WOMEN *for a Healthy* ENVIRONMENT

Three Rivers, Fifteen PFAS:

Assessing the Influence of Wastewater Effluent on Surface Water Contamination with Per- and Polyfluoroalkyl Substances (PFAS) in Pittsburgh's Three Rivers

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Preface

The following report analyzes the data collected by Women for a Healthy Environment to determine if and how our wastewater treatment systems are contaminating Pittsburgh's three rivers with per- and polyfluoroalkyl substances (PFAS). Of the 24 major wastewater treatment plants (WWTPs) in Allegheny County, we selected three who discharge directly into the Allegheny, Monongahela, and Ohio Rivers. We collected samples from the upstream of their outfalls and from the mixing zone, where the discharge undergoes its initial dilution with the stream (Pennsylvania Department of Environment Protection; Alaska Department of Environmental Conservation, Division of Water). We were able to provide a preliminary report of the amount PFAS that is polluting our ambient surface water from this waste stream so that we can better understand this issue.

PFAS are a class of chemicals that have been in use since the 1960s, but widespread attention and concern has only emerged in recent years.

PFAS are a class of chemicals that have been in use since the 1960s, but widespread attention and concern has only emerged in recent years. PFAS enter the environment and our bodies due to their use in various industries such as Class B aqueous film-forming foam (AFFF) and consumer products, which then pollute the environment directly and through our waste infrastructure (landfills, WWTPs) (Sunderland, et al., 2019). A new study from the U.S. Geological Survey, sampling of tap water from both public supplies and private wells, estimated that 45% of the tap water in the U.S. contains a detectable level of at least one PFAS (Smalling, et al., 2023). PFAS exposure is associated with a wide range of health effects including compromised immune system function, some cancers, reproductive health and developmental effects, thyroid disease, liver damage, digestive conditions, and more (Fenton, et al., 2021). This means that PFAS are increasingly permeating our environment and require fast, thorough action to be removed from our supply chain, waterways, and our environment.

We chose to collect samples to test for PFAS upstream and in the mixing zone of the wastewater discharge sites to fill the gap in the lack of data collection on behalf of the state and federal government. Other states, like Michigan, have begun sampling their wastewater effluent for PFAS to collect data and understand where the contamination is coming from (Bogdan, et al., 2021). While the Pennsylvania Department of Environmental Protection (DEP) partnered with the U.S. Geological Survey (USGS) to test the state's surface water for PFAS in 2019, this was not targeted to detect up and downstream of any specific emitters of PFAS (US Geological Survey). This study was intended to provide a

45% of the tap water in the U.S. contains a detectable level of at least one PFAS.

survey of PFAS in Pennsylvania surface water but also identified land-use associations with PFAS contamination, which will be discussed in further detail later in the report (Breitmeyer, et al., 2023).

We designed our surface sampling to specifically target one of the many sources of PFAS in our region but want to convey that this is not the only or primary source of PFAS in our waterways. Many different industries use and emit PFAS into the environment; this sampling will only collect a subsection of this issue. We aim to measure the influence of WWTPs due to the widespread attention to PFAS in drinking water systems that has overlooked the upstream sources that result in drinking water contamination including our wastewater systems.

Our municipal wastewater systems are continually polluting our waterways, every second, with wastewater discharge that is not treated for PFAS.

Our study found that PFAS levels were far higher in samples collected from the mixing zone (where the wastewater effluent and stream mixed) compared to ambient surface water samples taken just upstream of the discharge site. This indicates that our municipal wastewater systems are continually polluting our waterways, every second, with wastewater discharge that is not treated for PFAS. While the specific source of the PFAS compounds that reach WWTPs are unclear and require further investigation. The potential sources include landfill leachate, consumer products, industrial wastewater, and more. Due to the pervasive nature of PFAS compounds even those removed from manufacture in the U.S. decades ago can still be detected in stream samples and effluent samples (Minnesota Department of Health, Health Risk Assessment Unit, 2019).

The purpose of this project is not to place blame on municipal wastewater systems; they were never designed to remove PFAS compounds during the treatment process.

Instead, this project sets out to demonstrate:

- A lack of data and knowledge being gathered by our government agencies
- A lack of understanding of the evolving issue of PFAS contamination
- The importance of shifting attention to prevention of environmental contamination rather than cleanup

We believe that the state and federal government must act to protect the public from the health risks of PFAS at the expense of the polluter and not the ratepayer.

Increased surveillance of our water quality and stopping PFAS contamination at its source, by restricting its use in manufacturing and consumer goods, is necessary to be able to meet the newly proposed standards and health advisories for drinking water. If we fail to fully understand the problem by failing to collect this data, we cannot act – if we do not act now the contamination of our water, air, soil, wildlife, and our bodies will only be more daunting of a task to remediate in the future.

Section 1: Introduction

The quality and quantity of our water supply faces many challenges, from climate change and its effects to widespread chemical contamination. PFAS contamination is one of those challenges that is gaining increasing attention as evidence of its environmental persistence and human health impacts mounts (Fenton, et al., 2021). For this reason, Women for a Healthy Environment decided to investigate one of the ways that the PFAS crisis is affecting Allegheny County.

Women for a Healthy Environment

Women for a Healthy Environment (WHE) is an environmental health nonprofit organization that looks to improve the health and safety of the environments in which we live, work, learn, and play. WHE "educates communities about environmental risks to human health, supplies action steps to mitigate those risks, and advocates for solutions to better protect the region. WHE serves parents, students, children, school and early learning personnel, as well as health and community-based organizations, with an emphasis on those living in underserved communities" (Women for a Healthy Environment, n.d.)

WHE has been working to improve the safety, quality, and transparency of our water systems in Southwest Pennsylvania for many years. This attention has focused on drinking water systems rather than wastewater. In 2021, WHE published the "Something's in the Water" report that evaluated the quality and transparency of the community water systems located in Allegheny County (Women for a Healthy Environment, 2021). With the knowledge gained from the report, WHE's interest in water quality and safety has expanded, looking at various threats to drinking water, including PFAS.

WHE has on-the-ground, community-engaged experience in PFAS contamination. In July 2021, aqueous film forming foam (AFFF), a type of firefighting foam that contains PFAS, back flowed through a fire hydrant into the drinking water supply of McKeesport's Lower 10th Ward. WHE became involved with the McKeesport community following this incident, supporting researchers from the University of Pittsburgh Swanson School of Engineering in a research project to assess the contamination and distributed ZeroWater filters to those affected. Through WHE's involvement in McKeesport our attention has shifted to understanding other ways our environment and bodies become contaminated with PFAS (Pitt Swanson Engineering Virtual Newsroom, 2023).

PFAS Contamination

Per- and polyfluoroalkyl substances (PFAS) are a chemical class of thousands of human-made chemicals found in a variety of consumer products and used in many industries. These chemicals have strong chemical bonds that prevent them from naturally degrading completely in the environment – this is why they are known as "forever chemicals."

Due to these unique chemical bonds, PFAS chemicals offer a variety of benefits in many applications. They are sometimes added intentionally to consumer products to give the product either waterproof, stain resistant, or non-stick qualities. PFAS can also exist unintentionally in products because of their use in the manufacturing process (Gluge, et al., 2020). Some uses of PFAS include Class B aqueous film forming foam (AFFF), electronic and chrome-plating, textile factories, chemical manufacturing, the oil and gas industry, and many types of consumer products. PFAS then spread through the environment when they are shed from products and are discharged in wastewater from commercial manufacturing, municipal wastewater system effluent, the land application of wastewater biosolids, landfill leachate, fracking waste, and more (Sunderland, et al., 2019). This makes PFAS challenging to contain and even more important to track and act proactively to eliminate from the supply chain and environment.

Once PFAS chemicals are in the environment, they get into our bodies by consuming contaminated water, food, and soil, and through inhalation of aerosolized PFAS chemicals shed from products. This is an area of ongoing research, but it is currently understood that in situations with very elevated levels in drinking water supply, the water is the primary exposure route of concern. When the water supply levels are not elevated, consumption of contaminated food is the primary route of concern (Sunderland, et al., 2019). This is why wastewater effluent is so important – often it is discharged into surface waterways that supply municipal drinking water and for irrigation and wastewater biosolids can be land applied contaminating the food chain, the water, and the soil (Mroczko, et al., 2022). Wastewater is also where industrial and household sources of PFAS converge to enter our environment, making it a critical point for intervention.

The health effects associated with PFAS exposure are widespread – immune system effects, cancer (kidney, testicular, and breast), reproductive health effects including elevated risk of miscarriage, developmental effects like changes to puberty onset, liver damage, thyroid disease, increased cholesterol levels, inflammatory bowel disease, and more (Fenton, et al., 2021). Given the pervasiveness of PFAS compounds, their capacity to persist in the environment and bioaccumulate in our bodies, and the myriad of health risks associated with the chemicals, it is critical that we act now to prevent further contamination and spreading of PFAS in our environment.

Section 2: Our Vision and Expectations for PFAS Policy

PFAS chemicals are critical, emerging contaminants that have been gradually spreading through our built and natural environments for decades, and an ever-expanding body of evidence shows significant human health impacts of PFAS. Over past decades, "legacy" PFAS chemicals like PFOA and PFOS have been substituted with newer PFAS substances – like GenX – which were purported to be less harmful to human health. Government agencies regulate PFAS as individual chemicals, with Maximum Containment Levels proposed for PFOA, PFOS, and others, but not for the entire class (US Environmental Protection Agency Office of Water, 2023). This means that many other PFAS chemicals exist in our products, industries, homes, soil, and water, without our understanding their impacts. This process continues, despite evidence mounting that these substances are likely as harmful as their predecessors, if not more harmful (National Toxicology Program U.S. Department of Health and Human Services). PFAS producers and users have known about the toxicity of legacy PFAS chemicals for decades and should not be trusted on claims of safety for new PFAS compounds (Richter, Cordner, & Brown, 2018).

WHE believes that responsible agencies should regulate PFAS as a class of chemicals and not as individual and distinct substances. Regulating individual chemicals (like we saw with the phase-out of PFOA and PFOS) will continue to allow for new, potentially equally, or more dangerous substances to replace them in the marketplace. If we continue to allow older PFAS to be replaced by new ones, this will only extend the process of cleaning up the environment and put more people at risk. These products should be removed from our supply chains and waste systems whenever feasible.

Keeping the Burden Off Public Utilities and Taxpayers

While we support the treatment of wastewater and drinking water to remove PFAS compounds, this is an extremely expensive and arduous task. The State of Minnesota commissioned a report to analyze the cost to clean PFAS out of the state's waste streams and destroy the chemicals and found it would cost an estimated $2.7 to $18 million per pound of PFAS, while the original purchase of the same amount of the chemicals is $50 to $1,000 per pound (Bar Engineering Co., Hazen and Sawyer, Minnesota Pollution Control Agency, 2023). This massive financial burden should not fall on the ratepayers of drinking water and wastewater treatment systems.

WHE believes that the cost of cleaning up PFAS should fall on those who profited from the creation and use of the chemicals, following the polluter-pays principle. Ratepayers and taxpayers already bear the burden of health expenses and loss of productivity caused by health conditions associated with PFAS exposure. A recent study estimates that the healthcare cost burden of just thirteen conditions associated with PFAS exposure is expected to cost from more than $5 to $60 billion in the lifetime of the current U.S.

population (Obsekov, Kahn, & Trasande, 2023). This is only a preliminary analysis with the current understanding of PFAS contamination in the U.S. and its health effects and will continue to grow as our knowledge grows.

Given that the people already bear the brunt of this expense, in health, safety, and cost, the cleanup of PFAS from our environment to protect our health and safety should come at the expense of those who polluted it.

Section 3: Methods

Purpose

To demonstrate the necessity of increased ambient surface water surveillance and wastewater treatment plant discharge surveillance, we collected our own samples from the three major rivers in Allegheny County near three different wastewater treatment plants (WWTPs). While states can build broad expanses of data on surface water contamination and require testing of wastewater treatment facility effluent through the NPDES permit program Pennsylvania has not taken any of these approaches. Though there is increased state and federal attention to the public health and environmental health threat of PFAS contamination it is insufficient to prevent further exacerbation of the problem. Pennsylvania does not require WWTPs to test their effluent, leaving a critical knowledge gap. The first step to addressing PFAS contamination is understanding the extent of the threat; this sampling study is intended to start to fill that gap.

Site Selection

First, we reviewed NPDES permits for sewage treatment plants to find the wastewater treatment facilities existing in Allegheny County. Of these we found 24 major WWTPs – meaning those with a flow of at least one million gallons per day. We only looked at major facilities because those are the ones emitting a large enough volume of water and are more likely to have the greatest influence on the levels of contaminants in Pittsburgh's rivers. Next, this was narrowed down by how they discharge into the rivers. Most of these wastewater facilities discharge into tributaries that may or may not lead to the three rivers but Allegheny County Sanitary Authority (ALCOSAN), McKeesport Wastewater Treatment Plant, Oakmont Wastewater Treatment Plant, and Allegheny Valley Joint Sewage Authority (AVJSA) all directly discharge into one of the three rivers (see Figure 1).

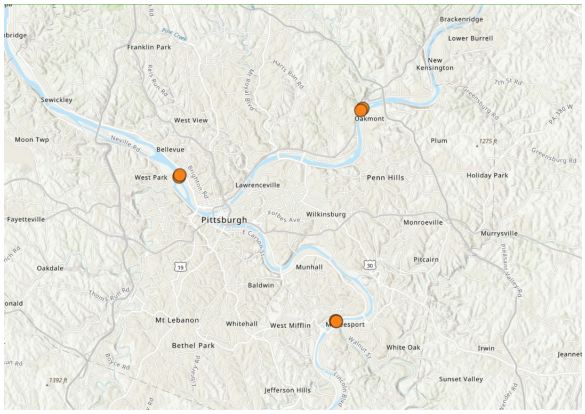

Figure 1 Map displaying the 3 WWTP sample sites. Orange markers represent the two samples collected from each site (made using ArcGIS).

We chose to sample upstream (approximately 15 meters upstream from the mixing zone in the midstream column) and at the mixing zone outfalls for each of these plants where we could visibly find the wastewater outfalls and mixing zones ALCOSAN, McKeesport, and AVJSA to assess if there is an elevated level of PFAS following the river. Upstream samples were collected approximately 15-20 meters upstream, in the middle of the river, to collect an ambient sample. Mixing zone samples were collected approximately 5-10 meters from the outfall, depending on the volume and speed of the water and the location of the mixing zone. Thanks to support from Three Rivers Waterkeeper, we were able to use their boats and kayaks to collect these samples from the direct mixing zone and upstream to give the best characterization of the amount of PFAS contaminating surface water from wastewater treatment facility discharge.

Hypotheses: We predict that the concentration of PFAS in the water will be elevated in the mixing zone of the wastewater discharge site compared to the upstream samples. This is due to industrial waste, potential landfill leachate, humans shedding PFAS from their bodies, PFAS-containing personal care and cleaning products going down the drain, and from PFAS-containing refuse that can enter a combined sewer system (Sunderland, et al., 2019).

Sampling Procedure

To decide the sampling method, we consulted guidelines for field water quality testing in surface waters and for PFAS testing guidelines for several states and commonwealths (PA, MA, ME, and MI) to decide the proper protocol. This required special attention to PFAS sampling-specific guidelines to avoid cross-contaminating samples with PFAS. Standard practices for collecting the samples were decided by consulting these guidelines and by consulting PFAS and sampling experts from Carnegie Mellon University and University of Pittsburgh.

We used a powder-free nitrile-gloved hand to collect a sample from beneath the surface interface. The high-density polyethylene (HDPE) bottles were triple-washed and rinsed with deionized water and methanol before being used to collect the sample. The bottle was dipped, filled, and emptied thrice, before the fourth fill from which the sample was collected. The sample was then poured into the Cyclopure test kit for processing.

Figure 2 Samples collected from AVJSA.

Samples were collected from below the surface interface via HDPE bottle instead of a surface dip because it is important to mitigate surface interface contamination. Surface water will have elevated levels of PFAS compared to the rest of the ambient water source due to the microscopic aquatic life at the surface that will have concentrated PFAS levels, as well as the interaction between the air and water (PFAS particles in aerosolized particles settling in the water) (Costanza, Arshadi, Abriola, & Pennell, 2019). To gather an accurate measure of the ambient surface water levels of PFAS, samples must be collected from at least several inches below the interface.

To determine the potential contamination due to sampling and laboratory analysis, one field blank (Cyclopure test conducted using deionized, PFAS-free water) was included and analyzed alongside the water samples. In addition, one duplicate was conducted to verify our results. The duplicate was collected from the ALCOSAN outfall since that sample was collected from a boat and allowed for easier collection.

It is important to note variances in the sampling procedure before discussing the results. The sample from ALCOSAN was collected from a motorized boat, in the immediate mixing zone. The samples from AVJSWA and McKeesport were also collected as close as possible

to the outfall in the mixing zone, but with limitations because they were collected by kayak. Sampling conditions were controlled as strictly as possible, given the constraints due to collecting samples from a boat in fast-moving water.

Ideally, we would also collect sucralose testing, which effectively acts as a wastewater effluent tracer. However, since we had the ability to sample from the water, thanks to support from Three Rivers Waterkeeper, we were able to collect samples from boats on the river rather than the nearest public access, making our ability to test much more effective and efficient. Since we were able to get closer to the outfalls, the necessity of sucralose testing was less imperative.

Testing Procedure: Cyclopure

The use of the Cyclopure test kits simplified the process for storing and transporting samples to the laboratory. Since these novel test kits extract the PFAS on site this process was completed and the devices were sent back following the directions, without requiring ice or refrigeration, and at a much lower cost. The Cyclopure lab tested our samples for 55 PFAS compounds, including 21 PFAS precursors and all PFAS compounds listed under the EPA Methods 533, 537, and 1633 draft. The lab established their methods according to these EPA methods with modifications and validated the results of their testing product to the EPA methods (Cyclopure, n.d.). This, in addition to their convenience and affordability, is why WHE selected to use this testing option.

Figure 3 Cyclopure test filtering through. The sample from the HDPE bottle was poured into the Cyclopure collection cup to filter through the Dexsorb pad, which extracts PFAS from the water.

Analysis Methods

Our entire process – from site selection to data analysis – utilized existing and relevant data sources including the ArcGIS map shared by the Public Herald showing where fracking waste was discharged, the Environmental Working Group's PFAS Interactive Map, viewing the data collected by the 2019 U.S. Geological Survey, and the Pennsylvania Department of Environmental Protection surface water sampling for PFAS, and using EPA's PFAS Analytic Tools and EJScreen.

Figure 4 Environmental Working Group's map of suspected industrial discharges of PFAS. The WWTPs that we sampled (green dots) are circled in yellow (Environmental Working Group n.d.).

The Environmental Working Group's map of suspected industrial discharges of PFAS was one of the original ways that we identified the WWTPs (the green dots that are circled in Figure 4) (Environmental Working Group). We know that WWTPs are a source of PFAS and wanted to characterize just how much of an influence they may have. All these potential emitters of PFAS located in proximity may complicate our samples but also may help us to understand them. This is a crucial data resource we will use to situate our sample results in the broader context of the river systems and the surrounding past and current potential users of these compounds.

Another important data comparison source is the Public Herald's map of how radioactive materials found in fracking waste reach our waterways (Figure 5) (Pribanic, 2019). We found this data to be relevant to our project because we were interested in how the use of PFAS chemicals in fracking may also contaminate our waterways or contribute to the PFAS coming out of WWTPs (Horwitt, 2021). While none of the WWTPs we sampled have confirmed receipt of fracking waste, they reside on a river that clearly has numerous point sources of hazardous waste entering our waterways. This also helps us to understand how the movement of waste from landfills ends up in municipal wastewater systems when the landfill leachate is sent there to be treated. Municipal WWTPs are critical point sources because they are the convergence of multiple waste streams and supply chains that contain PFAS. The blue dots in Figure 5 are approximations for drinking water supply locations. This is important because we see that our WWTPs of focus (circled in yellow) all discharge upstream of our drinking water supply. This is critical to understand given the rapidly expanding attention paid to PFAS in drinking water – not treating PFAS in WWTPs or tracing their sources is contributing to the expanding contamination of our drinking water supplies.

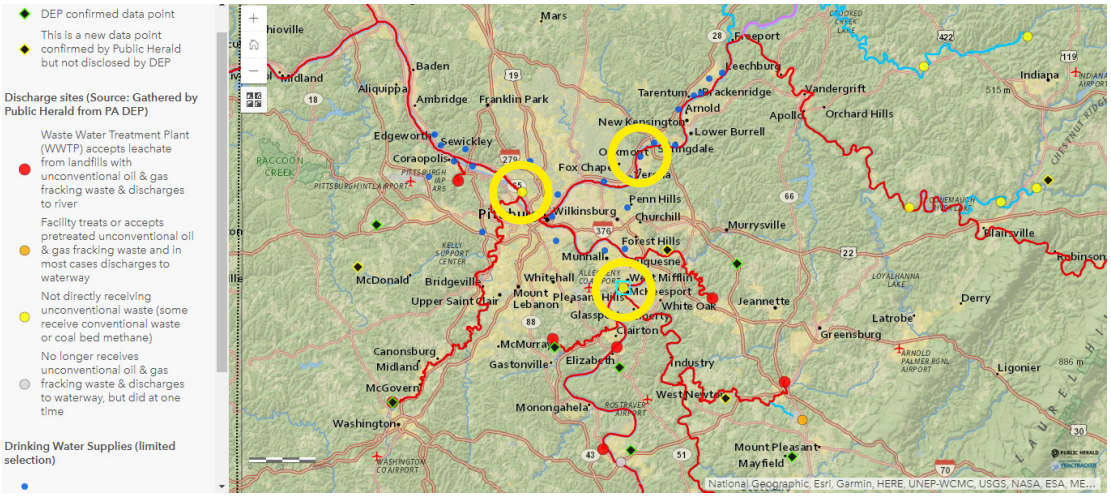

Figure 5 Public Herald's map of the pathway of radioactive materials from fracking and how they can connect to our drinking water supplies (Pribanic, 2019).

The other ambient surface water test results we have come from a project completed in 2019 in partnership between the U.S. Geological Survey (USGS) and the Pennsylvania Department of Environmental Protection (DEP), where they tested their preexisting water quality network (WQN) of water sampling sites for PFAS for the first time (Duris, Eicholtz, Williams, & Shull, 2021). From this, they produced a heat map of the state to show hot spots in the state (see Figure 6) and identified land-use associations with PFAS, as well as trends in the appearance of certain PFAS. The most frequently detected PFAS compounds from this study were PFOA, PFHxA, PFOS, and PFPeA (Breitmeyer, et al., 2023). In addition, the primary land-use associations with elevated PFAS levels identified in the study were electronics manufacturing and water pollution control like wastewater treatment plants (Breitmeyer, et al., 2023). We hope that our sampling can provide further context to these results by focusing on one of the identified land-use associations with elevated PFAS. When analyzing our results we will connect to this survey of the state whenever applicable.

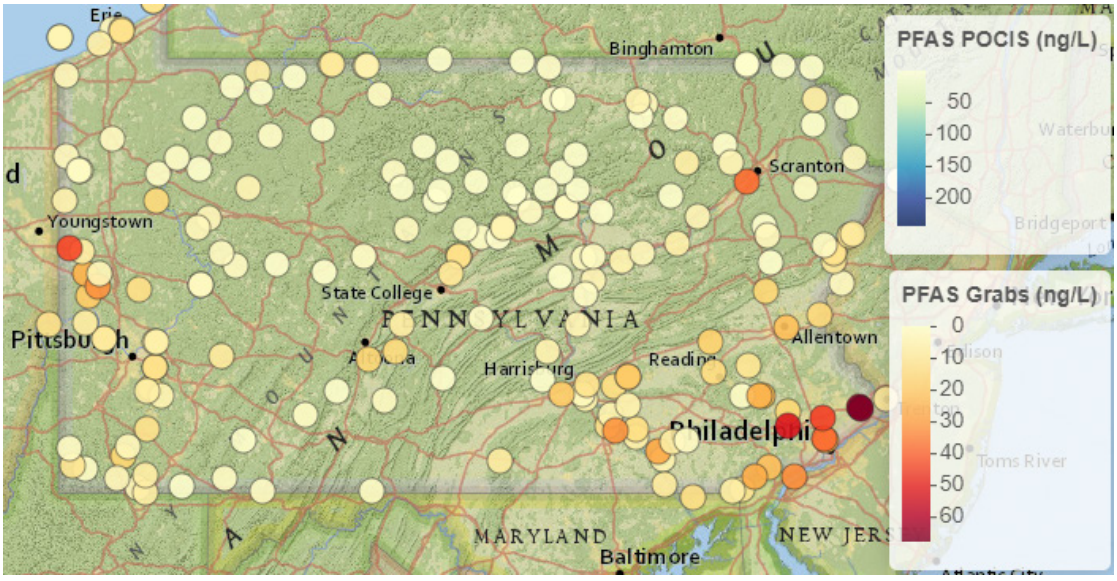

Figure 6 USGS and DEP's 2019 sampling study of Pennsylvania to assess ambient surface water contamination (Duris, Eicholtz, Williams, & Shull, 2021).

Lastly, we utilized two databases provided by the Environmental Protection Agency (EPA): their PFAS Analytic Tools (US Environmental Protection Agency, n.d.) and their EJScreen mapping tool (Environmental Protection Agency, n.d.). The PFAS Analytic Tools offer a similar mapping feature to the one provided by the Environmental Working Group but unfortunately it could not be utilized to the fullest extent in PA since wastewater testing is not required. Instead, it offered another database of potential emitters near our sample sites. The EJScreen tool views environmental hazards, like wastewater discharge, in relation to socioeconomic and demographic characteristics to provide information on environmental justice. PFAS, due to how quickly they move through the environment, through our air and waterways, affects us all. All work in PFAS remediation and mitigation should seek to alleviate any environmental injustices.

For our analysis, we will look at mixing zone samples in comparison to the upstream samples and both are analyzed in comparison to these existing data sources as applicable. Since these data sources are all collected differently, we can only hypothesize about the connections between their results. For example, whereas the Cyclopure kits test for 55 different PFAS compounds, the 2019 WQN study only tested for 33 PFAS. While these data sources can provide additional context to our results, our primary objective is to compare the upstream and the mixing zone result.

Section 4: Findings

Our findings were consistent with our hypothesis – PFAS levels were higher in the mixing zone where wastewater effluent hit the stream compared to the ambient surface water tested upstream of the mixing zone (see Table 1). The difference between the baseline sample and the mixing zone sample varied widely between the distinct locations but all were found to be elevated. It is important to note that the mixing zone samples are a measure of the effluent diluted with the stream – therefore we can inference that the actual effluent has a higher concentration of these PFAS compounds and may have additional PFAS that became too diluted in the mixing zone to detect.

Number of PFAS and Total PFAS Detected in the Three Rivers at WWTP Outfalls						
	Ohio River: ALCOSAN		**Allegheny River: AVJSA**		**Monongahela River: McKeesport**	
	Upstream	Mixing Zone	Upstream	Mixing Zone	Upstream	Mixing Zone
No. PFAS Detected	2	6	1	12	2	9
Total PFAS	3.7 ppt	15.3 ppt	1.2 ppt	36.1 ppt	3.4 ppt	26.3 ppt

Table 1 Number of PFAS Detected and Total PFAS (in ppt) in each sample detected in the upstream and mixing zone samples of each WWTP.

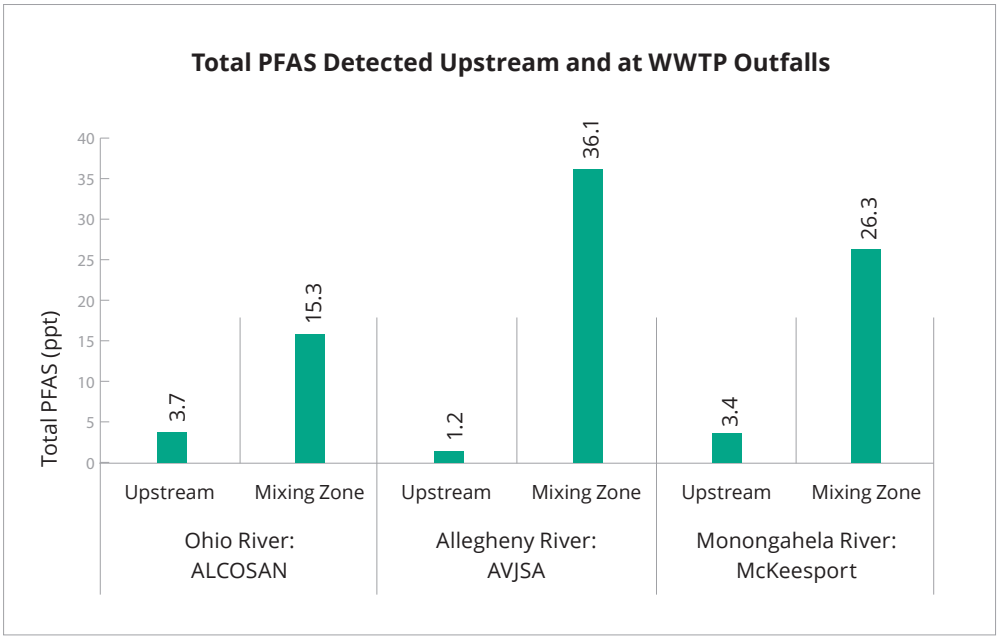

Figure 7 Total PFAS (ppt) detected upstream and at mixing zones for each of the three WWTPs.

Allegheny River:
Allegheny Valley Joint Sewage Authority

Starting with the results from the Allegheny River at Allegheny Valley Joint Sewage Authority's treatment plant (Table 2) we see that the upstream sample collected had only 1.2 ppt detected of PFOS. Due to the pervasiveness of PFAS in our environment this result is unfortunately unsurprising. As that was the only PFAS found above the detectable limit there was 1.2 ppt of PFAS in the upstream sample. Meanwhile, 12 PFAS were detected in the mixing zone sample for 36.1 ppt of PFAS. This was the highest amount of PFAS detected in any of our samples for this project and it raises interesting questions as to why these levels are so high. For more information regarding the full names of the PFAS compounds detected, see the Cyclopure Analyte List (Appendix 1) at the end of this document.

Allegheny River: Allegheny Valley Joint Sewage Authority		
Compound	**Upstream**	**Mixing Zone**
PFPeA	< 1 ng/L	2.5
PFHxA	< 1 ng/L	8.2
PFHpA	< 1 ng/L	1
PFOA	< 1 ng/L	3.5
PFNA	< 1 ng/L	1.4
PFDA	< 1 ng/L	1.2
PFBS	< 1 ng/L	1.6
PFHxS	< 1 ng/L	1.7
PFOS	1.2	6.9
5:3 FTCA	< 1 ng/L	4.4
6:2 FTS	< 1 ng/L	1.2
N-MeFOSAA	< 1 ng/L	2.5
Total PFAS (All Detected)	**1.2 ppt**	**36.1 ppt**

Table 2 Results from samples collected at AVJSA.

When we compare these results to the nearest results taken downstream from the 2019 USGS/DEP sampling their grab sample contained 5.8 ppt total PFAS (Duris, Eicholtz, Williams, & Shull, 2021). Though these samples are collected and tested using different methods (our sample was tested for 55 PFAS chemicals whereas the USGS and DEP study only tested for 33) comparing these results indicates that AVJSA's effluent could be contributing to the elevated PFAS ppt at the site sampled by DEP just downstream. Our upstream sample to assess the ambient surface water of the Allegheny River in that region only detected 1.2 ppt of total PFAS, whereas the ambient surface water sample collected downstream from AVJSA by the DEP study detected 5.8 ppt (Duris, Eicholtz, Williams, & Shull, 2021). Though there could be a myriad of reasons for this difference including sampling and testing differences and potential accidents or the years in between the influence of wastewater discharge upstream could be contributing to this increase.

Tracing the source of individual PFAS is extremely complicated but at times specific PFAS chemicals can act as markers of a specific point source of contamination. For example, 5:3 FTCA is emerging as a potential landfill leachate tracer because it forms from the composition of carpets in landfill (Interstate Technology Regulatory Council, 2023). The

presence of 5:3 FTCA in the mixing zone sample (4.4 ppt) thus indicates that AVJSA may be receiving landfill leachate. Due to the ubiquitous nature of PFAS tracing where each substance comes from is a challenge and makes it clear the importance of sampling wastewater at intake and discharge even more important.

If we look at this map of potential sources of PFAS contamination in the area, we see many located upstream and in AVJSA service area (which encompasses the north side of the river as seen in Figure 9). These could be contributing PFAS to both the upstream samples and the mixing zone sample. There are other wastewater facilities as well as many glasses manufacturing, chemical facilities, and electronics and metal plating industries, all of which commonly use PFAS in their facilities, all located upstream of AVJSA (Environmental Working Group).

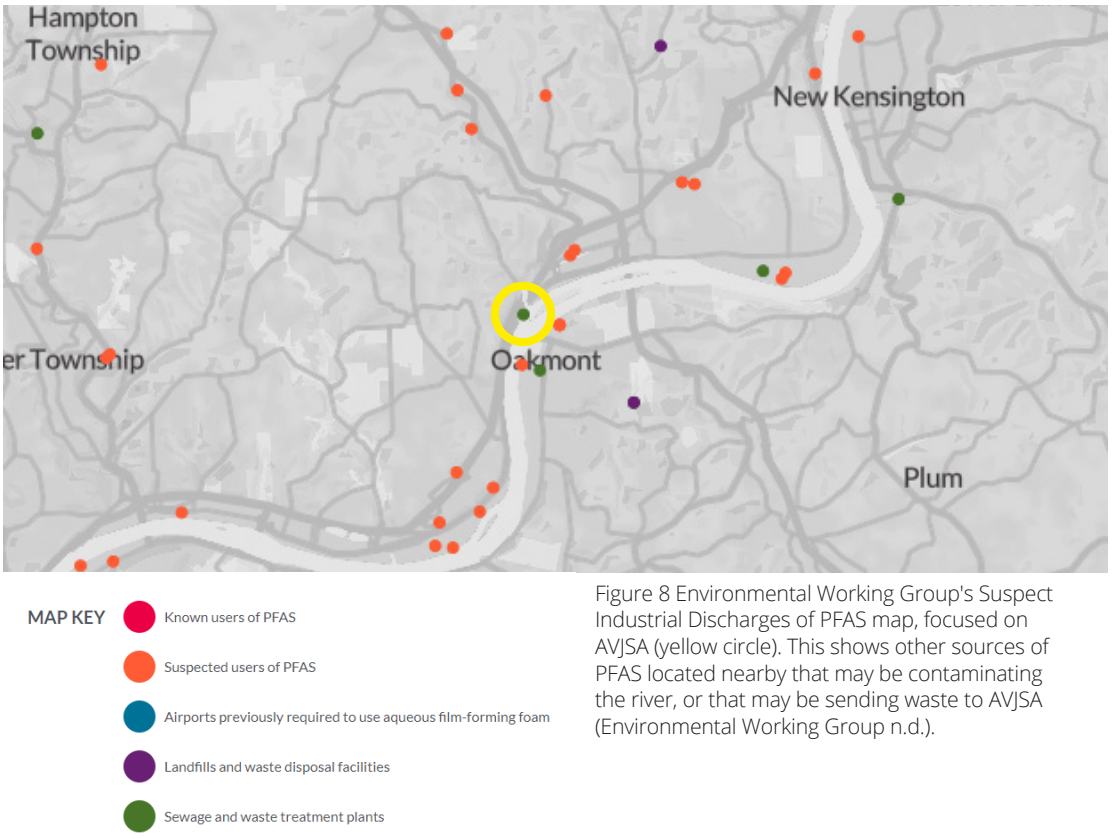

Figure 8 Environmental Working Group's Suspect Industrial Discharges of PFAS map, focused on AVJSA (yellow circle). This shows other sources of PFAS located nearby that may be contaminating the river, or that may be sending waste to AVJSA (Environmental Working Group n.d.).

While we do not have confirmation that these are using PFAS or that they are discharging PFAS through waste streams that are treated at AVJSA but we see specific PFAS chemicals, like 6:2 FTS, which the U.S. metal plating industry switched to when PFOS was phased out indicating waste from this industry being detected in the AVJSA mixing zone sample (National Association for Surface Finishing, 2019). We know that AVJSA accepts some industrial wastewater from their service area so this substance could be coming from one of them (Allegheny Valley Join Sewage Authority, n.d.). However, without sampling at intake and discharge we cannot know where specifically this is coming from.

Monongahela River: McKeesport Wastewater Treatment Plant

For McKeesport, we see that the upstream sample collected had a higher level of detectable ambient surface water PFAS contamination, at 3.5 ppt with three substances detected – PFOA, PFOS, and MeFBSA. McKeesport and the communities upstream are an industrial hub in the region. Industrial emitters could be the source of the elevated ambient surface water levels of PFAS detected from the upstream sample. As seen in the EWG map (Figure 10 on the next page) this could be coming from numerous emissions upstream on the Monongahela including other WWTPs, landfills, airports, and many other suspected users of PFAS. Without data collected from these industrial sources and from WWTPs we are in the dark as to how these reached our waterways. MeFBSA, for example, is a surfactant used in the semiconductor industry and in production of paints, inks, waxes, and synthetic leather (PubChem, n.d.). We would expect pollution of this PFAS to come from industrial wastewater from related facilities or from print shops or other businesses using high volumes of paints, inks, and waxes (PubChem, n.d.). The finding of this PFAS chemical in the ambient surface water was more surprising than detections of legacy PFAS like PFOA and PFOS. However, we know that both legacy and currently used PFAS compounds can quickly spread through the environment.

Monogahela River: McKeesport Wastewater Treatment Plan		
Compound	**Upstream**	**Mixing Zone**
PFBA	< 1 ng/L	7.9
PFPeA	< 1 ng/L	3.4
PFHxA	< 1 ng/L	4.4
PFHpA	< 1 ng/L	1.7
PFOA	1.1	2.2
PFBS	< 1 ng/L	1.6
PFOS	1.2	2.7
MeFBSA	1.1	1.4
PFHpS	< 1 ng/L	1
Total PFAS (All Detected)	**3.4 ppt**	**26.3 ppt**

Table 3 Results from samples collected at McKeesport.

The PFAS Analytic Tool was consulted for any reported spills or Toxic Release Inventory (TRI) records pertaining to MeFBSA in the area but there were none (US Environmental Protection Agency, n.d.). However, as stated, the area all along the Monongahela upstream is a major industrial hub for the region and has no shortage of industries that could be discharging MeFBSA into the river. The level of MeFBSA in the mixing zone, 1.4ppt, is only a slight increase from 1.1 ppt indicating that perhaps the primary source of MeFBSA in the mixing zone is still the stream, not the outfall.

PFOA was also detected in this sample but was not detected in the other two upstream samples. There are many sources of this substance including the same explanation of the many potential sources of MeFBSA upstream. In addition, the Lower 10th Ward, the McKeesport neighborhood affected by July 2021 back flow of AFFF, borders the wastewater treatment facility and could have led to ongoing contamination of the river from run off when they flushed the drinking water lines following the back flow. PFOA was

Figure 9 Environmental Working Group's map of suspected industrial discharges of PFAS. Many are located upstream on the Monongahela River, that could be contributing to the overall ambient surface PFAS and to the mixing zone results (Environmental Working Group n.d.).

one of the PFAS substances associated with the AFFF incident that was detected in the residents' drinking water; notably, this was the only ambient sample that detected any PFOA (Glabicki, 2023). This could be contributing to the high level of PFAS in this sample and those other emitters upstream.

Pennsylvania American Water, the utility company that owns the McKeesport WWTP, discloses on their website that McKeesport Wastewater System (including three WWTPs – McKeesport, Dravosburg, and Duquesne) serves approximately 12,000 customers, plus 9,800 customers served under bulk contracts in neighboring communities of White Oak Borough, Liberty Borough, East McKeesport Borough, Elizabeth Township, Lincoln Borough, Glassport Borough, Versailles Borough, and North Versailles Township (Pennsylvania American Water, n.d.). It is unclear from the information the company makes publicly available what wastewater from what specific industries would end up at the McKeesport WWTP which makes it more challenging to trace where the PFAS are coming from.

When looking at the area using the EJScreen tool, the results make sense given that the area upstream is in the 90th to 95th percentile (orange) and 95th to 100th percentile for wastewater discharge as compared to the rest of Pennsylvania (see Figure 11) (Environmental Protection Agency, n.d.). The extremely high number of wastewater discharge sites, potential industrial emitters, and the AFFF spill in McKeesport are likely all contributing to the higher levels of PFAS in our grab sample. Of the three WWTPs that we sampled, McKeesport was the only area close where the upstream of our sample site above the 90th percentile for wastewater discharge using EJScreen making this a notable site.

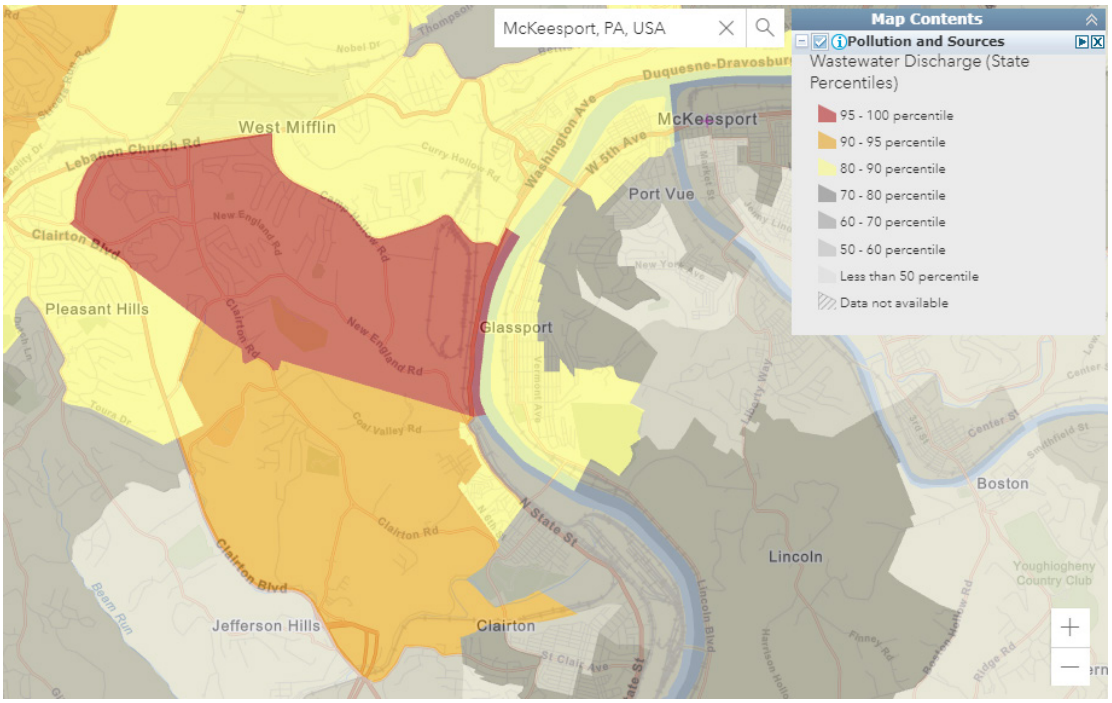

Figure 10 EJScreen Map of McKeesport and upstream on the Monongahela, showing state percentiles for wastewater discharge (Environmental Protection Agency, n.d.).

Meanwhile, nine different PFAS were detected in the mixing zone sample, for a total of 26.3 ppt of PFAS. This was the second highest mixing zone detection of PFAS, after AVJSA, and is substantially higher than the total PFAS (3.4 ppt) of the upstream sample. There are no other publicly available data sources on PFAS in the Monongahela collected in proximity to the WWTP so we do not have another data point to compare this to.

Ohio River:
Allegheny County Sanitary Authority (ALCOSAN)

ALCOSAN is the largest wastewater treatment plant in Allegheny County with the largest service area (see Figure 12) (ALCOSAN: Allegheny County Sanitary Authority, n.d.). ALCOSAN is a combined sewer system, meaning that through at least part of their infrastructure the sewer and storm water systems are combined, which can cause overflows in cases of significant precipitation (Environmental Protection Agency, 2015). According to their website, "ALCOSAN discharges approximately 140,000 gallons of treated wastewater per minute into the Ohio River. The water put back into the Ohio River is cleaner than what is in the river" (Pennsylvania American Water, n.d.). Our results here show that when it comes to PFAS this is not the case.

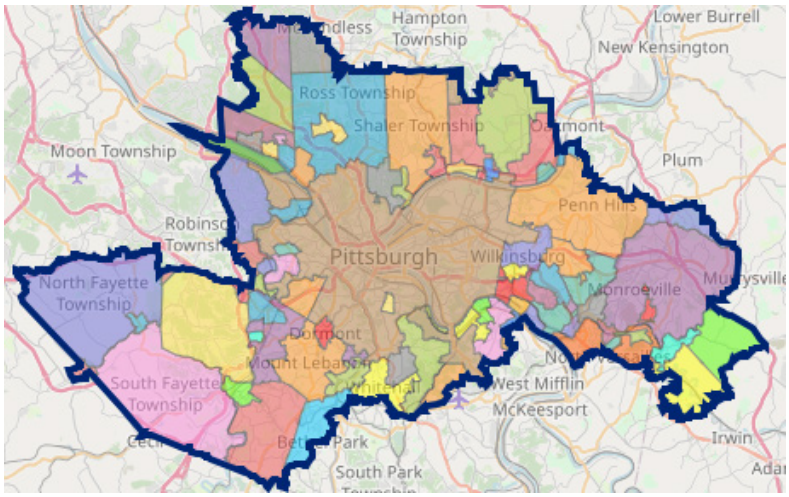

Figure 11 ALCOSAN Service Area (ALCOSAN: Allegheny County Sanitary Authority, n.d.).

Ohio River: ALCOSAN		
Compound	**Upstream**	**Mixing Zone**
PFPeA	< 1 ng/L	1.2
PFHxA	< 1 ng/L	4.2
PFOA	< 1 ng/L	2.5
PFBS	< 1 ng/L	2.1
PFHxS	< 1 ng/L	1.2
PFOS	1.5	4.1
MeFBSA	2.2	< 2 ng/L
Total PFAS (All Detected)	**3.7 ppt**	**15.3 ppt**

Table 4 Results from samples collected from ALCOSAN.

The results from ALCOSAN (Table 4) show the highest upstream levels of PFAS – 3.7 ppt – based on a combination of MeFBSA and PFOS. The level of MeFBSA detected (2.2 ppt) is twice the level that was detected in the McKeesport upstream sample. As discussed, MeFBSA is a surfactant used in the manufacturing of paints, inks, waxes, semiconductors, and synthetic leather (PubChem, n.d.). Given MeFBSA appearance in the Monongahela, it is unsurprising that it would appear in the Ohio River as well.

The Ohio River is the convergence of these rivers and many industrial sources that are likely to use PFAS, as we can see in Figure 13. Using the PFAS Analytic Tool it appears many industries that may use MeFBSA (amongst other PFAS) are located upstream making it impossible to presume a point source without much more widespread and involved testing (US Environmental Protection Agency, n.d.).

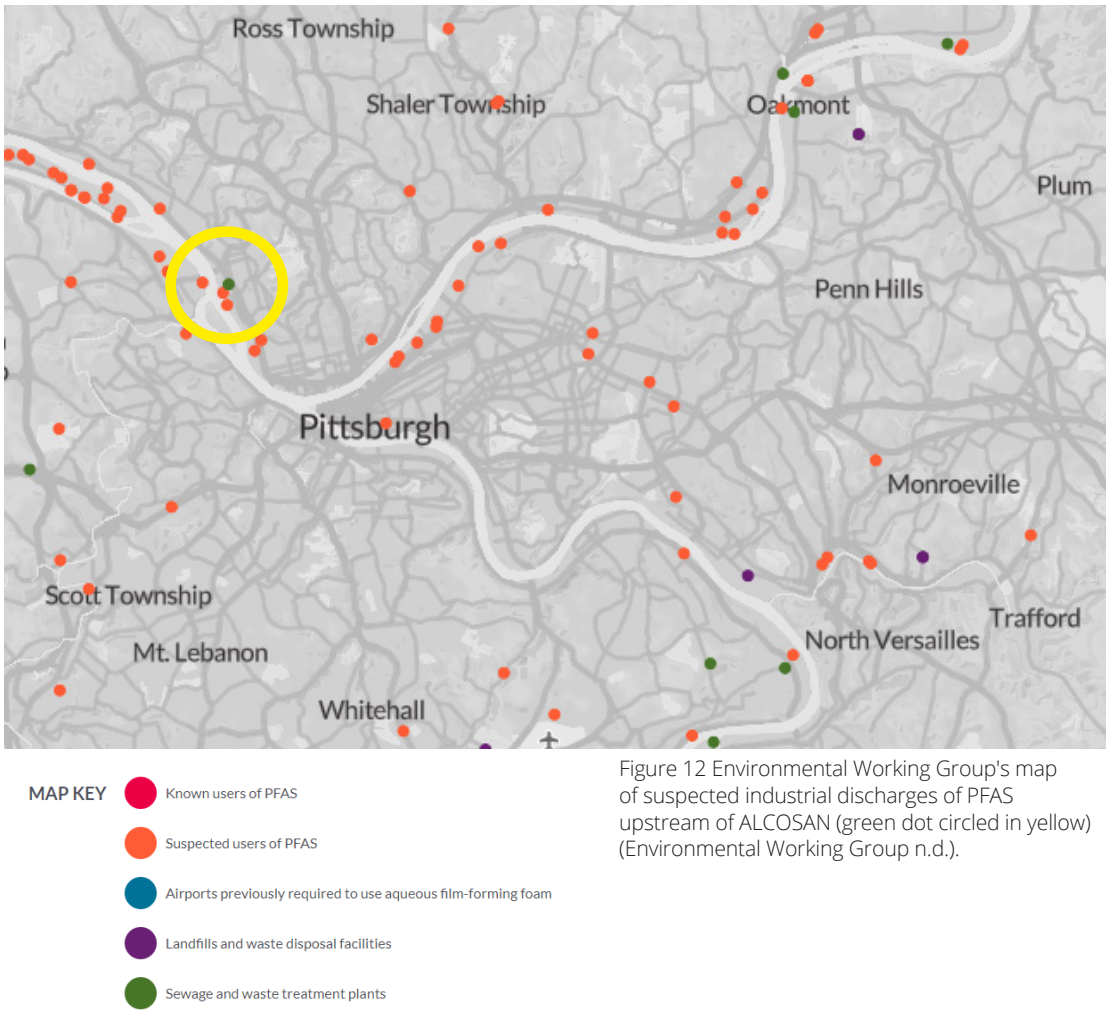

Figure 12 Environmental Working Group's map of suspected industrial discharges of PFAS upstream of ALCOSAN (green dot circled in yellow) (Environmental Working Group n.d.).

These show the lowest mixing zone results of all the samples, with only 15.3 ppt total PFAS, from seven different substances detected. Given the ALCOSAN's unique size we expected these results to be distinct from the other WTTPS. Of all the outfalls this was by far the largest, fastest moving, and greatest volume of water. Collecting the sample here could not be done via kayak and required a motorized boat to be able to reach the mixing zone given the speed of the moving water – 140,000 gallons pump out into the Ohio each minute (Pennsylvania American Water, n.d.). We predicted that this would create much more variability in sample results so we collected a duplicate, which will be discussed later in this report. The lower results for total PFAS here (15.3 ppt, compared to 26.3 at McKeesport and 36.1 at AVJSA) could be due to this variability in the mixing zone concentrations. To collect a truly representative sample from the mixing zone over time, especially for ALCOSAN but for all WWTPs, you would need a passive sampling device that could detect all the different PFAS leaving the facility over the course of a day rather than a simple grab sample.

It is also interesting that MeFBSA was not detected in the mixing zone sample though it was detected in the surface water. This differs from the McKeesport results where MeFBSA was still detected in the mixing zone. This demonstrates the variability in the mixing zone and indicates that MeFBSA may not be entering the Ohio River upstream or is coming from sources on the Allegheny or Monongahela rather than being received by ALCOSAN from industry as well.

Combined Analysis

Our results need to be viewed not only in conjunction with one another, with mapped data of potential emitters, but also with the few existing PFAS standards to see how our results compare. This is especially relevant when we consider that we are sampling the mixing zone, meaning the effluent is diluted with the stream water. This fact begs the question – what are the levels of PFAS in the WWTP's effluent? While we were unable to collect samples from the outfalls we collected a close approximation for their influence on stream PFAS levels by sampling in the mixing zone.

Every single sample we collected, upstream and mixing zone, came back with detectable levels of PFAS. This shows how the substance has pervaded our environment in the over half-century since its use began and raises alarm for the future of PFAS substances and how the replacements for "legacy PFAS" like PFOA and PFOS may likewise permeate the environment and what risks that may entail. While the future of PFAS regulation is unclear we can measure the results we have against what regulations do exist.

Considering that these substances persist in the environment forever the mixing zone samples testing near or above the proposed MCLs for PFOA and PFOS is of great concern.

The primary way that the EPA is seeking to regulate PFAS in our water currently is by proposing new National Primary Drinking Water Regulation (NPDWR) under the Safe Drinking Water Act (see Table 5) (US Environmental Protection Agency, 2021). This regulation will affect the levels of six different PFAS compounds allowable in drinking water. While our project is looking at PFAS in wastewater discharge we are comparing it to the NPDWR because there are no standards proposed under the Clean Water Act for wastewater discharges. The NPDWR is the only proposed federal regulation available for our comparison. We find these values useful for comparison because these rivers serve as a drinking water source for many municipalities and these standards, if approved, will become enforceable for drinking water systems. Considering that these substances persist in the environment forever the mixing zone samples testing near or above the proposed MCLs for PFOA and PFOS is of great concern.

EPA's Proposed MCLs Comparer to Detected Levels in Mixing Zone Samples					
Compound	**MCLG**	**Proposed MCL**	**AVJSA**	**McKeesport**	**ALCOSAN**
PFOA	0 ppt	4.0 ppt	3.5 ppt	2.2 ppt	2.5 ppt
PFOS	0 ppt	4.0 ppt	6.9 ppt	2.7 ppt	4.4 ppt
PFNA	1.0 Hazard index (unitless as a group)	1.0 Hazard index (unitless as a group)	1.4 ppt	nd	nd
PFHxS			1.7 ppt	nd	1.2 ppt
PFBS			1.6 ppt	1.6 ppt	2.1 ppt
HFPO-DA (GenX Chemicals)			nd	nd	nd
Hazard Index Calculations			**0.328969**	**0.00008**	**0.1334383**

Table 5 Comparison of the highest detections in our mixing zone samples based on the EPA's Maximum Containment Level Goals (MCLGs) and Proposed Maximum Containment Levels *MCLs) for PFAS in drinking water. *nd = non-detect

EPA's 2022 Interim Updated Health Advisory (HA) Levels for 4 PFAS Compounds				
Compound	**HA**	**AVJSA**	**McKeesport**	**ALCOSAN**
PFOA	0.004 ppt	3.5 ppt	2.2 ppt	2.5 ppt
PFOS	0.02 ppt	6.9 ppt	2.7 ppt	4.4 ppt
PFBS	2,000 ppt	1.6 ppt	1.6 ppt	2.1 ppt
HFPO-DA (GenX Chemicals)	10 ppt	nd	nd	nd

Table 6 The 2022 interim updated health advisory (HA) levels for PFOA, PFOS, PFBS, and GenX Chemicals, in comparison to the amounts detected in the mixing zone samples for the three wastewater treatment plants.

When we compare our highest detections in the mixing zone samples we see that two samples, those collected at AVJSA (6.9 ppt) and ALCOSAN (4.4 ppt), exceed the EPA's MCLs. PFOS was the most widely detected PFAS, seen in each sample we collected, and has an extensive toxicological profile and is known to be extremely hazardous. The levels of PFOA detected in the mixing zone were under the MCL but of course significantly higher than the MCLG (0 ppt). We calculated followed the Hazard Index equation for the other four PFAS compounds – PFNA, PFHxS, PFBS, and GenX – that are regulated as a group and found all to be well under both the MCL and MCLG. As a rule, the EPA sets an MCLG of 0 ppt for any substance determined to be a human carcinogen or likely to be a human carcinogen. The MCL are enforceable standards that are intended to be set "as close as feasible" to the MCLG given cost considerations (US Environmental Protection Agency Office of Water, 2023). The concern presented by these detections becomes clearer when we look at the health advisory levels set by the EPA.

Health advisories are non-enforceable, non-regulatory advisories set forth by the EPA to inform the public and relevant agencies and organizations to "offer protection for people from adverse health effects resulting from exposure throughout their lives to these individual PFAS in drinking water (US Environmental Protection Agency, 2020). The EPA's lifetime health advisory for drinking water is a guideline for the level of PFAS that can be consumed over a lifetime without elevating the risk of PFAS-related health problems. This guidance is based on the most up-to-date scientific information to limit health issues due to PFAS exposure in drinking water. Though the mixing zone samples are not drinking water samples, they represent the influence that WWTPs have on water bodies that serve as our drinking water source. These sample results show that all our mixing zone results for PFOA and PFOS are well above the health advisory for these substances. Thankfully, GenX chemicals were not detected in any of our samples and the PFBS results were far below the health advisory for drinking water. Still, as always, we must keep in mind that these are only a small subsection of the thousands of PFAS compounds that exist.

Summary

While we now understand wastewater treatment plants to be a critical point source of PFAS in Allegheny County, we cannot know how these PFAS are getting into the wastewater treatment facilities – by storm water, industrial discharges, our products, our homes, and other sources. However, if the DEP chose to collect this data from all WWTPs in the Commonwealth, the information would provide a crucial database to inform policy decisions and health advisories at the state, regional, and federal levels.

This highlights the necessity of monitoring and regulating the uses and discharge of all PFAS chemicals, not just those for which we now have proposed drinking water standards.

Most of the PFAS detected that have not been discussed in detail yet – PFPeA, PFHxA, PFHpA, PFNA, PFDA, PFBS, PFHxS, PFBA, PFHpS, NMeFOSAA – are used in numerous consumer products or are breakdown substances formed from other PFAS chemicals used in consumer products and industrial processes. Many of these substances are replacements for PFOA and PFOS, like PFBS (substitute for PFOS), or are detected amongst other PFAS in various products like PFHpA (US Environmental Protection Agency; PubChem, n.d.). These chemicals do not have a particularly unique use but are widely found in many products including household cleaning products, hygiene products, food packaging, water, stain resistance treatments, and more. It is impossible to trace the source without more extensive testing as the chemicals are coming from a combination of industrial sources, businesses, homes, and stormwater. This highlights the necessity of monitoring and regulating the uses and discharge of all PFAS chemicals, not just those for which we now have proposed drinking water standards.

Quality Assurance and Quality Control

To ensure the reliability of our data and to control for any other factors – like contamination from handling instruments or by transferring from the HDPE bottles to the Cyclopure collection cups – we collected a sample in a Cyclopure cup of deionized water for a field blank. Since there was no detection of any PFAS in the field blank we did not need to conduct a blank correction. This demonstrates that outside factors were well-controlled and that our results are a reliable and accurate depiction of levels of PFAS in the water. Our results can be assumed to not have been significantly influenced by any outside factors.

Field Blank	
PFBA	< 1 ng/L
PFPeA	< 1 ng/L
PFHxA	< 1 ng/L
PFHpA	< 1 ng/L
PFOA	< 1 ng/L
PFNA	< 1 ng/L
PFDA	< 1 ng/L
GenX	< 2 ng/L
PFBS	< 1 ng/L
PFHxS	< 1 ng/L
PFOS	< 1 ng/L
5:3 FTCA	< 1 ng/L
6.2 FTS	< 1 ng/L
MeFBSA	< 2 ng/L
N-MeFOSAA	< 1 ng/L
PFHpS	< 1 ng/L
Total PFAS (All Detected)	**0**

Table 7 PFAS results from the field blank sample. No PFAS were detected. This table only shows the compounds that were detected in other samples.

We also collected one duplicate during this round of sampling from the ALCOSAN mixing zone. We chose to analyze the Mixing Zone Sample 2 results because they detected a higher concentration of PFAS and detected additional PFAS compounds compared to Sample 1. We used the sample with the higher detections for analysis to capture our best approximation for the full impact of the wastewater effluent. We calculated the relative percent difference between the Mixing Zone 1 and 2 samples for individual compounds and for Total PFAS (ppt) to see the variance between the duplicates. The relative percent difference (RPD) by compound ranged from 22.22-200%. The RPD for total PFAS from Mixing Zone Sample 1 to 2 was 42.86%. For duplicate samples for PFAS in water we would hope to see a less than 30% change. However, since the samples were collected in the mixing zone, with fast-moving water, we would expect a substantial level of variance between the samples. The RPD seen here is not cause for concern.

Ohio River: ALCOSAN Results (Upstream and Mixing Zone with Duplicate)			
Compound	**Upstream**	**Mixing Zone (Sample 1)**	**Mixing Zone (Sample 2)**
PFPeA	< 1ng/L	< 1 ng/L	1.2 ppt
PFHxA	< 1ng/L	2.3 ppt	4.2 ppt
PFOA	< 1ng/L	2 ppt	2.5 ppt
PFBS	< 1ng/L	1.2 ppt	2.1 ppt
PFHxS	< 1ng/L	< 1 ng/L	1.2 ppt
PFOS	1.5 ppt	4.4 ppt	4.1 ppt
MeFBSA	2.2 ppt	< 2 ng/L	< 2 ng/L
Total PFAS (All Detected)	**3.7 ppt**	**9.9 ppt**	**15.3 ppt**

Table 8 Sample results for all samples collected at ALCOSAN, including the duplicates (Mixing Zone Samples 1 and 2).

Our understanding is that this variance is due to the lack of uniformity in wastewater discharge and in the mixing process. If we had collected duplicates of the stream samples, where the water was not so fast moving but relatively still, we would expect the samples to be more uniform. In a controlled setting we would find the variance between the duplicates to be more concerning but significant variance was to be expected given the circumstances.

Section 5: Limitations

These results are an approximation for PFAS contamination coming from wastewater effluent not treated for PFAS. The only way to understand the extent of the problem is to test the wastewater facility's influent and effluent itself as well as the ambient surface water, not just the surface water at the outfall location. Testing upstream and the mixing zone is a method to approximate the true impact of wastewater on the PFAS levels of our public waterways. In addition, our inability to test for a wastewater tracer like sucralose or caffeine is also a shortcoming of this study, but the ability to test close to outfalls makes this less necessary, as discussed.

Accessible, simple, widespread water sampling is essential for PFAS contamination to be monitored and understood and community science-oriented technology is critical for this goal.

The fact that we could not use EPA-certified testing results due to budget constraints for this project is a potential limitation, but supporting these emerging initiatives like Cyclopure that make community science a possibility is also a strength of this project. Accessible, simple, widespread water sampling is essential for PFAS contamination to be monitored and understood and community science-oriented technology is critical for this goal.

The solution for this issue is increased surveillance of surface water levels of PFAS and emission sources. This project was not intended to give a comprehensive overview of the issue but to focus on one waste stream. Another limitation is that we were unable to collect samples on multiple occasions to control for any influence of weather changes or to collect samples from streams at all the wastewater treatment facilities in the county. More surveillance is needed of this waste stream, as well as industrial sources.

Section 6: Conclusions and Recommendations

These results indicate that wastewater treatment facilities are one of many important sources of PFAS contamination of surface water. While our results confirmed our hypothesis that WWTPs in PA are a critical source of PFAS contamination, they also indicate that there are other sources that need to be understood and quantified. Building a database of wastewater discharge samples for PFAS can guide the state and federal government in acting to protect the environment and people from PFAS.

The EPA has only acted to regulate and address six PFAS; in this study alone, we have detected fifteen. This is an issue given that there are thousands of PFAS known to exist. For example, MeFBSA was detected in ambient surface water in two samples indicating that it is likely being discharged into the Monongahela and Ohio Rivers or it is aerosolized in the area and is depositing into the rivers. Regardless, MeFBSA is not one of the regulated PFAS compounds. This brings about concern that these actions are insufficient to protect our waterways and people from a continuing cycle of PFAS substances that are phased out and filtered from our water being replaced by other PFAS compounds that eventually must be phased out and filtered as toxicological data mounts. In the absence of more robust federal government action in collecting data on point sources to curb environmental pollution the onus falls on states – including PA – to act now.

It is important to note that all mixing zone results were below the limits that have been established in Michigan for WWTP discharge – 11 ppt for PFOS and 66 ppt for PFOA for discharges into a drinking water source (Michigan PFAS Action Response Team, 2023). However, these mixing zone results are the convergence of the effluent and the stream and represent a diluted sample. Unless data is collected from effluent before it is discharged by the wastewater treatment authority we cannot know if our WWTPs are discharging higher levels of PFOA and PFOS. As the only state that has set such limits for WWTP effluent this could be a useful guidepost to assess detections against and to evaluate against the most current science until Pennsylvania or the federal government set their own standards.

This is slow progress and opens the door to regrettable substitution like the replacement of legacy PFAS with GenX which is understood to be similarly harmful.

The EPA still has not established PFAS as a hazardous substance under the many laws that grant it regulatory authority – Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Clean Air Act, or Emergency Planning and Community Right-to-Know Act (Interstate Technology Regulatory Council, 2023). EPA is discussing designation under many of these laws, but it does not seem that PFAS will be regulated as a class but rather on a compound-by-compound basis. This is slow progress and opens the door to regrettable substitution like the replacement of legacy PFAS with GenX which is understood to be similarly harmful.

Currently, 180 PFAS compounds are reportable under the Toxic Substances Control Act (TSCA) with nine more to be added to Reporting Year 2023 following the passage of the National Defense Authorization Act (NDAA) of 2020. In addition, the NDAA of 2022 added a Significant New Use Rule (SNUR) to apply to PFAS substances that have not been imported, manufactured, or processed in the U.S. since 2006, as well as newly created PFAS (US Environmental Protection Agency, 2023). But there are thousands of PFAS compounds on the market that do not fall under either of these categories, leaving a vacuum of policy to protect the environment and people from PFAS exposure.

It is crucial that states act now to fill that policy vacuum and seek to remove PFAS from the supply chain and the environment and should seek to regulate the chemicals as a class. While Pennsylvania set its own MCLs (14 ppt for PFOA and 18 ppt for PFOS) that are much higher than the proposed MCLs from the EPA, the state has otherwise taken limited concrete steps to regulate PFAS independently (Pennsylvania Department of Environmental Protection, 2023).

Many states have banned the sale of food packaging that contains PFAS or have required its removal from firefighting.

However, other states are innovating. Michigan requires extensive testing and limits on PFAS in wastewater and biosolids for land application while Maine prohibits the land application of biosolids for agriculture (MI Department of Environment, Great Lakes, and Energy, n.d.; An Act to Prohibit the Contamination of Clean Soils with So-called Forever Chemicals, 2022). Many states have banned the sale of food packaging that contains PFAS or have required its removal from firefighting. Washington and California have taken significant steps to do comprehensive evaluation of the safety of chemicals and chemical classes, including PFAS, and then seek to remove them from all non-essential applications if deemed appropriate (Safer States, n.d.).

When we speak of PFAS, we talk at length of removing it from products and restricting its presence in environmental media. However, in many products and industries PFAS must be replaced with something else and we want to avoid regrettable replacements which replace PFAS with chemicals that are equally harmful or worse. We need to invest in research on safe alternatives.

Section 7: Considerations for Environmental Justice

We also must consider the environmental justice implications of PFAS contamination. The EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (US Environmental Protection Agency, 2014).

As seen in the map of McKeesport earlier in this report, industrial and wastewater discharge sites tend to be clustered together in low-income communities. The communities lack the resources to protect their own water source and the legal authority and autonomy to make such decisions. Corporations and industries upstream can contaminate the water that they then rely on for their drinking water. This is a major issue of fair treatment when industries are disproportionately located in low-income communities of color. Likewise, studies have found that communities of color are more impacted by PFAS contamination of their drinking water due to the disproportionate proximity to PFAS users and emitters (Liddie, Schaider, & Sunderland, 2023).

Since information regarding PFAS in wastewater is not required to be collected in Pennsylvania, it is not publicly available. Consumers lack the information they need to understand how their source water may be threatened by WWTP discharge and other sources of PFAS discharge into rivers and streams. Wastewater ratepayers cannot understand the implications that the service they are paying for can affect the ecosystem and their health making it impossible for them to engage with the system democratically. This deprives communities of the "meaningful involvement" component of the decision-making process thus forming a barrier to environmental justice around PFAS.

Whole home filtration systems, reverse osmosis systems, and carbon filters are all quite expensive and they are the only options that can reduce the amount of PFAS in one's drinking water.

In addition, it is an issue of affordability. The Cyclopure tests used to conduct this study cost $79 each and certified laboratory testing is even more expensive. This is a major issue for low-income communities who are more likely to face polluted water. There are also disparities in the depth of impact faced by those affected by PFAS contamination. Whole home filtration systems, reverse osmosis systems, and carbon filters are all quite expensive and they are the only options that can reduce the amount of PFAS in one's drinking water. This means higher-income individuals experience a significant advantage in protecting their families from PFAS exposure.

To prevent further PFAS contamination of our environment and our waterways requires treatment of PFAS from our waste streams. As mentioned earlier in this report, this will be extremely expensive considering the amount of infrastructure and maintenance needed to treat PFAS. Again, it is critical that this cost is covered by those who created the problem and not by ratepayers. Due to the disproportionate citing of wastewater discharge in low-income areas if the burden for PFAS treatment systems to be installed and operated in WWTPs falls on ratepayers it will only exacerbate that disparity.

Wastewater discharge is an environmental health issue that affects those far downstream of the community that produces and discharges the waste. The Ohio River provides drinking water for 5 million people across the several states that it traverses and those downstream do not have the authority to protect their own source water (Ohio River Foundation, n.d.).

Section 8: Consumer Recommendations

While removing PFAS from the supply chain wherever possible and from the environment requires coordinated effort between businesses and corporations there are things that individuals and families can do to limit their exposure in the meantime. The following section discusses some steps consumers can take to mitigate their exposure to PFAS (Environmental Working Group, 2018).

Household products

- Avoid stain-resistant carpets, furniture, and fabrics.
- Avoid purchasing clothing that is stain-resistant or waterproof including anything identified as containing Scotchguard or Gore-Tex.

Cookware

- If a product is marketed as free of PFAS compounds – PFTE, PFOA, and PFOS-free – but it is nonstick there is a chance that it contains other PFAS chemicals.
- Use glass, stainless steel, or cast-iron cookware.

Food and Food Packaging

- Avoid eating wild-caught fish from areas known to be contaminated with PFAS.
- Avoid fast food packaging that is not confirmed PFAS-free.
- Limit consumption of pre-cooked and packaged foods as many commercially available food packaging could potentially contain PFAS. Instead, opt for fresh, unprocessed foods.
- Avoid microwave popcorn bags as these bags are typically coated in PFAS.

Drinking water

- Some drinking water filters may lower the levels of PFAS in your drinking water. Use reverse osmosis or carbon filtration systems that are NSF certified. For example, ZeroWater filters are NSF certified carbon filtration systems for point of use.

Personal care products

- Avoid any products labeled as containing PTFE or “fluoro” ingredients.
- Use databases like Environmental Working Group’s Skin-Deep to check for the safety of cosmetics and other products (Environmental Working Group, 2023).

Section 9: Acknowledgments

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Appendices

1. Cyclopure's 55 PFAS Analyte List

PFAS detected by Cyclopure analytical methods.

Compound	Abbreviation	CAS#	EPA 1633
Perfluorobutanoic Acid	PFBA	375-22-4	Y
Perfluoropentanoic Acid	PFPeA	2706-90-3	Y
Perfluorohexanoic Acid	PFHxA	307-24-4	Y
Perfluoroheptanoic Acid	PFHpA	375-85-9	Y
Perfluorooctanoic Acid	PFOA	335-67-1	Y
Perfluorononanoic Acid	PFNA	375-95-1	Y
Perfluorodecanoic Acid	PFDA	335-76-2	Y
Perfluoroundecanoic Acid	PFUnA	2058-94-8	Y
Perfluorododecanoic Acid	PFDoA	307-55-1	Y
Perfluorotridecanoic Acid	PFTrDA	72629-94-8	Y
Perfluorotetradecanoic Acid	PFTeA	376-06-7	Y
Perfluoropropane Sulfonic Acid	PFPrS	423-41-6	
Perfluorobutane Sulfonic Acid	PFBS	375-73-5	Y
Perfluoropentane Sulfonic Acid	PFPeS	2706-91-4	Y
Perfluorohexane Sulfonic Acid	PFHxS	355-46-4	Y
Perfluoroheptane Sulfonic Acid	PFHpS	375-92-8	Y
Perfluorooctane Sulfonic Acid	PFOS	1763-23-1	Y
Perfluorononane Sulfonic Acid	PFNS	474511-07-4	Y
Perfluorodecane Sulfonic Acid	PFDS	335-77-3	Y
Perfluorododecane Sulfonic Acid	PFDoS	79780-39-5	Y
4:2 Fluorotelomer Sulfonate	4:2 FTS	414911-30-1	Y
6:2 Fluorotelomer Sulfonate	6:2 FTS	425670-75-3	Y
8:2 Fluorotelomer Sulfonate	8:2 FTS	481071-78-7	Y
10:2 Fluorotelomer Sulfonate	10:2 FTS	120226-60-0	
Perfluorobutane Sulfonamide	FBSA	30334-69-1	
N-Methylperfluorobutanesulfonamide	MeFBSA	68298-12-4	
Perfluorohexane Sulfonamide	FHxSA	41997-13-1	
Perfluorooctane Sulfonamide	PFOSA	754-91-6	Y
Perfluorodecane Sulfonamide	FDSA	N/A	
N-Ethylperfluorooctane-1-Sulfonamide	NEtFOSA	4151-50-2	Y
N-Methylperfluorooctane-1-Sulfonamide	NMeFOSA	31506-32-8	Y
Perfluorooctane Sulfonamido Acetic Acid	FOSAA	2806-24-8	
N-Ethyl Perfluorooctane Sulfonamido Acetic Acid	NEtFOSAA	2991-50-6	Y
N-Methyl Perfluorooctane Sulfonamido Acetic Acid	NMeFOSAA	2355-31-9	Y
N-methyl perfluorooctanesulfonamidoethanol	NMeFOSE	24448-09-7	Y
N-ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	1691-99-2	Y
Hexafluoropropylene Oxide Dimer Acid	HFPO-DA	13252-13-6	Y
4,8-Dioxa-3H-Perfluorononanoate	ADONA	919005-14-4	Y
Perfluoro-3-Methoxypropanoic Acid	PFMPA	377-73-1	Y
Perfluoro-4-Methoxybutanoic Acid	PFMBA	863090-89-5	Y
Perfluoro-3,6-Dioxaheptanoic Acid	NFDHA	151772-58-6	Y
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid	9Cl-PF3ONS	756426-58-1	Y
11-Chloroeicosafluoro-3-Oxanonane-1-Sulfonic Acid	11CL-PF3OUdS	763051-92-9	Y
Perfluoro(2-ethoxyethane) Sulfonic acid	PFEESA	113507-82-7	Y
Perfluoro-4-ethylcyclohexane Sulfonic Acid	PFECHS	646-83-3	
8-Chloroperfluoro-1-Octanesulfonic Acid	8Cl-PFOS	777011-38-8	
3-Perfluoropropyl Propanoic Acid	3:3FTCA	356-02-5	Y
2h,2h,3h,3h-Perfluorooctanoic Acid	5:3FTCA	914637-49-3	Y
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	Y
2H-Perfluoro-2-dodecenoic acid	FDUEA	70887-94-4	
2H-perfluoro-2-decenoic acid	FOUEA	70887-84-2	
Bis(perfluorohexyl)phosphinic acid	6:6PFPi	40143-77-9	
(Heptadecafluorooctyl)(tridecafluorohexyl) Phosphinic Acid	6:8PFPi	610800-34-5	
Bis(perfluorooctyl)phosphinic acid	8:8PFPi	40143-79-1	
N-(3-dimethylaminopropan-1-yl) perfluoro-1-hexanesulfonamide	N-AP-FHxSA	50598-28-2	

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