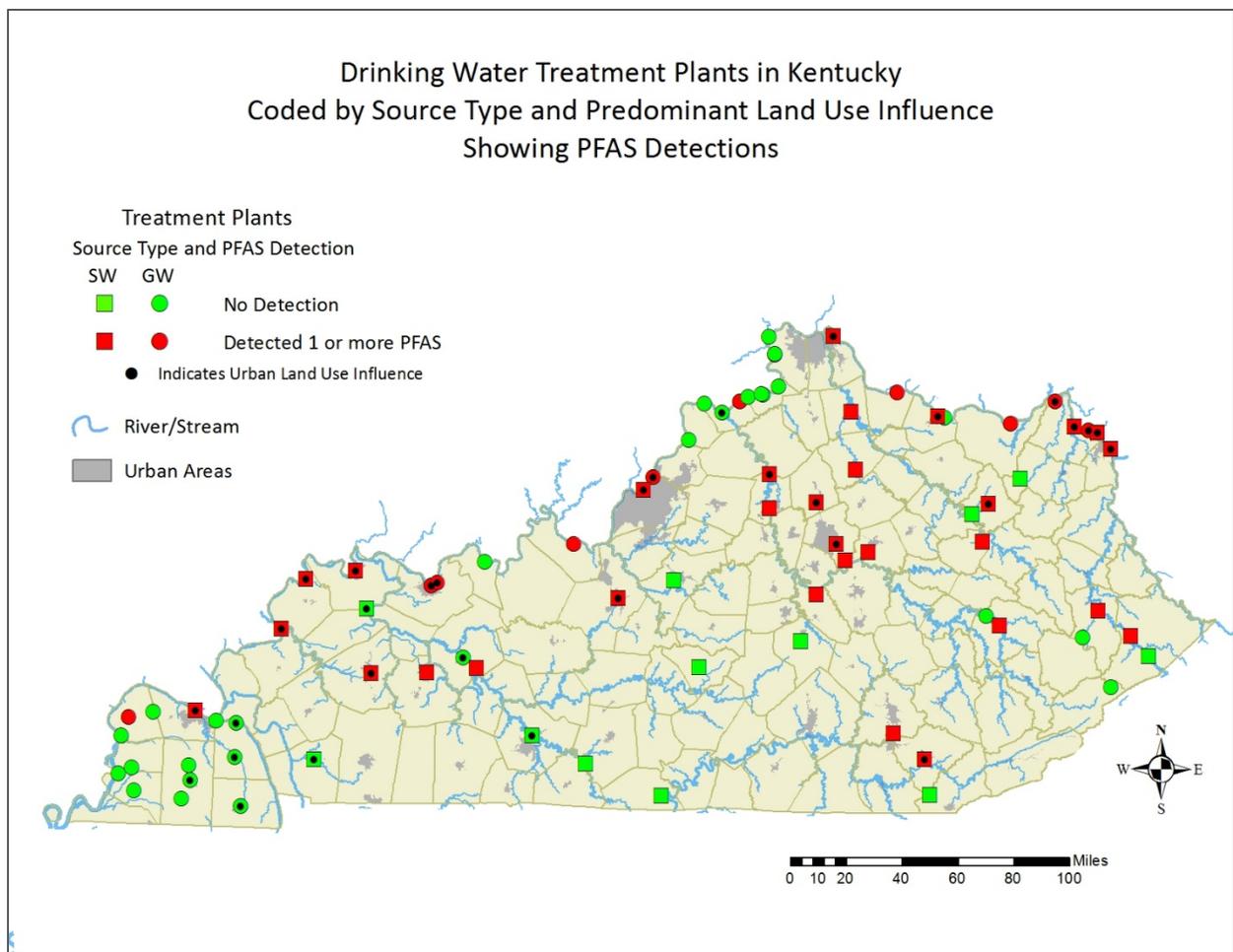
Figure 1. PFAS Detections at WTPs in 2019 Drinking Water Study

Purpose and Scope

The Department's evaluation of drinking water for PFAS occurrence was the first proactive step to characterize the risk of exposure associated with these chemicals. That study included numerous water systems that do not currently utilize treatment technology to remove these chemicals. Therefore, those results are an indicator of ambient PFAS concentrations within portions of those source waters. This is especially true for the drinking water systems that use groundwater as their sources because treatment requirements are not as stringent.

The next phase of this proactive approach is a broader evaluation of Kentucky's water resources for the occurrence of PFAS. Water resources include all of the waterways, waterbodies, and aquifers in the Commonwealth that contribute to drinking water and may be used for commercial, industrial, or recreational activities. This will expand our knowledge of the occurrence of PFAS in Kentucky's water resources. Additionally, it will alert the Department to any potentially problematic areas that may require further investigation.

4

While the scope of study is statewide, a limited number of locations were selected for monitoring in each major river basin of Kentucky. The selection of sites for sampling was determined based on several factors that include the costs associated with sample collection and analyses, laboratory capacity, the rigorous sample collection protocols, and data gaps from the previous study.

Objectives

This study had three main objectives:

- The primary objective of this study was to evaluate Kentucky's water resources for the occurrence of PFAS.
- The second objective was to identify watersheds that have confirmed or potential PFAS contamination.
- The third objective was to use the results of this limited study to approximate the potential for PFAS occurrence in Kentucky's water resources that have not yet been evaluated, which can inform planning for future monitoring efforts.

These objectives were pursued using the methods described below.

Materials and Methods

An adequate sampling strategy must address the paucity of PFAS data for Kentucky's waters. Because these chemicals are not currently regulated, no definitive listing of sites in Kentucky that potentially store or use PFAS exists. Therefore, a systematic assessment of water resources is a reasonable approach to continue evaluating the occurrence of PFAS in Kentucky. Monitoring stations for this study were identified using a deterministic approach, based in part on their potential to reveal the presence of PFAS. This approach allowed for coverage of waters across the state in key locations, such that results can be used to inform the need for follow up investigations.

The Department's previous study of PFAS occurrence in drinking water included 38 drinking water systems that use groundwater as their sources. The samples collected from these 38 water treatment plants (WTP) using groundwater generally characterized the occurrence of PFAS in Kentucky's primary aquifers. This is because none of those WTPs are known to utilize treatment technology specifically to remove PFAS, thus providing a snapshot of ambient conditions relative to the occurrence of these chemicals in those aquifers. Considering the knowledge gained from this previous research, groundwater was excluded from this second phase of PFAS study. Therefore, the evaluation of Kentucky's water resources for PFAS occurrence in this study focused on surface water monitoring stations.

The 40 surface water stations selected to monitor for the occurrence of PFAS are summarized in Table 2, below. These sites are largely drawn from established surface water monitoring stations from various programs, located in the necessary stream reaches. A few of these sites were not previously established by other monitoring programs. The selected sites

represent various sized streams and rivers across Kentucky, along with the associated variation in drainage areas. Each monitoring station was sampled only once as part of this study. Because of this limited sampling, this is considered a cursory study for the absence or presence of PFAS.

All samples were collected by Department personnel and followed the protocols outlined in the Department's Standard Operating Procedure for PFAS sample collection. The Department field staff had previous experience collecting PFAS samples, keeping training needs to a minimum. All samples were analyzed by the DEPS Laboratory using both the non-potable water PFAS analysis method (SW 846 Method 8327) and the drinking water PFAS analysis method (Method 537.1). A Quality Assurance Project Plan was developed and approved for this study. All quality assurance documents are included as appendices to this report.

Table 2. PFAS Monitoring Stations

LOCATION NAME	MAJOR RIVER	COUNTY	LATITUDE	LONGITUDE
Big Sandy River	BIG SANDY R	Boyd	38.404387	-82.595900
Levisa Fork	BIG SANDY R	Floyd	37.613282	-82.727148
Levisa Fork	BIG SANDY R	Pike	37.406980	-82.443260
East Fork Little Sandy River	BIG SANDY R	Greenup	38.474656	-82.760696
Little Sandy River	BIG SANDY R	Greenup	38.490460	-82.834180
Quarles Spring Branch	CUMBERLAND R-LOWER	Christian	36.664020	-87.524323
West Fork Red River	CUMBERLAND R-LOWER	Christian	36.651642	-87.377656
Big South Fork Cumberland River	CUMBERLAND R-UPPER	McCreary	36.699838	-84.536910
Cumberland River	CUMBERLAND R-UPPER	Knox	36.835800	-83.811980
Laurel River	CUMBERLAND R-UPPER	Laurel	37.059510	-83.998800
Sinking Creek	CUMBERLAND R-UPPER	Pulaski	37.050133	-84.603198
Barren River	GREEN R	Warren	37.017986	-86.472211
Buck Creek	GREEN R	McLean	37.510696	-87.159354
Elk Creek	GREEN R	Hopkins	37.385670	-87.412250
Muddy Creek	GREEN R	Ohio	37.434840	-86.885780
Pond River	GREEN R	Muhlenberg	37.317286	-87.369112
South Fork Beaver Creek	GREEN R	Barren	36.980640	-85.968190
Valley Creek	GREEN R	Hardin	37.639785	-85.907583
West Fork Drakes Creek	GREEN R	Simpson	36.773900	-86.541900
Bailey Run	KENTUCKY R	Anderson	38.035106	-84.842469
Harts Fork	KENTUCKY R	Madison	37.678858	-84.278292
North Elkhorn Creek UT 66.0	KENTUCKY R	Fayette	38.085800	-84.356100
North Fork Kentucky River	KENTUCKY R	Breathitt	37.534211	-83.348110
South Elkhorn Creek	KENTUCKY R	Woodford	38.160158	-84.643566
Walnut Meadow Branch	KENTUCKY R	Madison	37.593586	-84.324318
West Hickman Creek	KENTUCKY R	Jessamine	37.934467	-84.502258
North Fork Triplett Creek	LICKING R	Rowan	38.209213	-83.467257
South Fork Licking River	LICKING R	Harrison	38.378386	-84.303790
Mayfield Creek	MISSISSIPPI R	Graves	36.856035	-88.633462
Canoe Creek @ Rocks Rd	OHIO R	Henderson	37.817069	-87.611276
Canoe Creek @ S. Collier Ln	OHIO R	Henderson	37.803756	-87.627920
Casey Creek	OHIO R	Union	37.714444	-87.767825
Gunpowder Creek	OHIO R	Boone	39.026369	-84.679456
Otter Creek	OHIO R	Meade	37.930396	-86.028661
Beech Fork	SALT R	Nelson	37.796641	-85.480542
Brashears Creek	SALT R	Shelby	38.139147	-85.301787
Duck Spring Branch	SALT R	Jefferson	38.153660	-85.742200
Floyds Fork	SALT R	Jefferson	38.098492	-85.560207
Clarks River @ Sheenan Bridge	TENNESSEE R	McCracken	36.995971	-88.563001
Cypress Creek	TENNESSEE R	Marshall	37.029583	-88.412982

Results and Discussion

The eight unique PFAS that were analyzed in each of these samples are summarized in the Table 3. These are the same analytes as the 2019 PFAS Drinking Water study. All samples were analyzed by the DEPS Laboratory, using both the non-potable water analysis method (SW 846 Method 8327) and the drinking water analysis method (Method 537.1). The primary difference between these two analytical methods is the MDL. The non-potable water analysis method was developed for turbid waters and has MDLs of 20 – 40 nanograms per liter (ng/L or parts per trillion). The drinking water analysis method was developed for treated drinking water, which has extremely low turbidity, and has MDLs of approximately 1.0 ng/L. While difficult, the DEPS Lab has been able to adapt the drinking water analysis method to surface water samples, which allows for the detection of low-level PFAS concentrations for the current study. Table 3 summarizes the PFAS analyzed in each sample and the associated MDLs for each analytical method.

Table 3. PFAS analyzed and Method Detection Limits (MDL)

Analyte	Acronym	CAS Number	DW-MDL (ng/L)	NP-MDL (ng/L)
Perfluorobutanesulfonic acid*	PFBS	375-73-5	1.09	40
Perfluoroheptanoic acid*	PFHpA	375-85-9	0.875	40
Perfluorohexanesulfonic acid*	PFHxS	355-46-4	0.875	40
Perfluorononanoic acid*	PFNA	375-95-1	0.875	40
Perfluorooctanesulfonic acid*#	PFOS	1763-23-1	0.875	40
Perfluorooctanoic acid*#	PFOA	335-67-1	0.875	40
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	0.875	20
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	1.09	40

*Indicates PFAS analyzed in UCMR3. #Indicates PFAS for which EPA has issued a Health Advisory.
DW-Drinking Water Analysis Method; NP-Non-potable Water Analysis Method.

The following data review and discussion are based primarily on results of the drinking water analysis method samples. The lower detection limits associated with this analytical method provide a better indication of PFAS occurrence across a broader spectrum of concentrations. While not reported or summarized, the non-potable water analysis method results were reviewed to ensure consistency and data quality. The DEPS laboratory PFAS Data Assessment located in Appendix E describes the quality assurance measures and confidence in results for each analytical method. Utilizing the drinking water method results was determined appropriate based on the laboratory's assessment of quality assurance and confidence in both analytical methods, and the similarity of result values between the two methods. However, please note that due to much higher MDLs in the non-potable water method, there are far fewer analyte detections. All data for each analysis method are available in Appendix D.

Statewide Results

PFAS were detected at 36 of the 40 (90%) monitoring stations, and were found within each of the major river basins of Kentucky. However, detections were generally low. The most frequently detected PFAS was PFOS, which was found at 34 monitoring stations. This was followed closely by PFOA, which was found at 31 monitoring stations. The highest single detection was PFOS, which was found at 249 ng/L

at one of the monitoring stations in the Cumberland River Basin, in Christian County. The next highest detection was PFHxS, which was found at 135 ng/L at the same monitoring station. Three monitoring stations had PFOS greater than 70 ng/L. The only PFAS not detected in any sample was ADONA.

Although PFAS were detected at the majority of monitoring stations, roughly 85% of the detections were less than 5 ng/L. The four stations where no PFAS were detected are located in the Big Sandy River, Licking River and Cumberland River basins.

The table below summarizes results on a statewide basis, and the accompanying map in Figure 3 illustrates total PFAS concentrations at each monitoring station.

Table 4. PFAS Statewide Summary

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	21.8	8.29	47.1	135	ND	36.6	249	37.6
Median	1.575	ND	0.515	ND	ND	1.6	2.535	ND
# Detects	25	2	20	19	0	31	34	15
# Detects > 70	0	0	0	1	0	0	3	0

Max and Median values in ng/L; ND = Not Detected
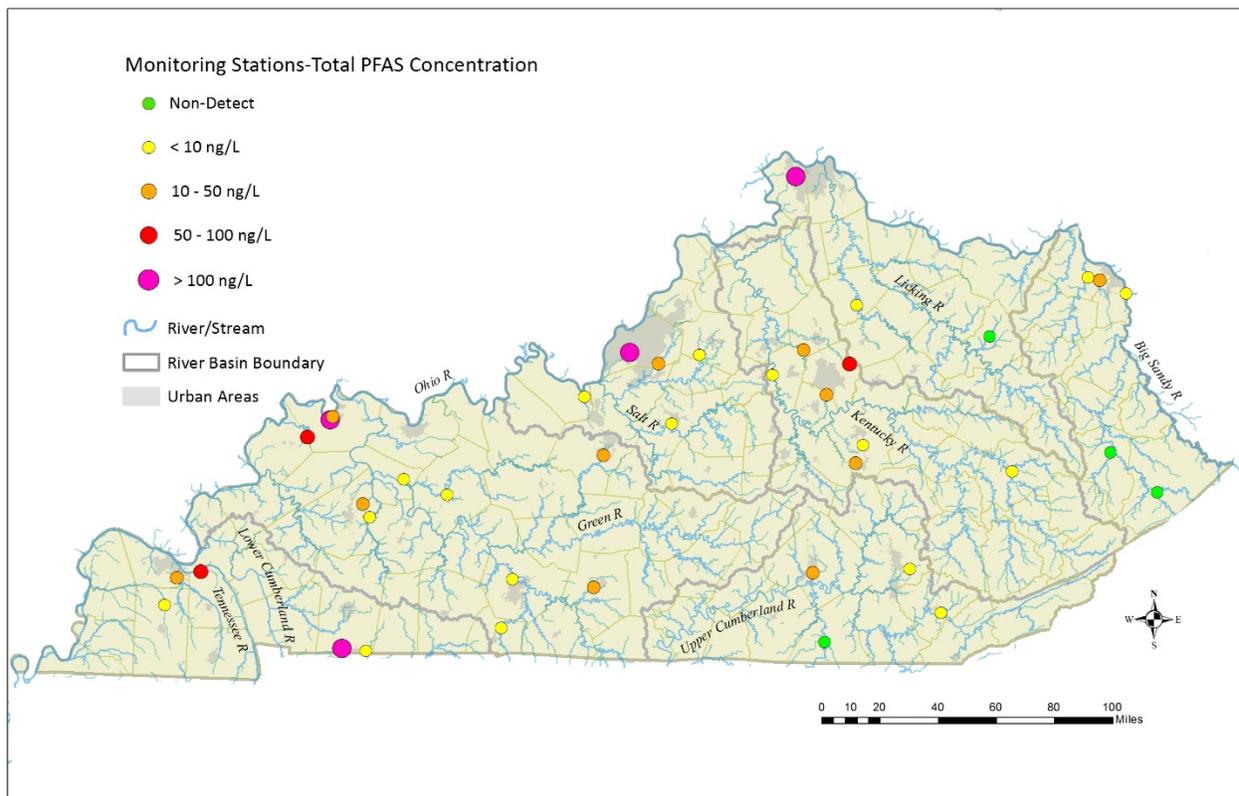
Figure 2. Statewide Total PFAS Concentrations

The sample results are grouped by major river basin for discussion and summary. Monitoring stations on minor tributaries that drain directly into a major river such as the Ohio River, Tennessee River, or Mississippi River are grouped together for discussion and summary.

Big Sandy River Basin

The five monitoring stations in the Big Sandy River basin represent stream segments with catchment areas ranging from 140 mi^2 to 4288 mi^2. These monitoring stations showed very few detections and very low concentrations, with PFAS detected at three of the five sites. The most frequently detected PFAS was PFOA, which was detected at three of the monitoring stations. The highest PFAS concentration in the basin was for PFOA, which was found at 4.1 ng/L in the East Fork Little Sandy River. The East Fork Little Sandy River also had the most detections, with six PFAS found in that sample. It is noteworthy that the Levisa Fork was sampled in two locations (Pike and Floyd counties) and had no PFAS detections at either station. These results are summarized in Table 5.

Table 5. Big Sandy River Basin PFAS Summary.

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	1.36	3.34	1.36	1.27	ND	4.1	2.3	ND
Median	ND	ND	ND	ND	ND	1.01	ND	ND
# Detects	1	1	1	1	0	3	2	0

Max and Median values in ng/L; ND = Not Detected

Cumberland River Basin

The six monitoring stations in the Cumberland River Basin represent both the upper and lower sections in Kentucky. The catchments draining the monitored stream reaches range from 7.5 mi^2 to 1,018 mi^2. There were PFAS detections at five out of the six stations in the Cumberland River Basin. These detections were generally low-level, except for those at Quarles Spring Branch in Christian County. The most frequently detected PFAS was PFOS, which was found at five of the six stations. The highest PFAS concentration was PFOS, which was detected at 249 ng/L in Quarles Spring Branch. This was followed by PFHxS, which was detected at 135 ng/L at the same station. Quarles Spring Branch also had the most numerous detections, with six PFAS found in that sample. There was one monitoring station, Big South Fork Cumberland River in McCreary County, where no PFAS were detected. These results are summarized in Table 6.

Table 6. Cumberland River Basin PFAS Summary

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	13.7	ND	12	135	ND	13.4	249	1.29
Median	1.6	ND	ND	2.31	ND	1.36	3.6	ND
# Detects	3	0	2	3	0	4	5	1

Max and Median values in ng/L; ND = Not Detected

Green River Basin

The eight monitoring stations in the Green River Basin represent stream segments with catchment areas ranging from 19 mi^2 to 1,854 mi^2. PFAS were detected at all eight of these monitoring stations. The most frequently detected PFAS was PFOS, which was found at all monitoring stations. This was followed by PFOA and PFBS, which were each found at seven of the monitoring stations. All PFAS detections were less than 5 ng/L and the highest PFAS concentration found in the Green River Basin was PFBS at 4.73 ng/L. The two monitoring stations with the highest number of PFAS detections were South Fork Beaver Creek (Barren Co.) and Valley Creek (Hardin Co.), each with six PFAS detected. These results are summarized in Table 7.

Table 7. Green River Basin PFAS Summary

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	4.73	ND	2.47	1.2	ND	4.17	3.75	2.85
Median	2.21	ND	1.27	ND	ND	1.25	2.37	1.22
# Detects	7	0	4	2	0	7	8	4

Max and Median values in ng/L; ND = Not Detected

Kentucky River Basin

There were seven monitoring stations in the Kentucky River Basin with catchment areas that range from 0.5 mi^2 to 1,098 mi^2. PFAS were detected at all monitoring stations in the Kentucky River Basin. The most frequently detected PFAS was PFOS, which was found at all seven stations. This was followed by PFOA, which was found at six stations. The highest concentration detected was PFOA, which was found at 31.2 ng/L in an Unnamed Tributary to North Elkhorn Creek in Fayette County. At that station a total of six PFAS were detected, and four of those detections were over 10 ng/L. These results are summarized in Table 8.

Table 8. Kentucky River Basin PFAS Summary

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	14.3	ND	20.4	14	ND	31.2	20.5	2.4
Median	3.2	ND	1.35	2.3	ND	3.25	5.63	ND
# Detects	5	0	5	5	0	6	7	1

Max and Median values in ng/L; ND = Not Detected

Licking River Basin

There were only two monitoring stations in the Licking River Basin, and their catchment areas are 71 mi^2 and 621 mi^2. One of those stations, South Fork Licking River, had two very low-level PFAS detections. The other, North Fork of Triplett Creek, had no PFAS detections. PFOA and PFOS were the only PFAS detected. These results are summarized in Table 9.

Table 9. Licking River Basin PFAS Summary

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	ND	ND	ND	ND	ND	1.82	3.12	ND
Median	ND	ND	ND	ND	ND	ND	ND	ND
# Detects	0	0	0	0	0	1	1	0

Max and Median values in ng/L; ND = Not Detected

Salt River Basin

There were four monitoring stations in the Salt River Basin with catchments ranging from 0.8 mi^2 to 674 mi^2. PFAS were detected at each monitoring station. The most frequently detected PFAS were PFOA and PFOS, which were found at three of the monitoring stations. The highest concentration found was PFOS at 95.1 ng/L, which occurred at Duck Spring Branch in Jefferson County. Duck Spring Branch also had the highest number of PFAS detections, with six analytes found in that sample. The other three sites showed only minor PFAS detections. These results are summarized in Table 10.

Table 10. Salt River Basin PFAS Summary

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	6.35	ND	17.6	46.3	ND	13.8	95.1	2.85
Median	4.31	ND	1.58	1.33	ND	3.42	6.64	1.39
# Detects	2	0	2	2	0	3	3	2

Max and Median values in ng/L; ND = Not Detected

Minor Tributaries to Major Rivers

These eight stations were located in streams that drain directly to either the Ohio, Tennessee or Mississippi rivers. These streams are located between Boone County and McCracken County and their catchments range from 2.7 mi^2 to 547 mi^2. The monitoring stations in this group showed the most frequent PFAS detections and some of the highest concentrations. The most frequently detected PFAS was PFOS, which was found at all eight stations. This was followed closely by PFOA, PFNA and PFBS, which were each detected at seven of the stations. The highest single concentration detected was PFHxS, which was found at 133 ng/L in Gunpowder Creek in Boone County. Table 11 summarizes the results for these monitoring stations.

Table 11. Minor Tributaries PFAS Summary

	PFBS	HFPO-DA	PFHpA	PFHxS	ADONA	PFOA	PFOS	PFNA
Max	21.8	8.29	47.1	133	ND	36.6	100	37.6
Median	2.465	ND	4.64	1.365	ND	5.74	5.185	3.455
# Detects	7	1	6	6	0	7	8	7

Max and Median values in ng/L; ND = Not Detected

Conclusion

In this study, 40 surface water monitoring stations were each sampled one time during the course of two months in the summer of 2020. These results, combined with those from the previous drinking water study, are part of a cursory evaluation of Kentucky's waters for PFAS occurrence. Catchment areas for the monitoring stations ranged from 0.8 mi^2 to 4288 mi^2. Monitoring stations were located in each of the major river basins in Kentucky, and several stations represented minor tributaries to major rivers.

PFAS were detected at 36 of the 40 (90%) monitoring stations, and were found within each of the major river basins of Kentucky. However, concentrations were generally low, and 85% of the detections were less than 5 ng/L. The most frequently detected PFAS was PFOS, which was found at 34 monitoring stations. This was followed closely by PFOA, which was found at 31 monitoring stations. The highest single detection was PFOS, which was found at 249 ng/L at one of the monitoring stations in the Cumberland River Basin in Christian County. The next highest detection was PFHxS, which was found at 135 ng/L at the same monitoring station. The only PFAS not detected in any sample was ADONA. The four stations where no PFAS were detected are located in the Big Sandy River, Licking River and Cumberland River basins.

Although the utility of these one-time samples is limited largely to determining presence and absence of PFAS on the day sampling occurred, they provided the means to achieve project goals. The primary objective of this study was to evaluate Kentucky's water resources for the occurrence of PFAS. This has been accomplished, and by combining these results with the previous study, the knowledge of PFAS occurrence has been expanded. The second objective was to identify watersheds that have confirmed or potential PFAS contamination. While the presence of PFAS represents contamination at some level, only 10% of the monitoring stations displayed total PFAS concentrations greater than 100 ng/L. However, these one-time samples do not account for temporal and hydrologic variations, which are important considerations for water quality evaluation. The third objective was to use the study results to approximate the potential for PFAS occurrence in Kentucky's water resources that have not yet been evaluated. While the data are insufficient for statistical analysis, the results show that there is potential for PFAS occurrence within other Kentucky waterways that have not been evaluated. The results of this study will be used to guide the Department's planning and decision making for further PFAS monitoring.

References

Interstate Technology and Regulatory Council, 2018, PFAS page:
https://www.itrcweb.org/Team/Public?teamID=78

deSilva, V., 2019, Groundwater Protection from PFAS Contamination, Groundwater Protection
   Council 2019 Annual Forum, Oklahoma City, OK.

KY Department for Environmental Protection, 2019, Evaluation of Kentucky Community
   Drinking Water for Per- & Poly-Fluoroalkyl Substances, Frankfort, KY.

Lemal, D.M., 2004, Perspective on fluorocarbon chemistry, Journal of Organic Chemistry,
   Volume 69, American Chemical Society, Columbus, OH, p 1-11.

US Environmental Protection Agency, 2018, https://www.epa.gov/pfas

Appendices

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