Technical Report:
PFAS concentrations in stormwater discharges from Richmond International Airport (RIC), April 2023-May 2024

Re: Virginia Pollutant Discharge Elimination System (VPDES) Permit VA0090301, renewal request submitted by RIC 12/29/2025

Linnea Saby, PhD
Consultant, Wild Virginia

This report summarizes PFAS monitoring data collected between April 2023 and May 2024 from three permitted stormwater outfalls and twelve internal sampling locations at Richmond International Airport (RIC) in Sandston, Virginia. These data were collected at the request of Virginia Department of Environmental Quality (VDEQ) in response to suspected PFAS contamination. Data and findings from the report are not available on the VDEQ or RIC website at this time, and data for this report were given directly to Wild Virginia from RIC.

The intent of this report is to help assess whether PFAS concentrations discharged from the facility represent a threat to receiving surface waters and whether those concentrations are protective of designated uses under the Clean Water Act. It is requested that this information be appropriately considered as a part of the VDEQ's review of the RIC VPDES permit renewal process, which is currently underway.

The observed PFAS concentrations in the RIC Investigation greatly exceed EPA health protective benchmarks and are likely to be causing considerable contamination of downstream waters. Across 10 sampling events, dozens of PFAS analytes were detected at levels that pose a considerable threat to human health. PFOS and PFOA, which are well-studied and highly relevant for regulatory contexts, were detected repeatedly at all three regulated outfalls.

The U.S. Environmental Protection Agency (EPA) released Draft Human Heath Ambient Water Quality Criteria (AWQC) for PFAS in 2024 under Clean Water Act Section 304(a). These criteria are intended to protect individuals exposed to pollutants in surface waters through drinking water and fish consumption and are specifically designed to inform state water quality standards and NPDES (or in this case, VPDES) permitting decisions. The concentrations measured at the RIC outfalls are several orders of magnitude higher than the scale of concentrations EPA has identified as protective of human health in surface waters. The data show observed PFOS values of up to 4.8 million times the EPA AWQC benchmark at the regulated outfalls. PFOA concentrations of more than 400,000 times greater than the AWQC are identified at regulated outfalls in the investigation. Table 1 shows mean and maximum PFOA and PFOS values and presents comparisons to the EPA Draft AWQC.

VDEQ has also developed its own provisional surface water thresholds based on EPA Draft Toxicity Values for several PFAS including PFOS (6.9 ng/L) and PFOA (1.3 ng/L) in response to the contamination in the Middle Chickahominy watershed (Middle Chickahominy PFAS Study Unified Command, 2022.). Note that the final EPA toxicity values, published in 2024, are far more stringent than the draft values for PFOA and PFOS

(EPA, 2021a; EPA, 2021b; EPA, 2024a; EPA, 2024b).[1] Even though the VDEQ provisional surface water threshold use these less-stringent draft EPA toxicity values, mean PFOS concentrations at one of the regulated outfalls (Outfall 003) were 130,000 times greater than the provisional threshold.

Table 1. Observed PFOS concentrations across 10 sampling events at regulated RIC outfalls. AWQC is the EPA Draft Human Heath Ambient Water Quality Criteria.

Outfall	Mean PFOS (µg/L)	Maximum PFOS (µg/L)	EPA Draft PFOS AWQC (µg/L)	aTimes Greater Than AWQC (Mean PFOS)	Times Greater Than AWQC (Max PFOS)
Outfall 001	47.4	142	0.0007	68,000	203,000
Outfall 002	106.9	221	0.0007	153,000	316,000
Outfall 003	1,590.9	3,390	0.0007	2,273,000	4,843,000

Results at regulated outfalls 001, 002, and 003

The dataset analyzed includes 10 sampling events at each of the three permitted discharge locations (Outfalls 001, 002, and 003). Several additional sampling events were set to have occurred per the RIC investigation plan (LimnoTech, 2023), but these data were not provided to Wild Virginia before this report was completed. Reviewing available data for the three permitted outfalls, each outfall was tested for 31 PFAS analytes. Outfall 001 shows detections for 18 analytes, Outfall 002 for 13 analytes, and Outfall 003 for 22 analytes. Thirteen analytes are detected at all three outfalls (including PFOS, PFOA, PFHxS, PFHxA, PFPeA/PFPeS, PFNA, PFBA, PFBS, PFHpA/PFHpS, PFHxSA, and 4-PFecHS), while Outfall 003 uniquely shows additional detections not seen at the other outfalls (8:2 FTS, PFOSA, PFNS, and PFTrDA).

Concentrations are also systematically higher at Outfall 003 for multiple key PFAS. For example, PFOS peaks at 3.39 mg/L (3390 µg/L) at Outfall 003 versus 0.221 mg/L (221 µg/L) at Outfall 002 and 0.142 mg/L (142 µg/L) at Outfall 001; PFHxS peaks at 1.71 mg/L (1710 µg/L) at Outfall 003 versus 0.106 mg/L (106 µg/L) and 0.0703 mg/L (70.3 µg/L) at Outfalls 001 and 002. Fluorotelomer sulfonates (notably 6:2 FTS and 8:2 FTS, concentrated at Outfall 003) and high sulfonate PFAS (PFOS, PFHxS) are all detected at Outfall 3 at values considerably higher than at Outfalls 1 and 2. Figures 1-3 show the mean value for each detected PFAS analyte at Outfalls 001, 002, and 003, respectively.

[1] EPA's draft toxicity values (used by VDEQ for the provisional threshold) were 1.5×10^{-9} mg/kg/day for PFOA and 7.9×10^{-9} mg/kg/day for PFOS. The final EPA toxicity values used for the 2024 PFAS drinking-water rule are approximately 3×10^{-11} mg/kg/day for PFOA and 2×10^{-11} mg/kg/day for PFOS, making the finalized toxicity values roughly 50 times lower for PFOA and about 400 times lower for PFOS than the draft values.

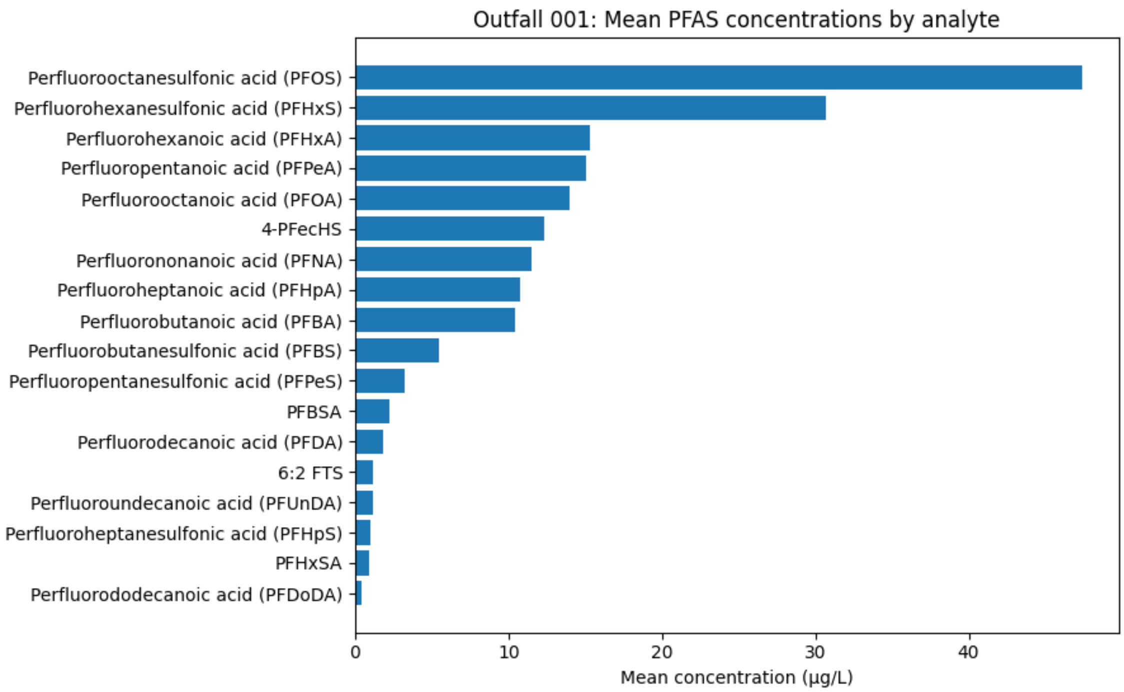

Figure 1. Mean PFAS concentrations of detected analytes across 10 sampling events at Outfall 001. Non-detect events were counted as "0" in mean calculations.

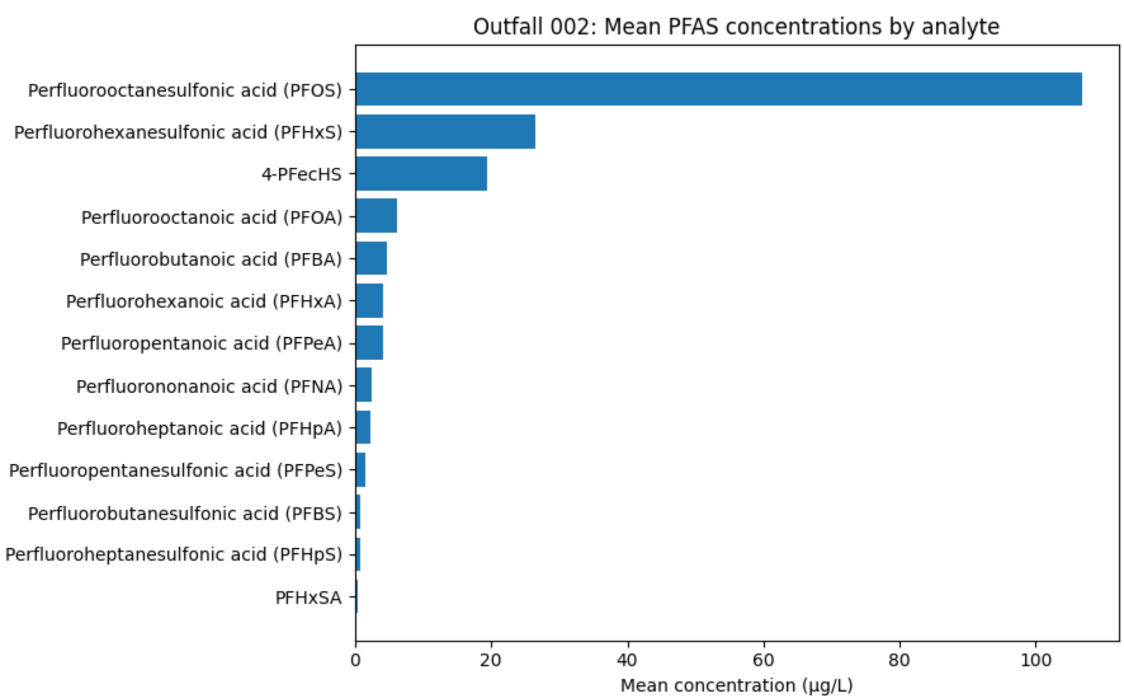

Figure 2. Mean PFAS concentrations of detected analytes across 10 sampling events at Outfall 002. Non-detect events were counted as "0" in mean calculations.

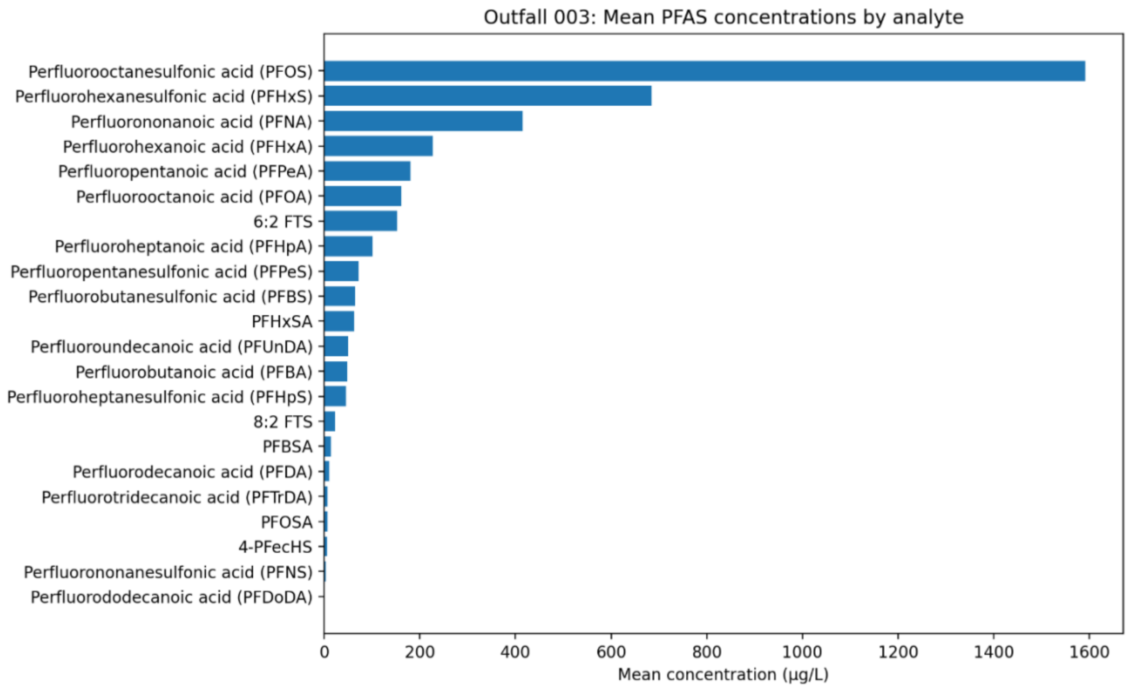

Figure 3. Mean PFAS concentrations of detected analytes across 10 sampling events at Outfall 003. Non-detect events were counted as "0" in mean calculations.

The high analyte concentrations at Outfall 003 do not necessarily confirm that the largest amount of PFAS contamination comes from the Outfall 003 watershed. Even larger total PFAS loads may be entering waterways from other areas, but may be more diluted. In particular, the watershed area for Outfall 1 (2032 acres) is much larger than for Outfall 2 (108 acres) or Outfall 3 (219 acres), so observed PFAS values at Outfall 1 are expected to be much more diluted than from the other areas. Therefore, the total load of PFAS entering the waterways could be higher for Outfall 1 than Outfall 3.

To produce more comparable estimates of total PFAS loading and gain a more complete picture of PFAS contamination entering waterways, discharge estimates for each Outfall are needed. Such estimates were not provided in RIC's data submittals to Wild Virginia. Section 4.1.2 of the RIC Investigation Plan (LimnoTech, 2023) notes that "Discharge flow estimates for outfalls" will be included in Field Log Books as a part of sampling procedures. VDEQ should request these estimates from RIC, if not already received, so that total PFAS loading can be calculated as a part of a remediation plan development.

Results at internal sampling locations

The 12 internal monitoring locations (STW1-1 through STW1-7 and STW3-1 through STW3-5) show that PFAS contamination is widespread within the airport drainage system prior to discharge at the permitted outfalls. The number of PFAS analytes detected at these sites ranges from 4 to 23. Several internal stations show particularly diverse PFAS profiles: STW3-1 and STW3-4 each have 23 detected analytes, while STW1-7 has 21 detected analytes.

PFOS concentrations within the internal drainage network are frequently higher than those measured at the permitted outfalls, since dilution occurs as water moves toward the final discharge points. The maximum PFOS concentrations observed is 4.32 mg/L at STW3-1, which is 6.2 million times greater than the EPA Draft AWQC. Several internal sites exhibit particularly elevated PFOS levels, including STW1-2 (3.78 mg/L), STW3-4 (2.94 mg/L), and STW1-1 and STW1-7 (approximately 1.07–1.09 mg/L).

PFOA concentrations follow a similar pattern but are generally lower than PFOS, while still being 4-5 orders of magnitude over EPA benchmarks. The highest PFOA value observed in the internal monitoring network is 0.626 mg/L at STW1-2 (which is 700,000 times greater than the EPA Draft AWQC), with other sites typically below 0.3 mg/L.

The presence of high PFOS concentrations and numerous PFAS analytes across multiple internal locations indicates that PFAS contamination is distributed throughout the airport stormwater infrastructure rather than confined to a single localized source. These data suggest that multiple drainage pathways contribute PFAS to the external outfalls and that concentrations measured at the permitted discharge points likely represent diluted mixtures originating from several sources within the airport stormwater system.

Addressing legacy PFAS pollution

The PFAS profile and distribution observed in the sampling results are strongly characteristic of long-term residual contamination from historical firefighting foam use. In particular, samples are dominated by PFOS and PFHxS, which are key components of legacy military-spec AFFF manufactured by 3M from the 1960s-2002 (IRTC, 2023). This indicates that any plan to mitigate PFAS discharge must include legacy cleanup actions such as soil excavation and disposal, groundwater pump-and-treat systems, hydraulic containment, or treatment with activated carbon or ion-exchange resins.

As noted on the VDEQ website, the Air National Guard completed a limited study on its contribution to legacy PFAS contamination on the RIC property in 2016 with a report issued in 2019. That report found multiple PFAS in groundwater samples, and future remediation studies are awaiting funding (ANG, 2019). We note that these activities occurred in the watershed for Outfall 001, and the RIC Investigation shows extensive PFAS contamination elsewhere in the Airport facility that would not be addressed by any future actions identified by the Air National Guard in the 2019 study.

Addressing future use of PFAS

PFAS-containing firefighting foams could be immediately phased out of use in favor of commercially-available PFAS-free alternatives. The RIC PFAS Investigation Plan notes that Federal Aviation Administration (FAA) regulations require airports to maintain firefighting agents that meet a military specification that effectively mandates PFAS-containing Aqueous Film-Forming Foam (AFFF, LimnoTech, 2023). Historically that is accurate, but since the completion of the RIC Investigation Plan, federal policy has shifted toward eliminating PFAS-based foams as approved fluorine-free alternatives (F3) have become available (FAA, 2023). Several approved fluorine-free alternative products are now commercially available.

Formulations meeting the new military specification include SOLBERG 3 % MIL-SPEC Synthetic Fluorine-Free Foam, BIOEX ECOPOL A3+, and National Foam's Avio Green Mil 3 %, which have all been certified as meeting the new performance standard and may be used by airports instead of AFFF.

Airports across the country have already transitioned away from PFAS use. Jackson Hole Airport (Wyoming) replaced PFAS-containing AFFF with fluorine-free foam in its aircraft rescue and firefighting vehicles in 2023 after the first certified F3 product became available. Similarly, Denver International Airport completed a full transition to fluorine-free foam in its aircraft rescue and firefighting fleet, removing PFAS-containing foam from vehicles and replacing it with F3. Seattle-Tacoma International Airport has also undertaken a conversion program, cleaning PFAS foam from its firefighting vehicles and replacing it with fluorine-free products to eliminate PFAS releases from airport operations. Use of the new products may require cleaning equipment, retraining firefighters, and replacing or modifying firefighting systems. Federal programs provide funding to help airports complete this transition.

Conclusion

Data from the RIC Investigation clearly show that the airport facility represents an ongoing major source of more than a dozen PFAS analytes, especially PFOS, to downstream surface waters. Under both wet and dry conditions, PFAS are being discharged through regulated outfalls at concentrations that are many orders of magnitude above both EPA and VDEQ health-based benchmarks. Under the Clean Water Act, discharges that compromise designated uses require additional source water controls and/or remediation actions to protect downstream water quality. Such measures are strongly warranted as part of any VPDES permit renewal.

References

Air National Guard (ANG). 2019. *Final Report, FY16 Site Inspections: Former 192nd Fighter Wing, Virginia Air National Guard, Richmond International Airport (Byrd Field), Sandston, Virginia. Delivery Order 0006*. May 2019.

Environmental Protection Agency (EPA). 2021a. *External Peer Review Draft: Proposed Approaches to the Derivation of a Draft Maximum Contaminant Level Goal for Perfluorooctanoic Acid (PFOA) in Drinking Water*. EPA-822-D-21-001. Washington, DC: U.S. EPA Office of Water.

EPA. 2021b. *External Peer Review Draft: Proposed Approaches to the Derivation of a Draft Maximum Contaminant Level Goal for Perfluorooctane Sulfonic Acid (PFOS) in Drinking Water*. EPA-822-D-21-002. Washington, DC: U.S. EPA Office of Water.

EPA. 2024a. *Human Health Toxicity Assessment for Perfluorooctanoic Acid (PFOA)*. EPA-822-R-24-007. Washington, DC: U.S. EPA Office of Water.

EPA. 2024b. *Human Health Toxicity Assessment for Perfluorooctane Sulfonic Acid (PFOS)*. EPA-822-R-24-008. Washington, DC: U.S. EPA Office of Water.

Federal Aviation Administration. *Transition to Fluorine-Free Firefighting Foam (F3) for Aircraft Rescue and Firefighting (ARFF)*. FAA Office of Airport Safety and Standards, 2023.

Interstate Technology and Regulatory Council (IRTC). 2023. *PFAS Technical and Regulatory Guidance Document and Fact Sheets PFAS-1*. Washington, D.C. IRTC, PFAS Team.

LimnoTech. 2023. *Richmond International Airport Stormwater Investigation Work Plan*. 501 Avis Dr., Ann Arbor, MI, 48108.

Virginia Department of Environmental Quality (VDEQ), Virginia Department of Health (VDH), and Middle Chickahominy PFAS Study Unified Command. 2022. *Provisional PFAS Screening Values for Surface Waters Designated as Public Water Supplies (PWS), Non-PWS Surface Waters, and Fish Tissue.* Memorandum to the Middle Chickahominy River PFAS Study Unified Command, December 9, 2022.