Airport Asphalt Pavement Technology Program

Determining the Environmental Impact of Recycled PFAS-Containing Pavement Materials

Stage 1 – Phase 1: Encapsulation and Leaching of Artificially Spiked Pavements

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AIRPORT ASPHALT PAVEMENT TECHNOLOGY PROGRAM

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The Airport Asphalt Pavement Technology Program (AAPTP) is a cooperative agreement effort between the **National Asphalt Pavement Association** (NAPA) and the **Federal Aviation Administration** (FAA) to advance asphalt pavements and pavement materials. The AAPTP advances solutions for asphalt pavement design, construction, and materials deemed important to airfield reliability, efficiency, and safety. The program leverages NAPA's unique technology implementation capabilities with assistance from the FAA and industry to advance deployment and adoption of innovative asphalt material technologies.

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List of Abbreviations, Acronyms & Units of Measurement

AC	Asphalt concrete
AFFF	Aqueous film forming foam
DI	Deionized
EIS	Extracted internal standard
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FDOT	Florida Department of Transportation
FTO	Fluorotelomer olefin
FTS	Fluorotelomer sulfonates
HDPE	High-density polyethylene
HMA	Hot mix asphalt
L/S	Liquid-to-solid ratio
LOQ	Limit of quantitation
MIST	Moisture-induced stress test
NAPA	National Asphalt Pavement Association
NCAT	National Center for Asphalt Technology
ng	Nanogram
NIS	Non-extracted internal standard
ORP	Oxidation-reduction potential
PCC	Portland cement concrete
PFAS	Per- and polyfluoroalkyl substances
PFCA	Perfluoroalkyl carboxylic acids
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PFSA	Perfluoroalkyl sulfonic acids
PSD	Particle size distribution
PUF	Polyurethane foam
RAP	Reclaimed asphalt pavement
RCA	Recycled concrete aggregate
SPE	Solid phase extraction
UHPLC-MS/MS	Ultra-high pressure liquid chromatography-tandem mass spectrometry

Executive Summary

The widespread use of aqueous film forming foams (AFFF) containing per- and polyfluoroalkyl substances (PFAS) for fire suppression at airfields and fire training sites has resulted in significant quantities of AFFF-impacted pavement at facilities across the United States. As the majority of Portland cement concrete (PCC) and asphalt concrete (AC) are recycled into new pavements, the potential for PFAS migration to the environment from the reincorporation of impacted pavements into new pavements remains a major concern. The extent to which PFAS are adsorbed or encapsulated within new pavement mixtures containing impacted materials is not currently well understood. A primary pathway of concern for PFAS release to the environment is leaching from exposure to rainfall, whether through unencapsulated storage of impacted pavement in material stockpiles or through its incorporation into new pavements.

Through a multidisciplinary collaboration, the University of Florida and Auburn University, in partnership with the National Asphalt Pavement Association, sought to address these existing knowledge gaps through a two-stage project. Stage 1 (Phase I), the focus of this report, investigated PFAS behavior during PCC and AC recycling using artificially impacted materials as proof of concept. Stage 2 (Phases II–IV) will expand on findings from Stage 1 to examine PFAS behavior from field-collected impacted pavements.

For Stage 1, unimpacted recycled concrete aggregate and reclaimed asphalt pavement were collected and spiked with known concentrations of PFAS-containing AFFF. The total concentrations in the artificially impacted pavements were assessed, then the materials were recycled into new pavements and subjected to various laboratory leaching procedures. An additional investigation of PFAS volatilization and release to the gas phase during the hot mix asphalt (HMA) process was conducted. This report details the background, methodology, and findings of Stage 1, which serve to inform subsequent investigations undertaken in Stage 2.

Findings from Stage 1 demonstrated that the degree of encapsulation is dependent on the type of PFAS (i.e., chain length, functional group), pavement, and leaching procedure utilized. While perfluorooctane sulfonic acid (PFOS), an eight-chain-length PFAS from the sulfonate subclass, is the dominant compound in legacy AFFF formulations, high encapsulation rates were achieved. When leaching was conducted on intact specimens, 85–98 percent retention (U.S. Environmental Protection Agency [EPA] Method 1315 and moisture-induced stress test [MIST]) was observed across pavement types. Under batch leaching conditions (EPA Method 1316), where pavements were crushed prior to testing, lower PFOS encapsulation was observed, with approximately 63 percent encapsulation in both asphalt and concrete. This preliminary investigation into PFAS volatilization during the HMA heating process, examined at 135 °C, demonstrated that while some PFAS from the carboxylate subclass were volatilized (e.g., perfluorooctanoic acid [PFOA]), less than

0.02 percent of the available mass was mobilized. Overall, while findings from this stage indicate that concrete and asphalt can achieve varying degrees of PFAS encapsulation and serve as proof of concept, the extent of encapsulation and the effects of pavement age and variability when field-impacted pavements are recycled warrant further investigation in Stage 2.

1. Introduction

Historic use of aqueous film forming foams (AFFF) containing per- and polyfluoroalkyl substances (PFAS) at fire training, airport, and military locations across the United States has resulted in hundreds of sites with PFAS-impacted pavement materials. When AFFF is applied to pavements, whether through spills or intentional applications, a foam coalesces and may either bind to the material it contacts or run off during precipitation events to the surrounding environment or drainage system. As impacted paved surfaces near their end-of-life or sites seek to remediate areas with known AFFF exposure, they are milled and stockpiled. In the United States, asphalt and concrete pavements are heavily recycled as aggregates in new pavement mixes, or as drainage, subbase, or fill materials [1]. However, the presence of PFAS and the extent to which they leach from impacted debris may limit the reuse potential of impacted asphalt and concrete pavements. Given the recent designation of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) as hazardous substances [1], it is increasingly important to understand the risk posed by AFFF-impacted pavements in current practices like reuse and stockpiling. Beneficial use and recycling guidelines have not yet been clearly defined for PFAS-containing pavement materials but are dependent on the concentrations and leachability of PFAS from the materials.

To determine the environmental risk posed by PFAS-containing pavement materials during recycling, the leachability of PFAS from AFFF-impacted pavement millings themselves, both Portland cement concrete (PCC) and asphalt concrete (AC), must first be understood. Similarly, when materials are reincorporated into new pavements, the leachability risk posed by those pavements requires investigation. Though there is emerging research regarding PFAS mobility from AFFF-impacted pavements, there is a lack of research regarding the recycling potential of PFAS-containing pavement materials.

Leaching tests have historically been used as tools in assessing the risk posed by a material. In the United States, a multitude of standardized leaching procedures are commonly applied for environmental assessment, each intended to provide leaching data under specific conditions. For example, the U.S. Environmental Protection Agency's (EPA's) Toxicity Characteristic Leaching Procedure (EPA Method 1311) represents leaching conditions that could be encountered if a material was disposed in a landfill environment, while the agency's Synthetic Precipitation Leaching Procedure (EPA Method 1312) is designed to represent leaching as a result of rainfall exposure. In this assessment, the following three leaching procedures, representing conditions potentially encountered in asphalt and concrete lifecycles, were used to assess the PFAS risks posed:

- EPA Method 1316 – Liquid–solid partitioning as a function of liquid–solid ratio using a parallel batch extraction procedure.

- EPA Method 1315 – Mass transfer rates of constituents in monolithic or compacted granular materials using a tank leaching procedure.
- Moisture-induced stress test (MIST) – Leaching from aged/environmentally stressed monolithic materials.

Specific methodology and background for each leaching procedure used are described further in Section 2.2 of this report.

1.1 Objectives

The aim of this project is to address knowledge gaps related to PFAS leaching from impacted pavements, with work organized in two distinct stages. Stage 1, the focus of this report, serves as proof of concept, examining the leachability of PFAS from artificially impacted pavements in a controlled, laboratory setting. As such, specific objectives were established for Stage 1:

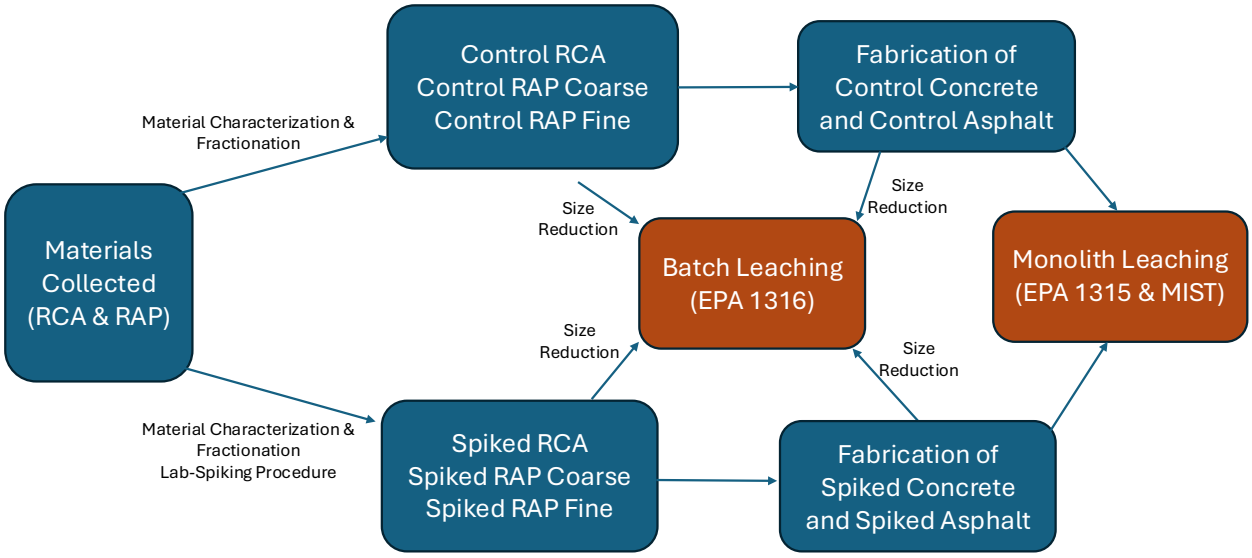
- Measure leachable and extractable PFAS concentrations in artificially impacted recycled pavement materials.
- Measure leachable and extractable PFAS concentrations in new pavements fabricated with artificially impacted recycled pavement materials.
- Investigate PFAS volatilization during the hot mix asphalt (HMA) process.
- Inform the feasibility of encapsulation of real, field-impacted pavements for Stage 2.

1.2 Document Organization

This report is organized into four sections, Section 1 being this introduction. Section 2 outlines the methodology followed for the artificial spiking of recycled pavement materials, the selected leaching procedures, pavement fabrication, exhaust gas sampling, and PFAS analysis. Section 3 presents relevant findings regarding leaching, encapsulation, and volatilization of PFAS from pavement materials. Finally, Section 4 provides a broad summary of the research performed in Stage 1 and the main conclusions.

2. Methodology

To assess encapsulation of PFAS in new pavements, recycled concrete aggregate (RCA) and reclaimed asphalt pavement (RAP) were collected and artificially spiked with AFFF. Artificially spiked RCA and RAP were then incorporated into new PCC and AC pavements. The total (i.e., extractable) PFAS concentrations of the solid pavement materials were measured and used to calculate leachability and encapsulation. The newly constructed PCC and AC specimens were subjected to three leaching procedures: EPA Method 1316 static batch leaching, EPA Method 1315 semi-dynamic tank leaching, and moisture-induced stress test (MIST). EPA Method 1316 static batch leaching assesses the leaching behavior of PCC and AC when size-reduced and rotated end-over-end over a 72-h period. EPA Method 1315 assesses leaching from intact PCC and AC specimens over a 63-day period. MIST assesses the leaching behavior of intact PCC and AC specimens when subjected to high environmental stress via cyclic pressure variations. A process diagram outlining the fabrication and experimentation for Stage 1 pavements is provided in Figure 1.



Note: Solid and leachate matrices generated from testing were extracted and analyzed for PFAS following EPA Method 1633.

Source: University of Florida

Figure 1. Process Flow Diagram for Experimentation in Stage 1

2.1 Pavement Fabrication

RCA and RAP that were not known to contain AFFF-impacted materials were sourced from two facilities in Florida. To effectively produce artificially impacted materials while preventing the creation of excess impacted materials, concrete and asphalt mix designs were determined before material acquisition and processing. To represent a typical concrete, the mix design for the PCC used in this work was in accordance with Florida Department of Transportation (FDOT) Section 347, non-structural concrete [2]. Appendix B

provides further detail on the selected PCC mix design. An HMA mix design was selected with guidance from the National Asphalt Pavement Association (NAPA), representing a typical airfield pavement, following the Federal Aviation Administration's (FAA's) P-401 specifications [3]. Appendix C provides details on the AC mix design selected.

2.1.1 Material Collection and Processing

The control (unspiked) RCA, not known to contain PFAS, was obtained from a facility in Gainesville, FL. The RCA collected was crushed to meet the requirements of a No. 57 gradation per ASTM C33 [4]. The RCA selected was representative of typical RCA graded for recycling in new non-structural PCC mixes. After collection, RCA was stored in 19-L high-density polyethylene (HDPE) buckets. The RCA was homogenized on a methanol-cleaned polyethylene tarp with methanol-cleaned shovels following ASTM D6323 [5]. The particle size distribution (PSD) of the RCA was determined following ASTM C136 [6]. Ensuring the RCA (in combination with the virgin coarse aggregate) met No. 57 stone requirements was critical for the PCC mix design; see Appendix A, Table A-1 for RCA and virgin coarse aggregate PSDs and No. 57 stone requirements.

Control RAP, not known to contain PFAS, was collected from a facility in Tampa, FL. The collected RAP was crushed to meet airport specification P-401, as informed by Auburn University's National Center for Asphalt Technology. The PSD was reported by the facility and is presented in Appendix A, Table A-2. RAP was stored in 19-L HDPE buckets and then homogenized on a methanol-cleaned polyethylene tarp with methanol-cleaned shovels following ASTM D6323 [5]. Using a sieve shaker, all material larger than 12.7 mm (1/2 inch) was removed, and the remaining material was fractionated using a sieve with 2.36 mm (No. 8) openings; material retained on the sieve was considered coarse, and material passing the sieve was considered fine.

2.1.2 Artificial Impacting of Recycled Pavements

Using an AFFF with known concentrations of legacy PFAS, including PFOS, processed RCA and RAP samples were artificially impacted to replicate concentration and speciation typical of field-impacted pavements. The complete PFAS characterization of the legacy AFFF used in this study is provided in Appendix A, Table A-3 for reference. An AFFF dose was calculated to yield concentrations of common or regulatorily significant PFAS such as PFOS, PFOA, perfluorohexane sulfonic acid (PFHxS), perfluorohexanoic acid (PFHxA), and 6:2 fluorotelomer sulfonate (6:2FTS)—within typical ranges for impacted RAP and RCA (Table 1). It should be noted that PFAS concentrations within AFFF-impacted concrete and asphalt are variable, and available data remain limited given the emerging nature of this field of research. A concentration within the range of values presented was achieved by artificially spiking RCA and RAP with a 2-percent AFFF solution.

Pavement materials were spiked at a liquid-to-solid ratio (L/S) of 2 in 19-L HDPE buckets that were rotated end-over-end for 24 h and allowed to equilibrate for 8 h before the solid

material was removed and air dried. Coarse and fine fractions of RAP were spiked independently.

Table 1. Summary of PFAS Concentration Ranges from Existing Literature on AFFF-Impacted Concrete and Asphalt Pavements

Pavement Type	Concentration (ng/g)				
	PFOS	6:2FTS	PFOA	PFHxS	PFHxA
Concrete [a, b, c, d]	50–3,688	0.5–2,200	5–300	9–2,550	6–1,050
Asphalt [a, e]	47–1,952,000	<LOD–3.3	0.01–13,500	11–183,000	<LOD–2.8

LOD = limit of detection.
[a] Li et al., 2024 [7]
[b] Thai et al., 2022 [8]
[c] Thai et al., 2025 [9]
[d] Williams et al., 2023 [10]
[e] Srivastava et al., 2022 [11]

2.1.3 Reincorporation into New Pavements

As described, the selected PCC mix design is a standard FDOT Section 347 non-structural mix. Following ASTM C192 [12], control (incorporating control RCA) and experimental (incorporating artificially impacted RCA) PCC mixes were fabricated with 20 percent coarse aggregate replacement. Both mixes used limerock as the primary coarse aggregate, sand as the fine aggregate, and Type IL cement. Prior to batching, the limerock and RCA were soaked for 24 h and allowed to dry for 1 h. Sand was dried completely at 100 °C for 24 h and assumed to have a moisture content of 0 percent. During batching, subsamples of RCA (1 kg) and limerock (4.5 kg) were taken for moisture content, and the coarse aggregate mass was adjusted accordingly before mixing. After mixing, the temperature, slump, air content, and unit weight were measured following ASTM C143 [13] and ASTM C138 [14]; see Appendix B for PCC mix quality data. Cylindrical specimens were formed in 10.16 cm × 20.32 cm (4 × 8 inch) HDPE molds following ASTM C192 [12]. To avoid sample and equipment contamination, specimens were sealed in their molds using an HDPE lid and duct tape, then left to cure in sealed conditions for 28 days. At 28 days, specimens were demolded and promptly prepared for subsequent testing.

Herein, the PCC specimens incorporating control RCA will be referred to as “unspiked concrete,” and the PCC specimens incorporating artificially impacted RCA will be referred to as “spiked concrete.” It should be noted that during the concrete mix in which spiked RCA was used as a partial coarse aggregate replacement, the mix began to foam. This foaming action resulted in an air content of 13 percent, rather than the designed 3 percent, which is more porous than what is typically encountered. Table 2 provides details regarding the contribution of RCA to various fractions for the PCC mix.

Table 2. Percent Mass Replacement by Artificially Spiked RCA and RAP in PCC and AC Mixes

Fraction	Percent Replacement by Mass	
	PCC Mix Replacement by RCA	RAP Mix Replacement by RAP
Coarse Aggregate	20	N/A
Total Aggregate	12.5	21
Final Concrete	9.9	20

N/A = not applicable.

As described, the selected HMA mix design is modeled after a standard airfield pavement design (FAA P-401). Following AASHTO T 312 [15], control and experimental HMA mixes were fabricated with 20 percent RAP replacement by mass (Table 2). Detailed design parameters for the utilized HMA mix are provided in Appendix C. Prior to batching, coarse and fine RAP fractions were recombined (separated for effective spiking) at the original ratio of 66 percent fines; Table 2 provides RAP's original PSD. Then RAP, virgin granite, and virgin sand were conditioned at 135 °C; RAP was conditioned solitarily in a separate oven for purposes of the gas sampling outlined in Section 2.7. The aggregates were then mixed with PG 76-22 binder, and gyratory specimens (150 mm × 95 mm) were prepared following AASHTO T 312 [15]. The bulk specific gravity and percent air voids were then determined following AASHTO T 166 [16] and AASHTO T 269 [17] (Table C-1 and Table C-2 in Appendix C). Herein, the HMA specimens incorporating control RAP will be referred to as "unspiked asphalt," and the HMA specimens incorporating artificially impacted RAP will be referred to as "spiked asphalt."

2.2 Environmental Assessment of Leachability

To assess the leachability of artificially impacted pavements, three leaching tests were performed: EPA Method 1316, EPA Method 1315, and MIST. All materials, including control RAP and RCA as originally collected, were subjected to batch leaching (EPA Method 1316) to assess the leachability of the materials themselves. Fabricated pavements, both spiked and unspiked (controls), underwent all batch and monolithic leaching procedures. Table 3 provides a summary of the conducted leaching tests.

In the standard batch leaching test, EPA Method 1316, materials are size-reduced (≤9.53 mm or 3/8 inch) and leached in an end-over-end fashion for 72 h. While this batch procedure typically involves parallel leach tests with varying ratios of liquid to the same amount of solid, only the highest L/S ratio of 10 was examined to provide a conservative estimate of the highest likely leached concentration.

Table 3. Summary of Leaching Tests Conducted on Recycled Pavement Materials and New Pavements

Pavement	Type	Leaching Procedure		
		Batch	Monolithic	
		EPA 1316 at L/S 10	EPA 1315	MIST
Asphalt	Control RAP as collected	X		
	Spiked RAP as collected	X		
	Fabricated pavement, unspiked (control)	X	X	X
	Fabricated pavement, spiked	X	X	X
Concrete	Control RCA as collected	X		
	Spiked RCA as collected	X		
	Fabricated pavement, unspiked (control)	X	X	X
	Fabricated pavement, spiked	X	X	X

In monolithic leaching, specimens are left intact; the methods examined were EPA Method 1315 and MIST. In EPA Method 1315, specimens are leached over a 63-day period under semi-dynamic conditions, where intact cylinders are repeatedly exposed to fresh volumes of water, representing conditions potentially encountered in flooded or saturated in-place pavements. Unlike previously described EPA methods, the MIST procedure is not a standardized leaching procedure. Rather, MIST places intact specimens through artificial weathering/environmental stress by exposing pavements to cyclic pressure variations under saturated conditions. Uniquely, the leachate produced from this procedure provides insight into the leaching potential from aged pavements.

2.2.1 Batch Leaching: EPA Method 1316

EPA Method 1316 is a parallel batch leaching procedure that assesses the leaching of size-reduced materials. An example photograph of this procedure is provided in Figure 2. Batch leaching was performed following a modified EPA Method 1316 [18] at an L/S of 10. All collected and artificially impacted materials were subjected to batch leaching, including control and artificially impacted RCA and RAP as well as the fabricated spiked and unspiked concrete and asphalt specimens. Each material was size-reduced to less than 9.53 mm (3/8 inch) following ASTM C702 [19]; all surfaces and tools were cleaned with

Liquinox soap and subsequently rinsed with methanol before size reduction. Following the method, 90 g of material was combined with 900 mL of nanopure deionized water (<15 MΩ/cm) in a 1-L HDPE bottle and rotated end-over-end for 72 h; all batch tests were conducted in triplicate. The samples were allowed to settle for 30 min, then the pH was recorded, and 125-mL samples were collected from each replicate and stored at −18 °C until extraction.



Source: University of Florida

Figure 2. Parallel Batch Leaching (EPA Method 1316, L/S = 10)

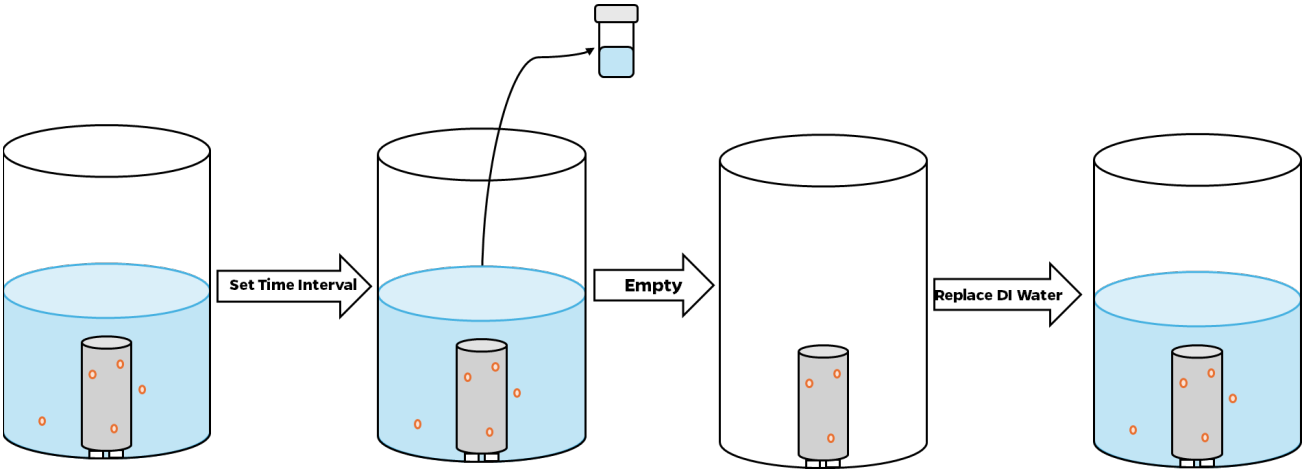
2.2.2 Semi-Dynamic Tank Leaching: EPA Method 1315

Per EPA Method 1315, the surface area of each specimen was determined using the average of four diameter measurements and the average of three length measurements. The volume of eluent (deionized water) was then determined based on a liquid-to-surface area ratio of 9 ± 1, resulting in an eluent volume of 7,500 mL. As described in EPA Method 1315, the leaching procedure occurs over 63 days with nine distinct leaching intervals assessed (Table 4).

Table 4. EPA Method 1315 Leaching Schedule

Interval Label	Interval Duration (h)	Interval Duration (days)	Cumulative Leaching Time (days)
T01	2.0 ± 0.25	–	0.08
T02	23.0 ± 0.5	–	1.0
T03	23.0 ± 0.5	–	2.0
T04	–	5.0 ± 0.1	7.0
T05	–	7.0 ± 0.1	14.0
T06	–	14.0 ± 0.1	28.0
T07	–	14.0 ± 0.1	42.0
T08	–	7.0 ± 0.1	49.0
T09	–	14.0 ± 0.1	63.0

For each leaching interval, the specimen was placed on polyethylene grating in the center of a methanol-cleaned 19-L bucket. The specimen was then completely submerged in 7,500 mL of eluent, the bucket was sealed, and the specimen was left to leach for the set time interval. Once the set time interval was complete, the specimen was removed and allowed to drip dry for 20 s, then weighed. The eluent was then stirred, and a 125-mL sample was collected 2 inches below the surface and stored at −18 °C until extraction. Using a YSI meter, the pH, conductivity, oxidation-reduction potential (ORP), and temperature were measured (data are available in Appendix A, Table A-5 through Table A-8). The eluent was then discarded, the bucket and grating were cleaned with Liquinox soap and rinsed with methanol, and the process was repeated for the subsequent time intervals. A representation of the leaching procedure is provided in Figure 3.



DI = deionized.

Source: University of Florida

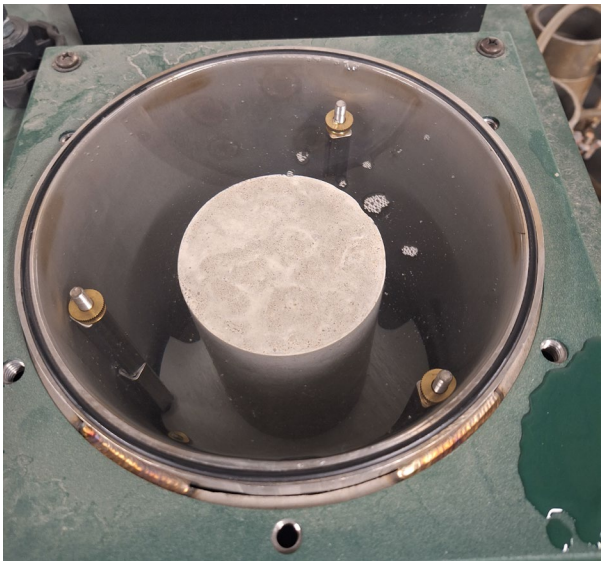
Figure 3. EPA Method 1315 Process Diagram for Sampling at Each Set Time Interval

2.2.3 Leaching Under Weathered Conditions: MIST

MIST is a procedure used to simulate environmental weathering and stress on intact specimens and subsequently assess the impact to their strength. However, for this research, MIST was used as a leach test by collecting the resulting process water. For this test, the specimen was placed in a chamber filled with 60 °C water and left to condition submerged at atmospheric pressure for 20 h; this is called the adhesion period. Following the adhesion period, a bladder in the tank is repeatedly inflated and deflated, such that the pressure in the tank is raised to 40 psig and reduced to atmospheric pressure 3,500 times over a period of approximately 4 h.

After the test was completed, water was drained from InstroTek's Moisture Induced Stress Tester (M.i.S.T.™) apparatus and a 1-L subsample was collected and stored at −18 °C until extraction. Between specimens, the instrument was cleaned with methanol and rinsed

with water three times. An example photograph of a concrete specimen undergoing the MIST procedure is provided in Figure 4.



Source: Auburn University

Figure 4. MIST Instrument Containing Concrete Specimen

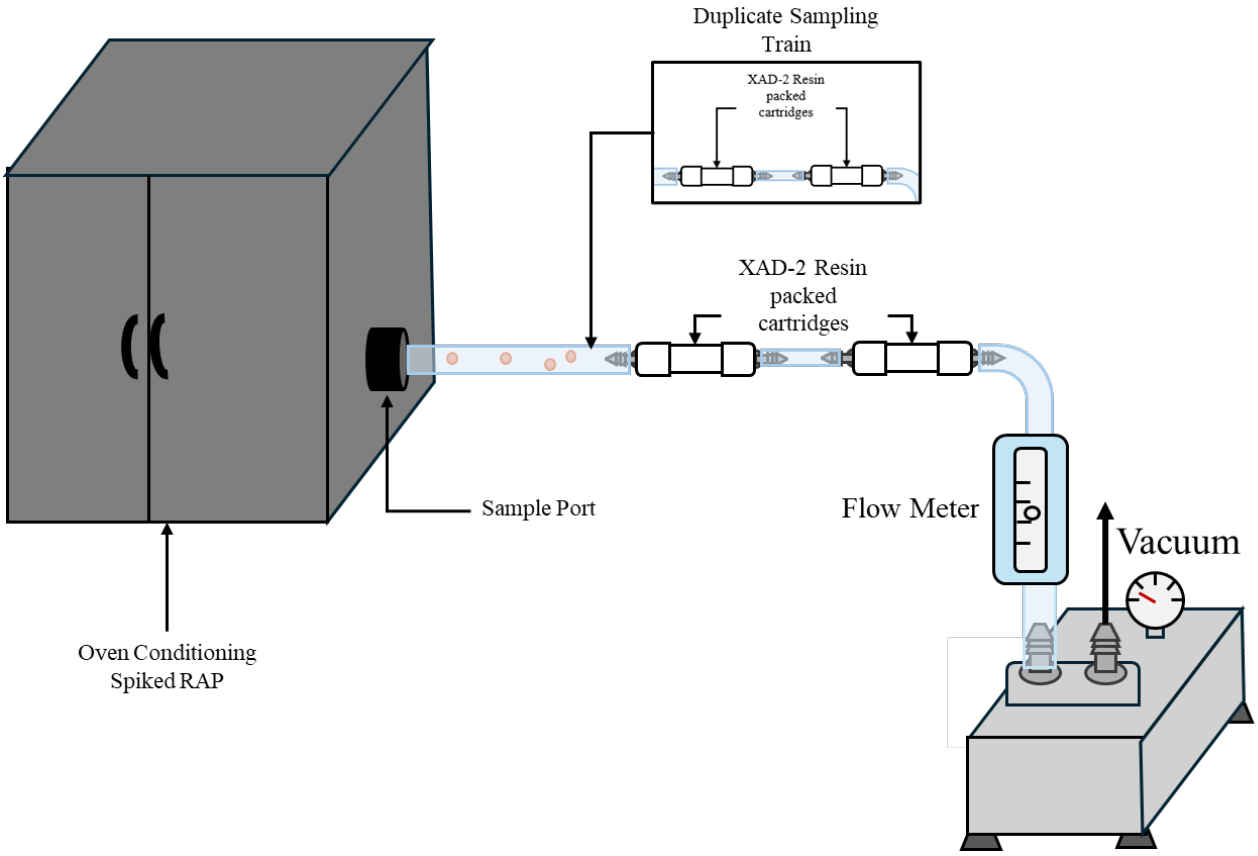
2.3 Assessment of Emissions During HMA Process

In addition to research focused on leaching and encapsulation, NAPA was also interested in a preliminary investigation of the potential for PFAS volatilization during Stage 1. As outlined in Section 2.1.3, during the HMA process RAP is cured at 135 °C for 1.5 h, potentially allowing the volatilization of some PFAS to exhaust gases [20].

To preliminarily assess the potential for PFAS emission during the HMA process, gaseous samples were collected during the RAP conditioning (heating) stages described in Section 2.1.3 by routing RAP conditioning oven exhaust gases through a sorbent-based (XAD-2) sampling train, depicted in Figure 5. As illustrated, exhausts were split into two sampling trains, one dedicated to the analysis of semivolatile anionic PFAS (e.g., PFOA) and the other dedicated to the analysis of volatile neutral PFAS (e.g., fluorotelomer olefins [FTOs]).

Sampling trains consisted of two polyvinyl chloride (PVC) cartridges filled with 4–5 g of Amberlite XAD-2 resin retained between two polyurethane foam (PUF) discs. Cartridges were connected via polyethylene tubing to a flow meter and vacuum pump to monitor and maintain a consistent gas flow throughout sampling. To ensure existing contamination was not introduced by the oven or control RAP components (e.g., RAP binder), blank and control samples were collected. The blank sample was collected by bringing the oven to conditioning temperature with no material inside, while the control sample was collected during the conditioning of unspiked RAP.

Oven exhaust gas was sampled at a rate of 4 L/min, resulting in approximately 360 L (0.36 m^3) of exhaust gas sampled. It should be noted that the sampled gas volume is not representative of the exhaust volume produced; the resulting data were used to determine the mass of PFAS emitted per mass of conditioned RAP.



Source: University of Florida

Figure 5. Diagram of Gas Sampling Setup Used to Sample Exhaust Gas from RAP Conditioning During the HMA Process

2.4 PFAS Extraction and Analysis

2.4.1 Solid Samples

The total (i.e., extractable) PFAS concentrations of the recycled pavement materials and newly formed pavements were measured to determine how much PFAS were available to leach during the leaching procedures described in Section 2.2. Total PFAS concentrations were later used in conjunction with leachate concentrations to determine leachability or encapsulation. To determine the "total," or extractable, PFAS concentrations present in the aggregate and newly formed pavement materials, solid samples were solvent-extracted following EPA Method 1633 [21]; all solvent extractions were conducted in triplicate.

Solid samples were size-reduced to below 2 mm in diameter and aliquoted into 50-mL polypropylene tubes. The extracted mass was dependent on the estimated PFAS

concentration and ranged from 0.2 g–4 g ± 0.05 g. For PFAS quantitation, all solids were spiked with mass-labeled internal standards prior to extraction (extracted internal standard [EIS]) (Appendix D, Table D-1), then vortexed for 30 s to incorporate the EIS and equilibrated for 30 min. Then, 7 mL of 0.3 percent ammonium hydroxide in methanol was added to each sample, the mixture was vortexed for 30 s, sonicated for 30 min, rotated end-over-end for 30 min, and centrifuged at 4,000 rpm for 10 min. The resulting supernatant was pipetted into a 15-mL polypropylene tube. The extraction procedure was repeated with an additional 7 mL of 0.3 percent ammonium hydroxide in methanol, and the supernatants were combined.

As an initial cleanup step, 10 mg of ENVI-Carb (MilliporeSigma Supelco) graphitized carbon was added to the extracts, which were then vortexed for 30 s, centrifuged for 10 min, and immediately (<10 min of contact after centrifugation) transferred to new 15-mL polypropylene centrifuge tubes. The extracts were then concentrated via nitrogen evaporation down to 4 mL and reconstituted to 50 mL with Optima-grade water. The pH was adjusted within the range of 5–6 with glacial acetic acid. As an additional cleanup step, samples were subjected to solid-phase extraction (SPE) following EPA Method 1633 [21].

Final extracts were concentrated down to 2 mL and spiked with a new mass-labeled internal standard (non-extracted internal standard [NIS]) (Appendix D, Table D-2). Samples were stored at −18 °C until analysis for 40 PFAS via ultra-high pressure liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS).

2.4.2 Aqueous Samples

To determine leachability/encapsulation of aggregate and pavement samples, all leachates generated were extracted following the SPE procedure outlined in EPA Method 1633. Prior to SPE, aqueous samples were aliquoted, and their weights were recorded. Sample pH was then adjusted to 5–6 with glacial acetic acid. For PFAS quantitation, samples were spiked with EIS (Appendix D, Table D-1) and vortexed for 30 s to incorporate the EIS; the samples were then allowed to equilibrate for 30 min. Samples then underwent SPE, resulting in a 4–5 mL extract. The extracts underwent an additional cleanup step in which 10 mg of ENVI-Carb (MilliporeSigma Supelco) graphitized carbon was added to the extracts, which were then vortexed for 30 s, centrifuged for 10 min, and immediately (<10 min of contact after centrifugation) transferred to new 15-mL polypropylene centrifuge tubes. The extracts were concentrated down to 2 mL via nitrogen evaporation and spiked with NIS (Appendix D, Table D-2). Samples were stored at −18 °C until analysis for 40 PFAS via UHPLC-MS/MS (Appendix D, Table D-3).

2.4.3 Gaseous Samples

XAD-2 resin was cleaned to be PFAS-free via sequential Soxhlet extraction following EPA Other Test Method 45 (OTM-45) [22]. All cartridge components, tubing, and sampling equipment were cleaned in methanol before use. To ensure that significant sample loss

was not encountered during the sample collection, storage, or extraction process, XAD-2 resin used for anionic PFAS analysis was spiked with pre-sampling internal standard (Appendix D, Table D-6) before sampling.

After sampling, spent XAD-2 resin and PUF from the exhaust gas sampling described in Section 2.3 were transferred into 50-mL polypropylene centrifuge tubes and weighed. Resin utilized for anionic PFAS analysis was spiked with EIS (Appendix D, Table D-7) before extraction. Then, 14 mL of 5 percent ammonium hydroxide in methanol was added to each centrifuge tube, and the samples were rotated end-over-end for 18 h and centrifuged at 4,000 rpm for 10 min; the resulting supernatant was transferred to a new 15-mL polypropylene centrifuge tube. The extraction procedure was repeated with an additional 7 mL of 5 percent ammonium hydroxide in methanol, and the supernatants were combined. The resulting extracts were concentrated to 2 mL via nitrogen evaporation, spiked with NIS (Appendix D, Table D-8), and stored at −18 °C until analysis. Sample extracts were analyzed for 63 anionic PFAS (Appendix D, Table D-9) via UHPLC-MS/MS.

Resin utilized for neutral PFAS analysis was spiked with EIS (Appendix D, Table D-10) before extraction. Then, 14 mL of 75/25 (v/v) ethyl acetate in methanol was added to each centrifuge tube, and the samples were rotated end-over-end for 18 h and centrifuged at 4,000 rpm for 10 min; the resulting supernatant was transferred to a new 15-mL polypropylene centrifuge tube. The extraction procedure was repeated with an additional 7 mL of 75/25 ethyl acetate in methanol, and the supernatants were combined. The resulting extracts were concentrated to 1 mL via nitrogen evaporation and stored at −18 °C until analysis. Sample extracts were analyzed for 27 neutral PFAS (Appendix D, Table D-11) via gas chromatography-high resolution mass spectrometry.

3. Results

For brevity, the following results and discussion focus on regulatorily relevant or dominant PFAS in legacy AFFF formulations: PFOA, PFOS, PFHxA, PFHxS, PFPeA, 6:2FTS, and 8:2 FTS. As mentioned in Section 2.2, the legacy AFFF used to artificially impact RCA and RAP in this work was analyzed (EPA Method 1633) prior to use in spiking and was identified to contain 27 PFAS. Table A-3 in Appendix A provides detailed PFAS composition and concentrations measured in the legacy AFFF. Comprehensive datasets on "total" and leachable concentrations derived from aggregates and fabricated pavements in this work, including all detected compounds (from EPA Method 1633), are provided in Appendix E, Table E-1 through Table E-10.

Given the low presence or extracted quantities, some analyses resulted in PFAS measurements below instrument limits of quantitation (LOQ). To provide a conservative estimate of potential presence/leachability, concentrations in these instances were assumed to be present at the LOQ and are noted as such. A complete list of detected analytes and their respective method quantitation limits are provided in Appendix D, Table D-4 and Table D-5.

3.1 "Total" Available PFAS

As described in Section 2.4.1, the total solvent-extractable PFAS concentration, or the "total" PFAS concentration available to leach, was determined for RCA, RAP, and fabricated concrete and asphalt. Experimental pavements (incorporating artificially AFFF-impacted RAP and RCA) were analyzed in triplicate, along with their control counterparts (incorporating control RAP and RCA). Given the known PFAS composition and concentration of the AFFF utilized in this study and the expected range of certain compounds within impacted RAP and RCA (Section 2.1.2), targeted concentrations were between 5 and 20 ng/g for PFOA and 600 and 800 ng/g for PFOS. As the impacted materials were recycled into new concrete and asphalt pavements, the theoretical total concentration of PFAS in the new pavements was calculated using Equation 1.

$$Theoretical\ PFAS\ concentration = \frac{(concentration\ in\ spiked\ material) \times (mass\ of\ spiked\ material)}{mass\ of\ specimen} \quad (1)$$

In both concrete and asphalt, three classes of PFAS dominated: carboxylic acids (PFCAs), sulfonic acids (PFSAs), and fluorotelomers (FTSs). In the fabricated concrete, ∑PFOS, 6:2FTS, 8:2FTS, and PFHxS were present in the highest concentrations, agreeing with the concentrations observed in the spiked RCA (Appendix E, Table E-2). PFCAs were also present in the concrete, but at lower concentrations. Similarly, in the fabricated asphalt, ∑PFOS, 6:2FTS, 8:2FTS, and PFHxS were present in the highest concentrations, and PFCAs were observed at comparatively lower concentrations, again agreeing with the concentrations observed in the spiked RAP (Appendix E, Table E-2).

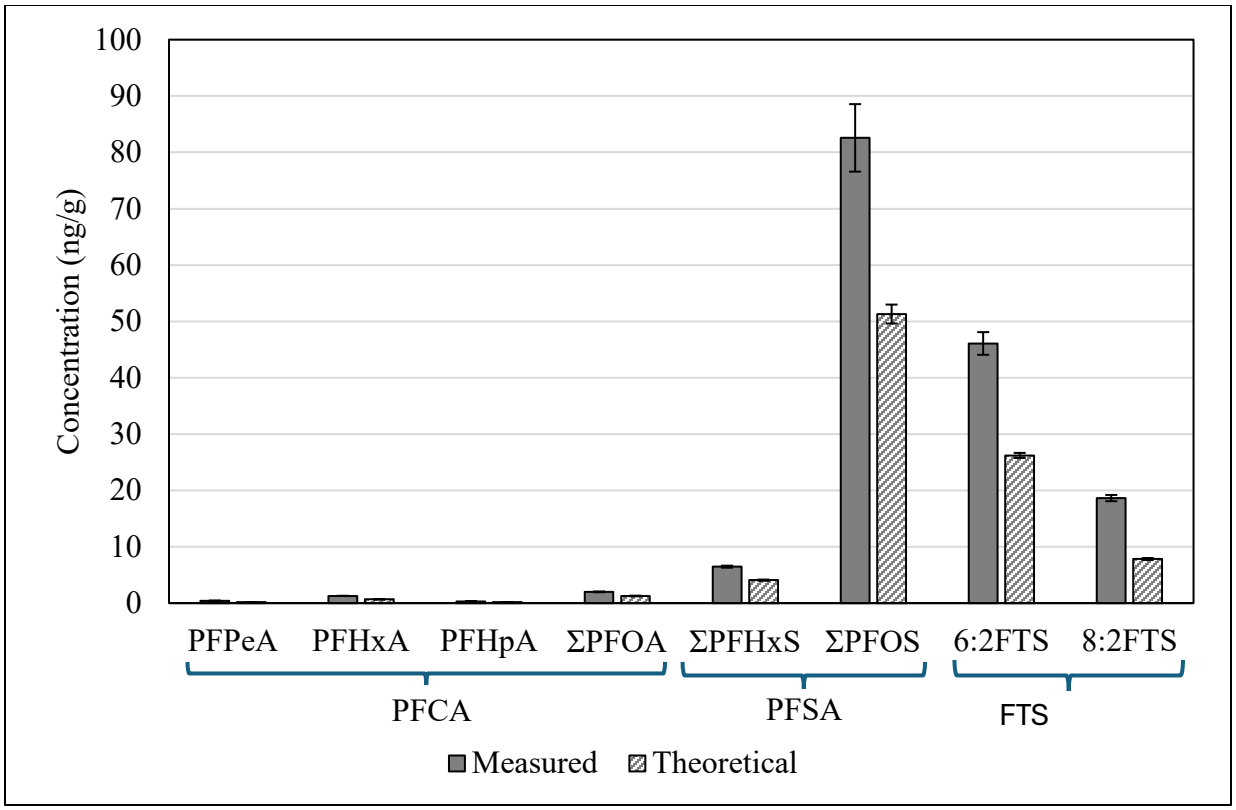
3.1.1 RCA and Fabricated Concrete

In all control RCA and concrete samples, concentrations for the 40 target PFAS (Appendix D, Table D-3) were not detected or below LOQ; Table E-1 in Appendix E provides the full analysis for control pavement materials. "Total" PFAS concentrations achieved in artificially spiked RCA aggregate are provided in Table 5. Using Equation 1 and the mass utilized in new pavement mixes, theoretical concentrations in fabricated specimens were calculated; both are provided in Table 5.

Table 5. Concentration of Dominant PFAS Compounds in Artificially Impacted RCA, Percentage RCA Replacement by Mass, and Theoretical Concentration in Spiked Concrete Calculated Using Equation 1

Concrete			
PFAS	**Concentration in RCA (ng/g)**	**RCA Mass Replacement (%)**	**Theoretical Concentration in New Pavement (ng/g)**
PFPeA	<LOQ	9.90%	0.158
PFHxA	6.83		0.683
PFHpA	1.72		0.172
ΣPFOA	12.7		1.27
ΣPFHxS	40.8		4.08
ΣPFOS	513		51.3
6:2FTS	262		26.2
8:2FTS	78.4		7.84

The actual concentrations yielded in fabricated concrete that utilized the spiked RCA compared to the calculated theoretical values are shown in Figure 6. Of the 21 PFAS detected in (Appendix E, Table E-2), eight species were dominant, collectively accounting for 99 percent of the total available quantifiable PFAS mass in the spiked concrete. As illustrated in Figure 6, measured concentrations in the spiked concrete were higher than the calculated theoretical concentrations for all PFAS; however, low variability across triplicate measurements suggests this may be attributable to deviations in the mass of RCA replaced.



Notes: Concentrations are reported in ng/g and were calculated using Equation 1. Error bars represent the standard error observed across triplicates.

Source: University of Florida

Figure 6. Measured and Theoretical Concentrations of PFAS in Spiked Concrete Specimens

3.1.2 RAP and Fabricated Asphalt

In all control RAP and asphalt samples, concentrations for the 40 target PFAS (Appendix D, Table D-3) were not detected or below LOQ; Table E-1 in Appendix E provides the full analysis for control pavement materials. The same approach was used to evaluate theoretical and measured concentrations in asphalt fabricated with artificially impacted RAP. Total PFAS concentrations achieved in the artificially spiked RAP are provided in Table 6.

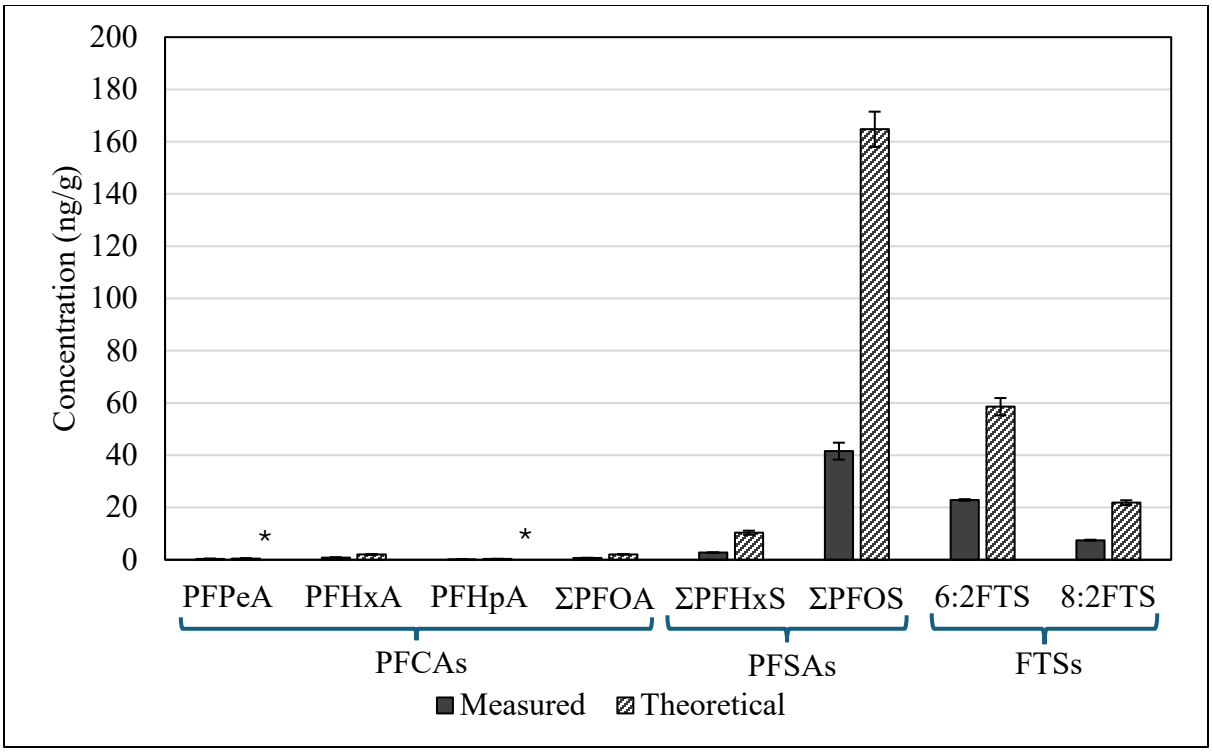
Table 6. Concentrations of Dominant PFAS Compounds in Artificially Impacted RAP, Percentage RAP Replacement by Mass, and Theoretical Concentration in Spiked Asphalt Calculated Using Equation 1

PFAS	Asphalt			
	Concentration in RAP, Coarse (ng/g)	Concentration in RAP, Fine (ng/g)	RAP Mass Replacement (%)	Theoretical Concentration in New Pavement (ng/g)
PFPeA	<LOQ	2.68	20.0%	0.390
PFHxA	4.69	12.5		0.843
PFHpA	<LOQ	2.22		0.130
ΣPFOA	7.45	11.6		0.732
ΣPFHxS	34.5	58.8		2.74
ΣPFOS	627	807		41.6
6:2FTS	197	331		22.9
8:2FTS	84.0	118		7.48

Note: The fine fraction of RAP contributes 13.2 percent mass replacement, and the coarse fraction contributes 6.8 percent mass replacement.

Figure 7 displays the theoretical and actual yielded PFAS concentrations determined in the artificially impacted asphalt specimens. Of the 16 PFAS detected (Appendix E, Table E-2), eight species were dominant, collectively accounting for nearly 100 percent of the total quantifiable PFAS mass available in the spiked asphalt.

Unlike in concrete, the measured and theoretical concentrations of the spiked asphalt specimens differed greatly. As with the spiked concrete specimens, this could be a factor of heterogeneity across samples; however, it is more likely attributed to losses throughout the HMA process. For example, during curing, conditioning, or mixing, it is possible that PFAS were lost to the surfaces of tools and containers. For both the spiked concrete and spiked asphalt, questions remain regarding extraction efficiency of the matrices and the loss of PFAS during the fabrication processes.



Notes: Concentrations are reported in ng/g and were calculated using Equation 1. Asterisks denote measured concentrations that were below LOQ and are presented here as at LOQ.

Source: University of Florida

Figure 7. Measured and Theoretical Concentrations of PFAS in Spiked Asphalt Specimens

3.2 PFAS Leachability

As described in Section 2.2, aggregates and fabricated pavements were subjected to batch (EPA Method 1316) and/or monolithic (EPA Method 1315 and MIST) leaching tests. The PFAS concentrations measured in subsequent leachates were then contextualized to their "total" available mass (derived from Equation 2) by accounting for the leachate volume produced (Equation 3). The percentage of the available PFAS mass leached was then calculated (Equation 4).

$$Mass\ of\ PFAS\ available = (mass\ of\ solid) \times (PFAS\ concentration\ in\ solid) \quad (2)$$

$$Mass\ of\ PFAS\ leached = (volume\ of\ leachate) \times (PFAS\ concentration\ in\ leachate) \quad (3)$$

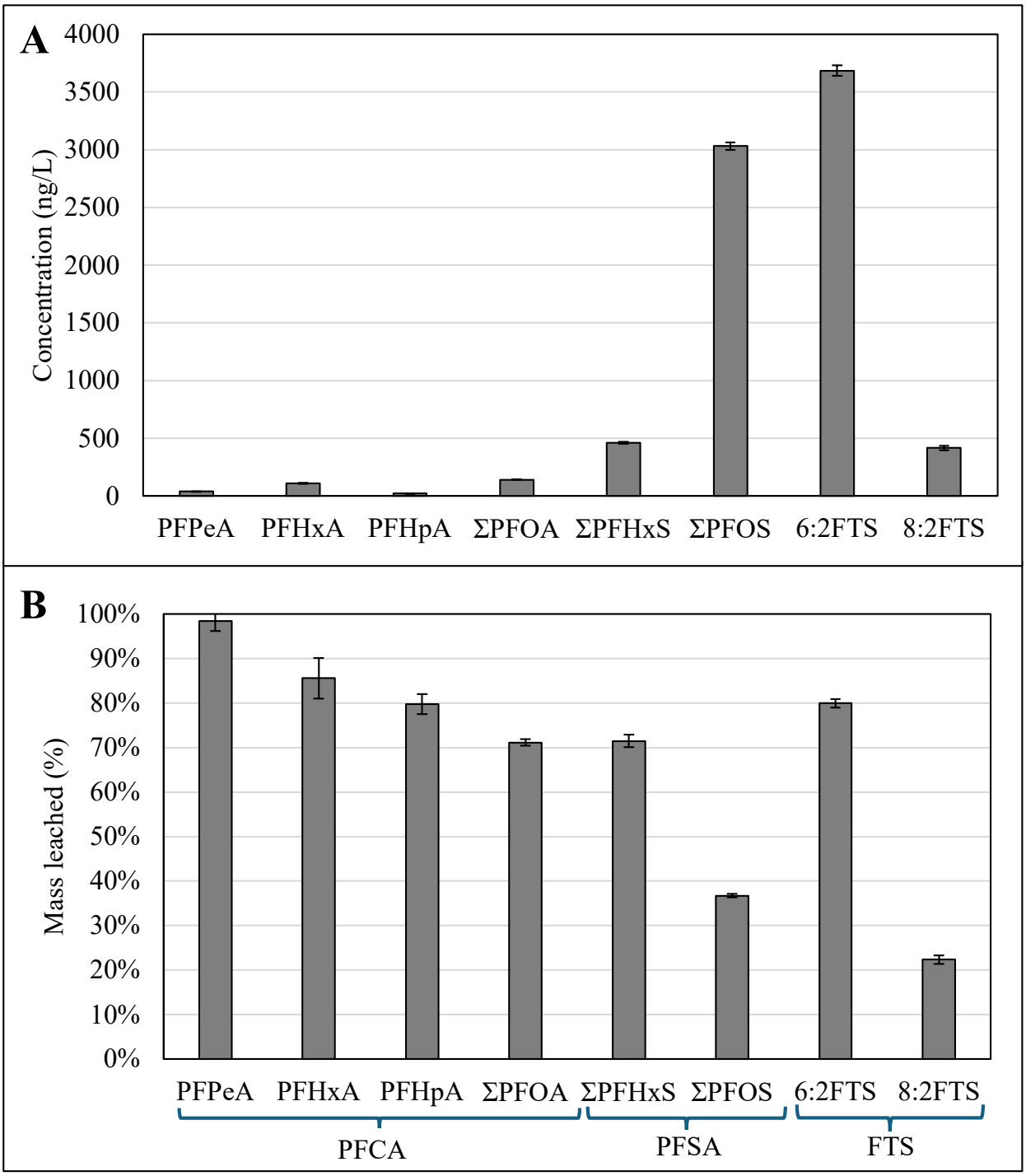
$$Mass\ leached\ (\%) = \frac{mass\ of\ PFAS\ leached}{mass\ of\ PFAS\ available} \quad (4)$$

To provide context to the potential leaching risks posed by these materials, leachate concentrations were compared to federally relevant primary drinking water standards established by the EPA [23] (see Appendix A, Table A-4). Direct consumption is not considered an exposure pathway for leachate from pavements; however, these risk-based thresholds are commonly used to screen leaching risks and to assess the degree of dilution or attenuation needed in the environment to ensure protection of human and

environmental health. For PFAS, primary drinking water standards exist for PFOA, PFOS, PFHxS, and PFNA. Comparing leached concentrations to these screening criteria provides a conservative assessment of risk based on current toxicological understanding.

3.2.1 Batch Leaching: EPA Method 1316

Parallel batch leaching followed EPA Method 1316, in which size-reduced materials were rotated end-over-end for 72 h at an L/S of 10. Comprehensive leaching data for all PFAS observed in batch leachates can be found in Appendix E, Table E-3 and Table E-4. In all batch leachates of control pavement materials, concentrations of the 40 target PFAS (Appendix D, Table D-3) were not detected or were below the LOQ; Table E-3 in Appendix E provides the full analysis for batch leachates of control pavement materials. Concentrations leached from fabricated concrete that incorporated spiked RCA are provided in Figure 8A, along with the associated percent leached in Figure 8B.



Source: University of Florida

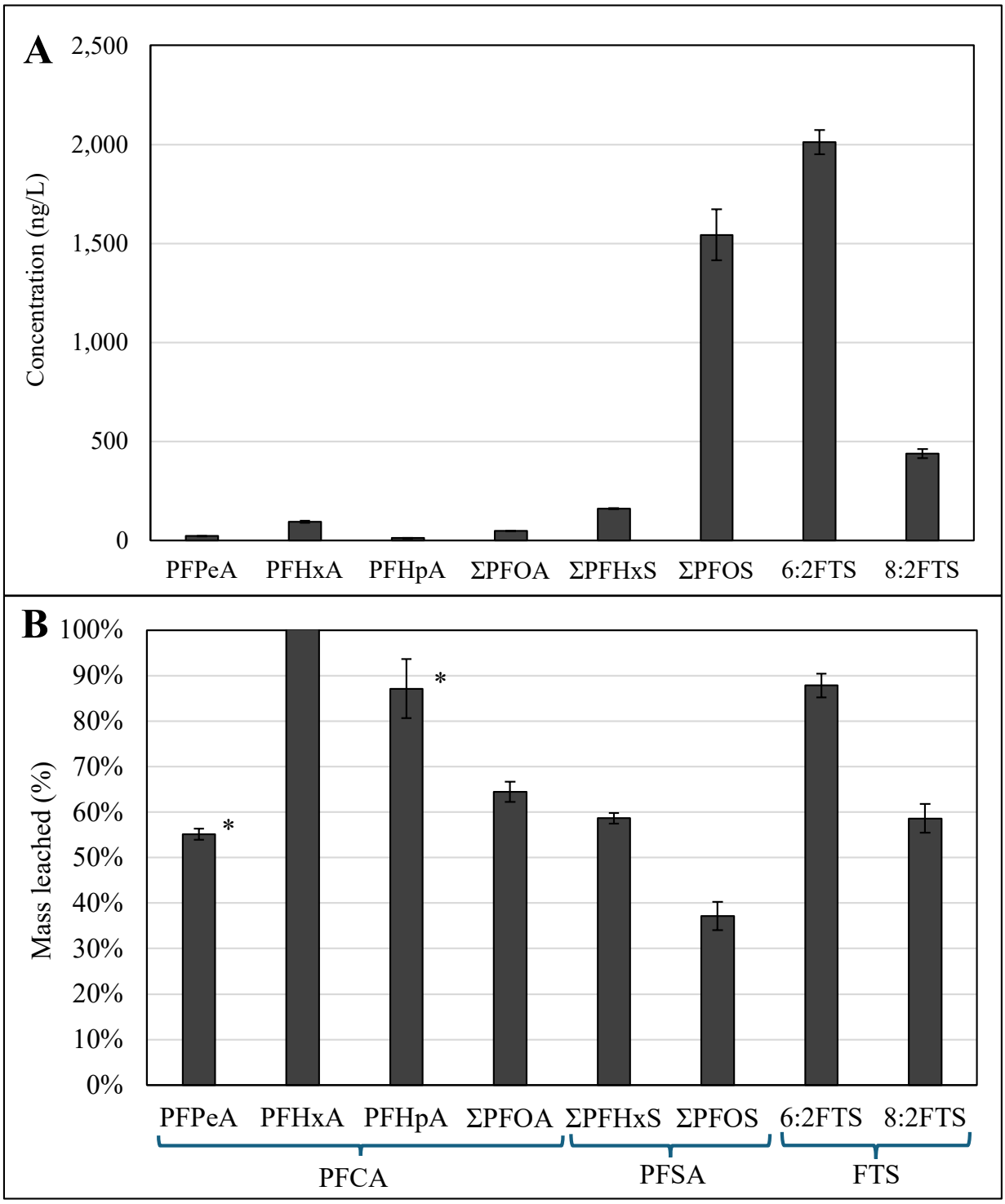
Figure 8. A: Concentrations (ng/L) of Eight Dominant PFAS Compounds Leached from Spiked Concrete (EPA Method 1316, L/S = 10); B: Mass of PFAS Leached as a Percentage of "Total" Available PFAS

Of the 18 PFAS detected (Appendix E, Table E-4), eight PFAS from the PFCA, PFSA, and FTS classes dominated concentrations observed from batch leaching of spiked concrete, collectively accounting for 99 percent of the total available, and quantifiable, PFAS mass in

the spiked concrete batch leachate; this is attributed to their significant presence in AFFF. As shown in Figure 8A, ∑PFOS and 6:2FTS leached at the highest concentrations, 3,000 ng/L and 3,700 ng/L, respectively, followed by ∑PFHxS (460 ng/L), 8:2FTS (420 ng/L), and ∑PFOA (140 ng/L). Present at the lowest concentrations were PFHxA (110 ng/L), PFHpA (24 ng/L), and PFPeA (42 ng/L). Compared to EPA primary drinking water standards, which exist for PFOA (4.0 ng/L), PFOS (4.0 ng/L), and PFHxS (10 ng/L) [23], concentrations leached from concrete exceeded thresholds for PFOS, PFOA, and PFHxS by 750, 35, and 46 times, respectively.

Based on the percentage of mass leached, shown in Figure 8B, an encapsulated mass was derived. The overall mass encapsulation of PFAS in batch leaching of concrete was 50 percent. In fabricated concrete, higher encapsulation was observed as chain length increased across all three classes: PFCA, PFSA, and FTS. For example, across the PFCAs PFPeA (C_5) was encapsulated by 2 percent, PFHxA (C_6) by 14 percent, PFHpA (C_7) by 20 percent, and PFOA (C_8) by 29 percent. This suggests higher mobility of shorter-chain PFAS in concrete compared to longer-chain counterparts, consistent with current literature on the environmental mobility of PFAS. In addition, 63 percent of ∑PFOS, 78 percent of 8:2FTS, 20 percent of 6:2FTS, and 28 percent of PFHxS were encapsulated. As discussed in Section 2.3, the spiked concrete had a higher air content than designed, which likely caused increased leaching due to an increase in porosity and surface area.

Concentrations leached from fabricated asphalt that incorporated spiked RAP are provided in Figure 9A, along with the associated percent leached in Figure 9B.



Note: Asterisks denote when "total" concentration used for calculations was below LOQ and was assumed to be at LOQ.

Source: University of Florida

Figure 9. A: Concentrations (ng/L) of Eight Dominant PFAS Compounds in Spiked Asphalt Batch Leachate; B: Mass of PFAS Leached as a Percentage of "Total" Available PFAS

Of the 13 PFAS detected (Appendix E, Table E-4), eight PFAS from the PFCA, PFSA, and FTS classes dominated concentrations observed from batch leaching of spiked asphalt, collectively accounting for 99 percent of the leached concentration; this is attributed to their significant presence in AFFF. As shown in Figure 9A, and similar to what was observed for concrete, ∑PFOS and 6:2FTS leached at the highest concentrations, 1,500 ng/L and 2,000 ng/L, respectively, followed by 8:2FTS (440 ng/L), ∑PFHxS (160 ng/L), and PFHxA (94 ng/L). Present at the lowest concentrations were ∑PFOA (47 ng/L), PFPeA (22 ng/L), and PFHpA (11 ng/L). Compared to primary drinking water standards, concentrations leached from asphalt exceeded thresholds for PFOS, PFOA, and PFHxA by 380, 12, and 1.6 times, respectively. Compared to concrete, spiked asphalt batch leachate concentrations were lower overall, consistent with the "total" concentrations measured in Section 3.1, in which spiked concrete contained higher concentrations than spiked asphalt.

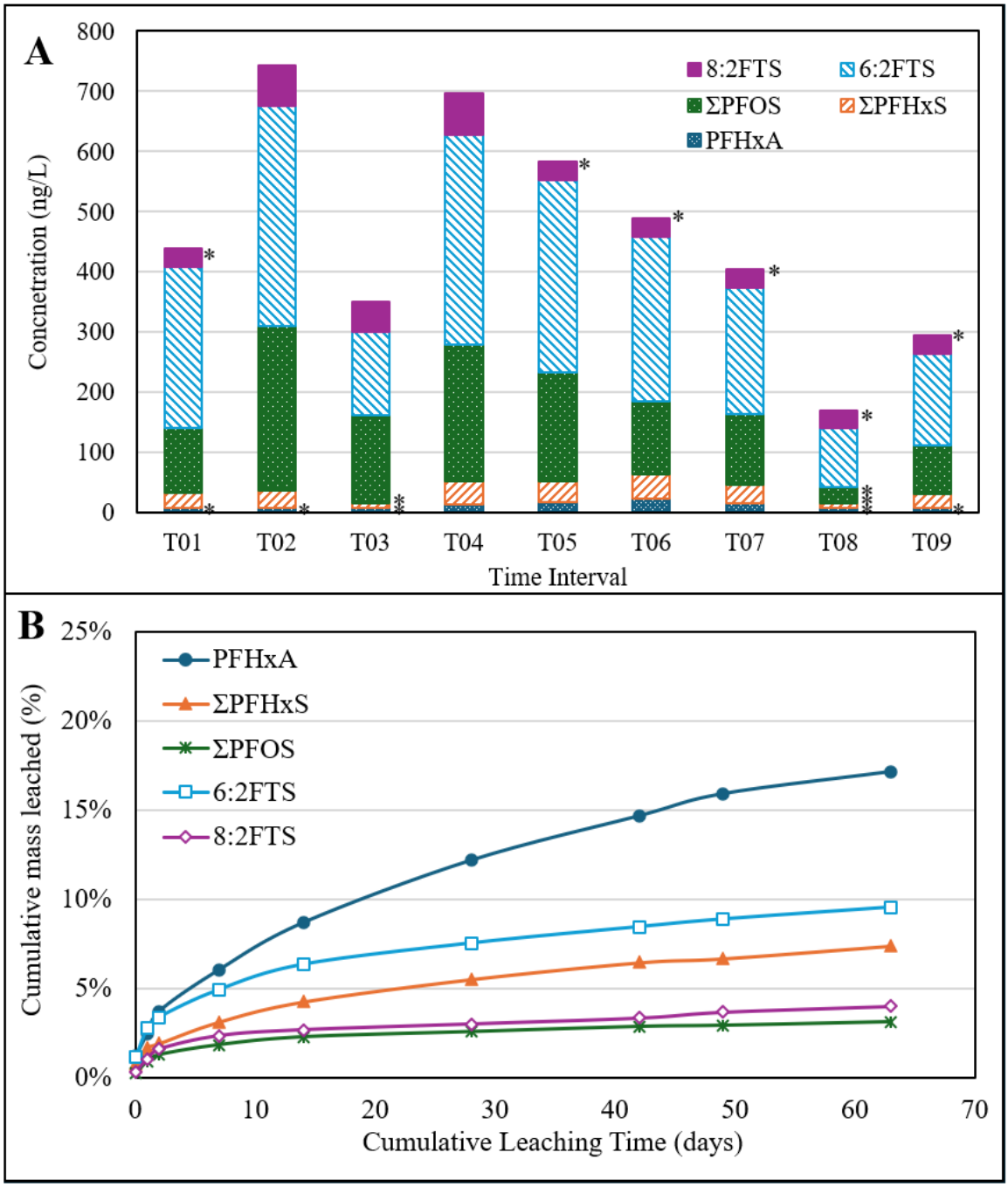
Based on the percentage of mass leached, shown in Figure 9B, an encapsulated mass was derived. The overall mass encapsulation of PFAS in batch leaching of asphalt was 44 percent. A less notable chain-length trend was observed in spiked asphalt batch leachate, in which encapsulation increased with increasing chain length for PFSA and FTS subclasses, but not as uniformly for compounds in the PFCA subclass. Zero percent of PFHxA (C_6) was encapsulated, and 13 percent of PFHpA (C_7) was encapsulated. PFPeA (C_5) did not follow this trend (45 percent encapsulation); however, the "total" available PFPeA mass was derived from the LOQ concentration. PFHxS was encapsulated by 41 percent, 6:2FTS by 12 percent, and 8:2FTS by 41 percent. Compared to concrete, slightly higher encapsulation was observed in asphalt for PFOA and PFOS, with 36 percent of ∑PFOA and 63 percent of ∑PFOS encapsulated.

Some batch leachate concentrations were observed above primary drinking water standards, but data from batch leaching suggest that partial encapsulation of PFOA and PFOS in concrete and asphalt is possible during batch leaching. This suggests that concrete may better encapsulate compounds with chain lengths ranging from C_6 to C_8 during batch leaching than asphalt.

3.2.2 Semi-Dynamic Tank Leaching: EPA Method 1315

Similar to the batch leaching results presented in Section 3.1, results from EPA Method 1315 are presented as both concentrations and percentage leached. While EPA Method 1316 assesses leaching from size-reduced materials, EPA Method 1315 evaluates leaching from a monolithic specimen over an extended period, as described in Section 2.2.2. This leaching procedure was performed on control and spiked concrete and asphalt specimens. Comprehensive leaching data for all PFAS observed in EPA Method 1315 leachates can be found in Appendix E in Table E-5 through Table E-8. In all EPA Method 1315 leachates of control pavement materials, concentrations of the 40 target PFAS (Appendix D, Table D-3) were not detected or were below the LOQ; Table E-5 and Table E-7 in Appendix E provide the full analysis for EPA Method 1315 leachates from control

pavement materials. Only five compounds were identified above the LOQ in the spiked concrete and asphalt leachates: PFHxA, PFHxS, PFOS, 6:2FTS, and 8:2FTS. These are discussed below. Concentrations leached from spiked concrete are provided in Figure 10A, along with the associated percent leached in Figure 10B.



Note: Asterisks in Figure 10A denote concentrations below LOQ that were assumed to be at LOQ for the purpose of calculations.

Source: University of Florida

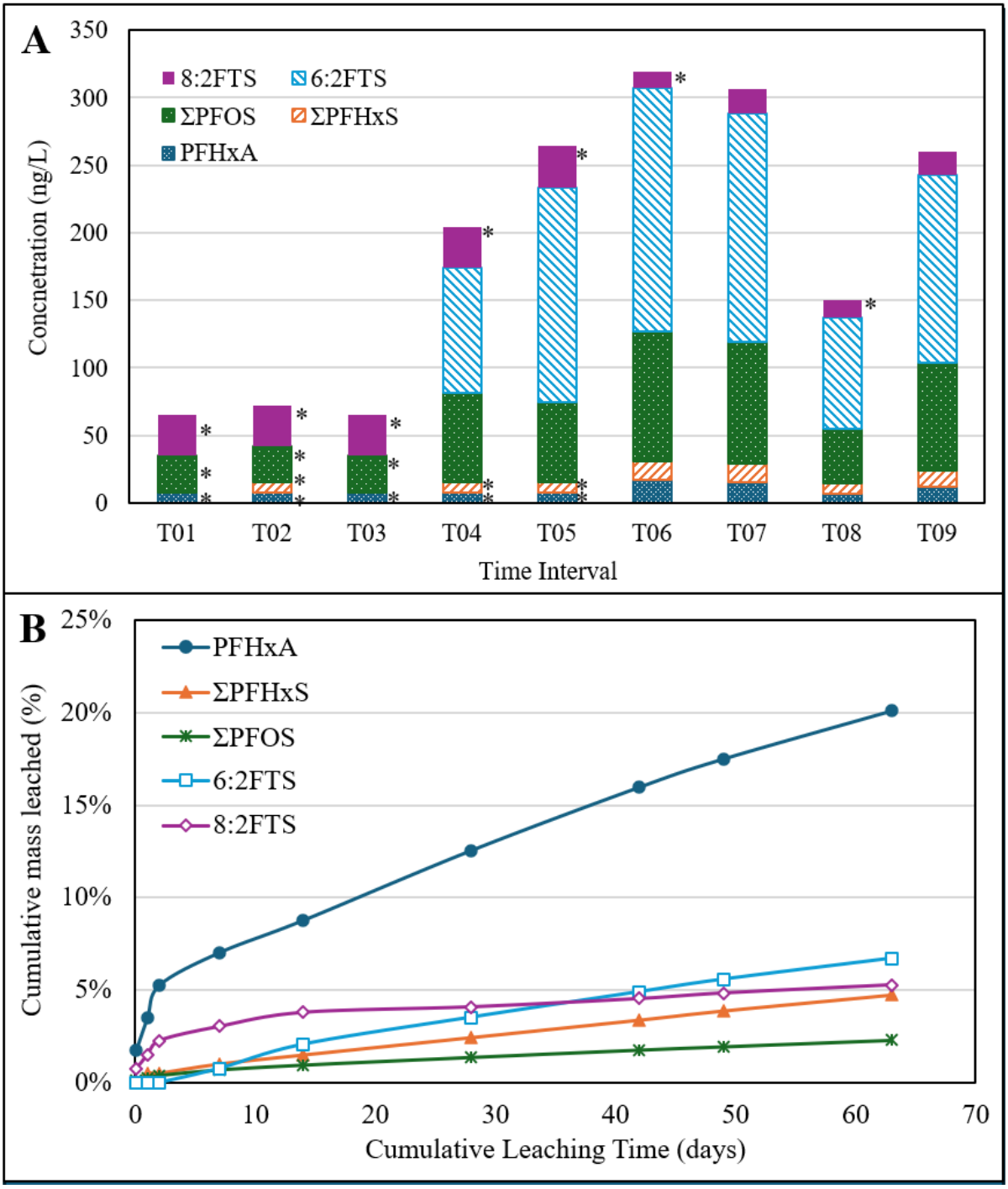
Figure 10. A: Concentrations (ng/L) in Spiked Concrete (EPA Method 1315) Leachates over the 63-Day Leaching Period; B: Cumulative Percentage of PFAS Leached from Spiked Concrete During Semi-Dynamic Tank Leaching (EPA Method 1315)

As shown in Figure 10A, ∑PFOS and 6:2FTS leached at the highest concentrations, 82–270 ng/L and 98–370 ng/L, respectively. Given that ∑PFOS was available at the highest concentrations, followed by 6:2FTS, this suggests that 6:2FTS is more mobile in concrete during monolithic leaching. Figure 10A illustrates that $\sum_5$PFAS concentrations peaked at T02 (1 day of cumulative leaching) at 740 ng/L and tended to steadily decline from T03 to T09, with concentrations ranging from 170 to 700 ng/L. Individually, ∑PFOS and 6:2 FTS followed a similar trend, peaking at T02 (270 ng/L and 370 ng/L, respectively) and tending to steadily decline thereafter. ∑PFHxS concentrations remained relatively consistent over time (7.2–41 ng/L). PFHxA peaked during T04–T06 (15–22 ng/L), while 8:2FTS peaked during T02–T04 (51–69 ng/L), suggesting that the leaching behaviors differ over time and between compounds.

EPA Method 1315 leachates were then compared to existing primary drinking water standards. ∑PFOS and PFHxS concentrations exceeded thresholds by a maximum of 68 and 4.1 times, respectively, over the 63-day period. ∑PFOA remained below the LOQ for the duration of the leaching tests and therefore could not be compared to drinking water thresholds.

Based on the percentage of mass leached, shown in Figure 10B, an encapsulated mass was derived. The overall mass encapsulation of PFAS in monolithic leaching of concrete via EPA Method 1315 was 95 percent. As depicted in Figure 10B, 97 percent of the ∑PFOS, 96 percent of 8:2 FTS, 93 percent of ∑PFHxS, 90 percent of 6:2FTS, and 83 percent of PFHxA remained encapsulated. A similar trend to that observed during batch leaching was observed here, in which shorter-chain PFAS (PFHxA, ∑PFHxS, and 6:2FTS) leached more readily than longer-chain PFAS (∑PFOS and 8:2FTS). Additionally, the rate of mass flux began to plateau between 2 and 4 weeks of leaching, supporting the trends observed in the concentrations depicted in Figure 10A.

Concentrations leached from spiked asphalt are provided in Figure 11A, along with the associated percent leached in Figure 11B.



Note: Asterisks denote concentrations below LOQ that were assumed to be at LOQ for the purpose of calculations.

Source: University of Florida

Figure 11. A: Concentrations (ng/L) in Spiked Asphalt 1315 Leachates over the 63-Day Leaching Period; B: Cumulative Percentage of PFAS Leached from Spiked Concrete During Semi-Dynamic Tank Leaching (EPA Method 1315)

As shown in Figure 11A, ∑PFOS and 6:2FTS leached at the highest concentrations, 41–96 ng/L and 83–170 ng/L, respectively. Given that ∑PFOS was available at the highest concentrations, followed by 6:2FTS, similar to concrete, this suggests that 6:2FTS is more mobile in asphalt during monolithic leaching. Figure 11A illustrates that $\sum_5$PFAS concentrations increased from T01 to T05, with concentrations ranging from 65 to 270 ng/L, peaked at T06 (28 days of cumulative leaching) at 320 ng/L, and declined from T07 to T09, with concentrations ranging from 150 to 310 ng/L.

Compared to EPA Method 1315 leaching of concrete, asphalt leaching was delayed, suggesting that porosity and organic carbon content may impact encapsulation. Individually, ∑PFOS and 6:2 FTS followed a similar trend, peaking at T02 (270 ng/L and 370 ng/L, respectively) and tending to steadily decline. ∑PFHxS concentrations peaked at T06 and T07 (140 ng/L) and ranged from 7.2 to 140 ng/L over the duration of the leaching test. PFHxA peaked at T06 (17 ng/L) and ranged from 6.9 to 17 ng/L over the leaching duration. 8:2FTS concentrations remained more consistent over the leaching duration, ranging from 12 to 30 ng/L. Again, these data suggest that leaching behaviors differ over time and between compounds.

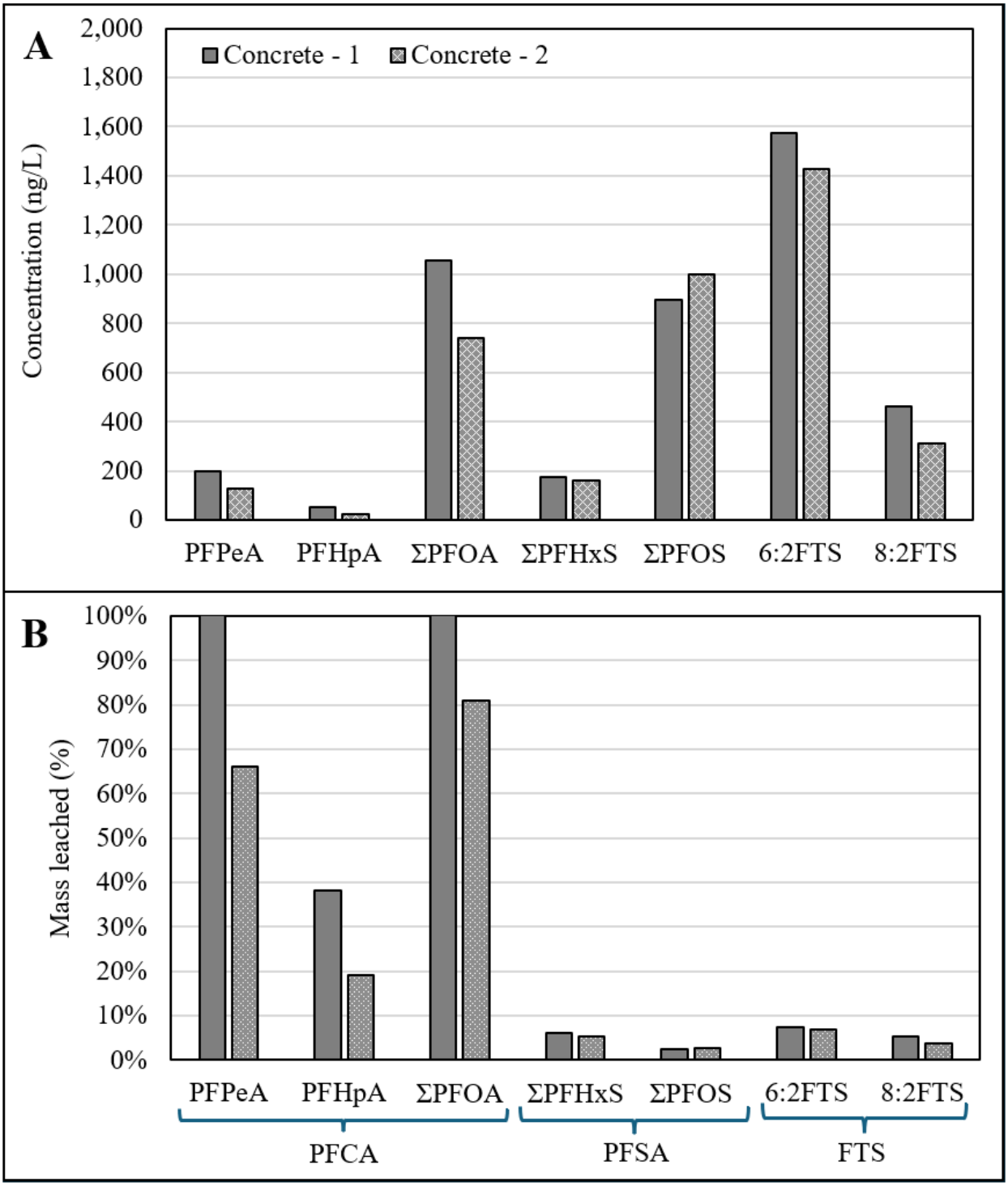
EPA Method 1315 leachates were then compared to current EPA drinking water standards. ∑PFOS and PFHxS concentrations exceeded thresholds by a maximum of 24 and 1.4 times, respectively, over the 63-day period. ∑PFOA remained below the LOQ for the duration of the leaching tests and therefore could not be compared to drinking water thresholds.

Based on the percentage of mass leached, shown in Figure 11B, an encapsulated mass was derived. The overall mass encapsulation of PFAS in monolithic leaching of asphalt via EPA Method 1315 was 96 percent. As depicted in Figure 11B, 98 percent of ∑PFOS, 95 percent of 8:2 FTS, 95 percent of ∑PFHxS, 93 percent of 6:2FTS, and 80 percent of PFHxA were encapsulated. PFOA remained below the LOQ through the duration of testing. Longer-chain compounds tended to have higher degrees of encapsulation than shorter-chain compounds, except for 8:2FTS, which leached more rapidly than its shorter-chain counterpart (6:2FTS). Unlike the spiked concrete, the mass fluxes do not appear to have as dramatic of a plateau, supporting the observations made from Figure 11A that leaching from asphalt is delayed compared to concrete.

3.2.3 MIST Leaching

Like EPA Method 1315, MIST was performed on intact specimens. While MIST is not a traditional leaching procedure, a leachate is produced from testing that results from subjecting specimens in saturated conditions to cyclical pressure variations (as described in Section 2.2.3). Comprehensive leaching data of all PFAS observed from MIST leachates can be found in Appendix E, Table E-9 and Table E-10. In all MIST leachates of control pavement materials, concentrations for the 40 target PFAS (Appendix D, Table D-3) were not detected or were below the LOQ; Table E-9 in Appendix E provides the full analysis for

MIST leachates from control pavement materials. Concentrations leached from concrete fabricated with spiked RCA are provided in Figure 12A, along with the associated percent leached in Figure 12B.



Note: Two specimens were tested, and their respective concentrations are displayed in Figure 12A.

Source: University of Florida

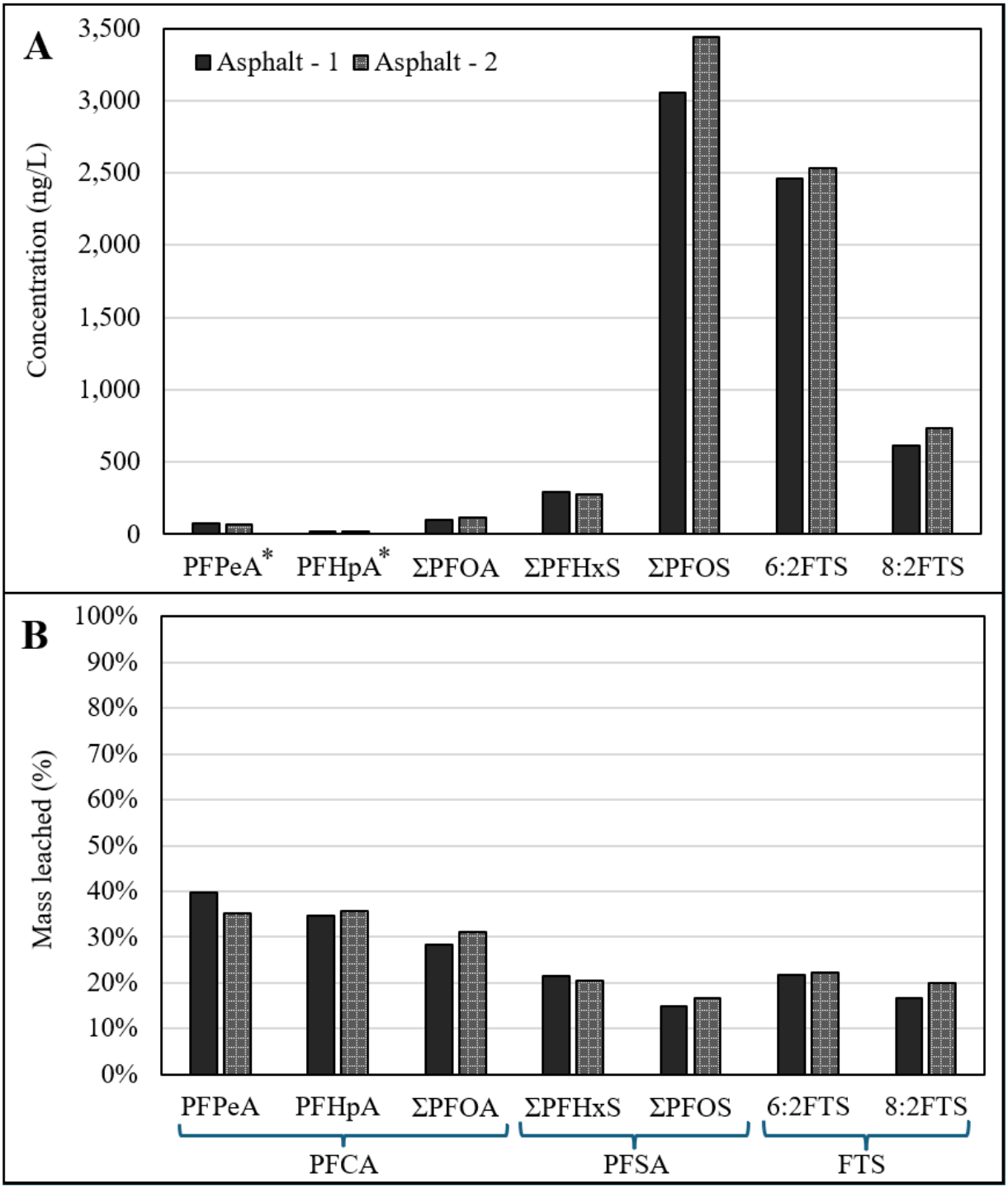
Figure 12. A: Concentrations (ng/L) in MIST Leachates from Spiked Concrete Specimens; B: Mass of PFAS Leached as a Percentage of Mass Available from Spiked Concrete Specimens During MIST

Of the 17 PFAS detected (Appendix E, Table E-10), seven PFAS from PFCA, PFSA, and FTS classes dominated concentrations observed from spiked concrete, attributing 40–41 percent of the concentrations observed in leachate across duplicates. As shown in Figure 12A, ∑PFOA, ∑PFOS, and 6:2FTS leached at the highest concentrations, 740–1,054 ng/L, 896–1,002 ng/L, and 1,427–1,574 ng/L, respectively, followed by 8:2FTS, ∑PFHxS, PFPeA, and PFHpA at 313–462 ng/L, 160–177 ng/L, 128–202 ng/L, and 26–52 ng/L, respectively.

Unlike the monolithic leaching under EPA Method 1315, leachates from MIST demonstrated comparable concentration releases of PFOA and PFOS from concrete, suggesting that environmental weathering and stress may increase potential leachability of PFCAs from concrete materials. It should be noted that PFHxA, identified in previous batch and monolith leachates, was identified at significant concentrations in MIST leaching, beyond the mass available to leach. Given the agreement between concentration measurements across replicates and the lack of contamination observed in leachates from unspiked pavements, this confounding data was excluded from assessment calculations. However, data on leached and total concentrations are provided for reference in Appendix E, Table E-10. Compared to EPA primary drinking water standards for PFOA, PFOS, and PFHxS, concentrations observed in MIST leachates exceeded thresholds by 185–264, 5.10–27.1, and 2.07–2.60 times, respectively.

From the percentage of mass released to leachate and measured “total” available concentrations, an encapsulation rate was derived (shown in Figure 12B). The overall mass encapsulation of PFAS in MIST leaching of concrete was between 85 and 87 percent. Where ∑PFOA displayed lower mass encapsulation (0–20 percent) compared to ∑PFOS encapsulation of over 95 percent in both replicates. PFPeA encapsulation ranged from 0 to 34 percent, PFHpA encapsulation ranged from 62 to 81 percent, and PFHxS encapsulation ranged from 94 to 95 percent. Both FTS compounds observed demonstrated encapsulation over 90 percent in both concrete replicates. Leaching behavior from concrete corroborated previously observed data from batch and monolith testing, demonstrating PFAS within the PFCA subclass to be more mobile (with respect to available mass) than PFSA or FTS subclasses.

Concentrations leached from spiked asphalt are provided in Figure 13A, alongside the associated percentage leached in Figure 13B.



Notes: Two specimens were tested, and their respective concentrations are displayed in Figure 13A. Asterisks denote concentrations measured below LOQ and presented as at LOQ.

Source: University of Florida

Figure 13. A: Concentrations (ng/L) in MIST Leachates from Spiked Asphalt Specimens; B: Mass of PFAS Leached as a Percentage of Mass Available from Spiked Asphalt Specimens During MIST

Of the 17 PFAS detected (Appendix E, Table E-10), seven PFAS from the PFCA, PFSA, and FTS classes were dominant, collectively attributing 90–92 percent of the concentrations observed in leachate across duplicates. Unlike what was observed for concrete, compounds leached from asphalt during MIST were predominantly PFSAs, which more closely aligned with profiles observed during batch and monolith leaching.

As shown in Figure 13A, ∑PFOS, 6:2FTS, and 8:2FTS leached at the highest concentrations, 3,438–3,055 ng/L, 2,457–2,530 ng/L, and 616–736 ng/L, respectively. ∑PFHxS, ∑PFOA, PFPeA, and PFHpA concentrations were 277–290 ng/L, 102–113 ng/L, 68–77 ng/L, and 22–23 ng/L, respectively. To preserve consistency with concrete specimens, PFHxA was excluded from this concentration assessment; however, data on leached and total concentrations are provided for reference in Appendix E, Table E-10. When compared with EPA primary drinking water standards for PFOA, PFOS, and PFHxS, concentrations observed in MIST leachates exceeded thresholds by 26–28, 3.4–4.1, and 4.3–4.4 times, respectively.

From the percentage of mass released to leachate and measured "total" available concentrations, an encapsulation rate was derived (shown in Figure 13B). The overall mass encapsulation of PFAS in MIST leaching of asphalt was between 80 and 81 percent across replicates, with ∑PFOS encapsulated by 83–85 percent and ∑PFOA encapsulated by 69–72 percent. PFPeA encapsulation ranged from 60 to 65 percent, PFHpA encapsulation from 64 to 65 percent, and PFHxS encapsulation from 79 to 80 percent. Compared to leachate derived from concrete MIST testing, leachate from asphalt under MIST conditions demonstrated higher encapsulation of PFCAs. However, these data also suggest that concrete achieves higher encapsulation of PFSAs and FTSs compared to asphalt under MIST conditions.

3.3 PFAS Emission During HMA Process

As described in Section 2.3, the exhaust gas from RAP conditioning was sampled during the HMA process. Two trains were sampled, one for anionic PFAS compounds and one for neutral PFAS compounds. To ensure existing contamination was not contributed by the oven or control RAP components, blank and control samples were collected and denoted as the "oven blank" and the "control RAP." Table 7 displays results for the blank, control, and experimental sampling events.

Table 7. Concentrations (ng/m³) of Anionic PFAS Compounds in Exhaust Gas During the HMA Process

Sample ID	Concentration (ng/m³)				
	PFHxA	∑PFOA	PFDA	∑PFOS	6:2FTS
Oven Blank	ND	0.35	ND	ND	1.06
Oven Blank BT	ND	ND	ND	ND	1.69
Control RAP	ND	ND	ND	ND	<LOQ
Control RAP BT	ND	ND	ND	ND	<LOQ
Spiked RAP	17.3	5.62	1.04	ND	1.04
Spiked RAP BT	ND	<LOQ	<LOQ	ND	<LOQ
Blank	ND	<LOQ	ND	ND	<LOQ

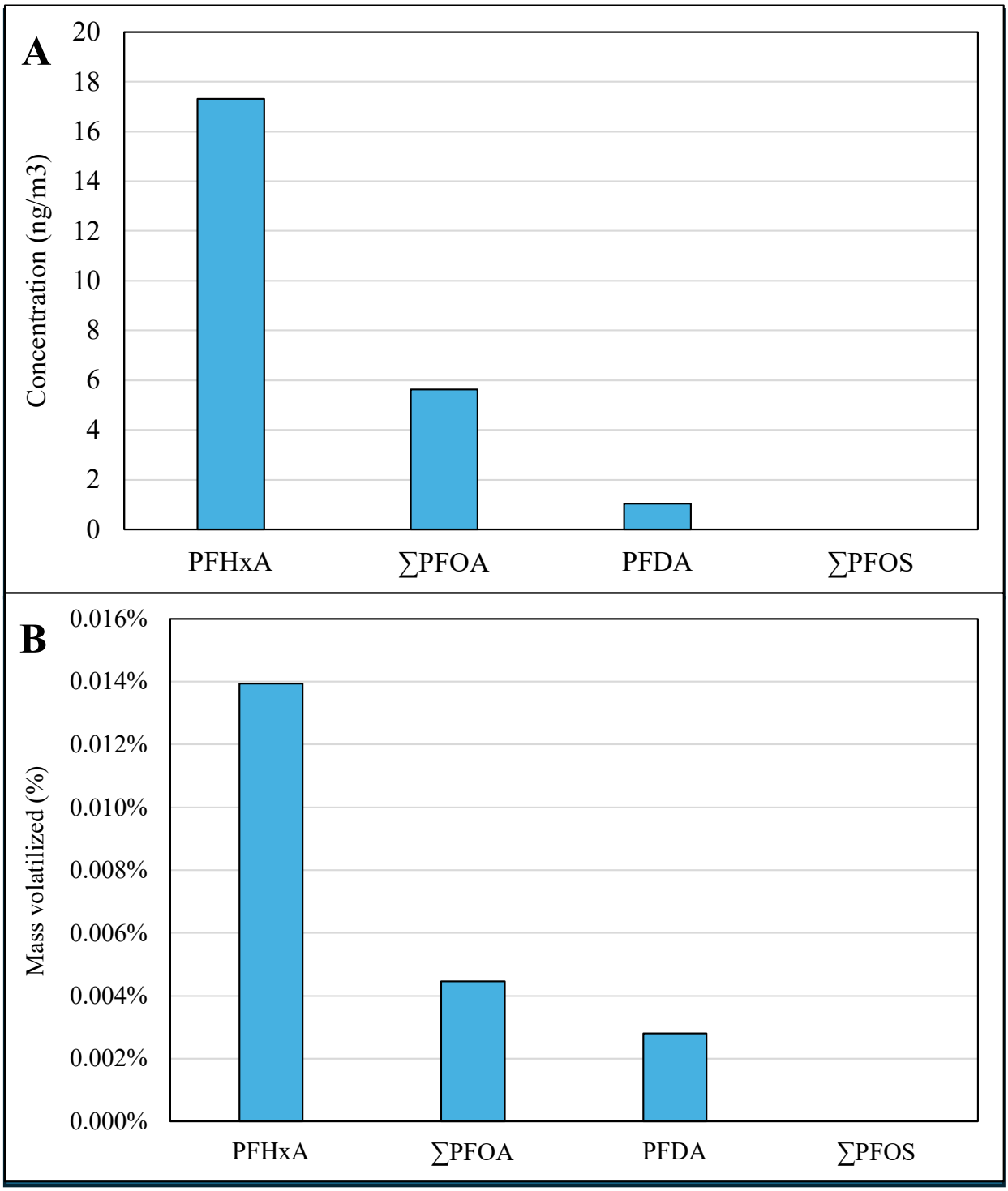
Note: BT refers to the breakthrough cartridge that is designed to collect PFAS compounds if the first cartridge becomes completely saturated.

As shown in Table 7, four anionic PFAS compounds were detected: PFHxA, ∑PFOA, PFDA, and 6:2FTS. ∑PFOA was detected in the oven blank, but not in the control sample; therefore, it was assumed that ∑PFOA present in the oven was volatilized during the oven blank sampling event and did not impact the experimental (spiked RAP) sampling event. 6:2FTS was detected in the oven blank, oven blank breakthrough, control RAP, and control RAP breakthrough, suggesting possible contamination; therefore, 6:2FTS was excluded from further analysis. It is noted that ∑PFOS was not detected during the oven blank, control RAP, or spiked RAP sampling events.

Similar to the leaching analysis, the percentage of mass volatilized was assessed for each detected compound using Equation 5.

$$Mass\ volatilized\ (\%) = \frac{(gaseous\ PFAS\ concentration) \times (volume\ of\ gas\ sampled)}{(mass\ of\ PFAS\ available\ in\ solid)} \quad (5)$$

Gaseous concentrations were compared to current and proposed air standards, and the percentage of mass volatilized was evaluated; however, because no thresholds exist at the federal level, existing state-based levels were utilized. Figure 14 displays the concentrations of PFHxA, PFOA, PFDA, and ∑PFOS observed during the spiked RAP sampling event.



Note: ∑PFOS was not detected.

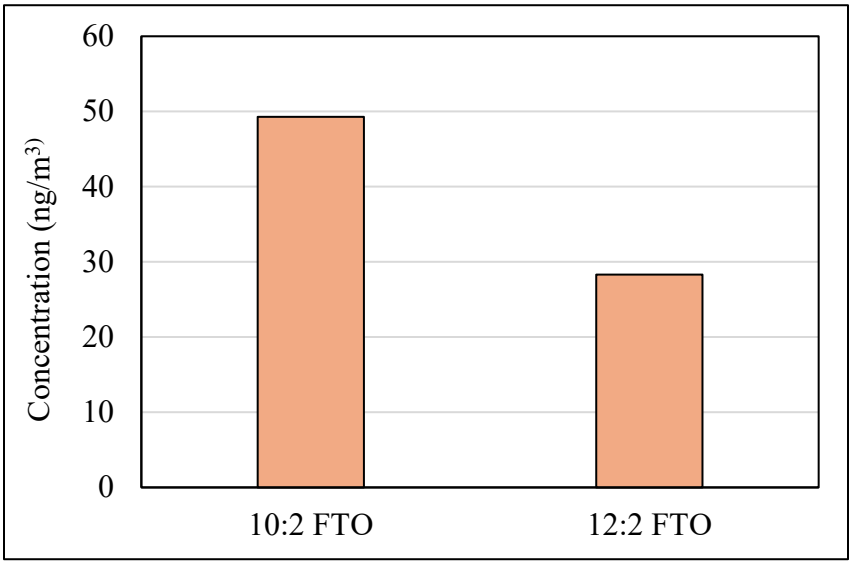
Source: University of Florida

Figure 14. A: Concentrations (ng/m³) of Anionic PFAS Compounds Observed During the Spiked RAP Sampling Event; B: Percentage of Mass Volatilized During RAP Conditioning at 135 °C.

As shown in Figure 14A, no ∑PFOS was detected in the exhaust gas, suggesting it did not have the opportunity to volatilize at the temperatures required to condition the RAP (135 °C). However, the data illustrate that PFHxA, ∑PFOA, and PFDA volatilized during RAP conditioning. From this preliminary data, a clear trend can be observed in which concentrations decreased as chain length increased. PFHxA is the shortest in chain length (C_6) and is measured at a concentration of 17 ng/m^3, followed by ∑PFOA (C_8) measured at 5.6 ng/m^3, and PFDA (C_{10}) measured at 1.0 ng/m^3. These concentrations were compared with current air quality screening parameters. Michigan has an air quality screening level in place for PFOA at 70 ng/m^3 [24], over ten times the concentration observed. New York has proposed a guideline concentration for ambient air for PFOA of 5.3 ng/m^3 [25], slightly lower than the concentration for ∑PFOA observed at 5.6 ng/m^3.

As demonstrated in Figure 14B, less than 0.015 percent of each anionic compound detected volatilized. The trend observed in Figure 14A is also observed here, in which shorter-chain compounds volatilized more readily than longer-chain compounds. PFHxA (C_6) volatilized most at 0.014 percent, followed by ∑PFOA (C_8), of which 0.005 percent volatilized, and PFDA (C_{10}), of which 0.003 percent volatilized. These data suggest that during RAP conditioning in a laboratory setting, 99.99 percent of anionic PFAS mass remains in the solid phase or transforms into other fluorinated compounds that were not analyzed in this targeted assessment.

In addition to anionic PFAS compounds, neutral PFAS compounds were analyzed. Neutral compounds more readily volatilize and are the compounds traditionally analyzed in gaseous samples [26], [27]. Figure 15 shows the two neutral compounds detected: 10:2FTO and 12:2FTO.



Source: University of Florida

Figure 15: Concentrations (ng/m^3) of Neutral PFAS Compounds Observed During the Spiked RAP Sampling Event

The two neutral PFAS compounds detected are FTOs, and they were observed at higher concentrations than the anionic PFAS compounds. 10:2FTO was observed at a concentration of 49 ng/m^3, and 12:2FTO was observed at a concentration of 28 ng/m^3. These higher concentrations may be expected as neutral compounds volatilize more readily. As no air quality standards or guidelines currently exist for neutral PFAS, a risk assessment through comparison is not possible. Further, the original concentrations of these compounds in the artificially impacted RAP were not the focus of this work and not analyzed; therefore, the percentage of mass volatilized cannot be determined.

4. Summary and Conclusions

Major knowledge gaps remain regarding the potential release of PFAS from AFFF-impacted pavement during recycling processes, both within material stockpiles and during encapsulation into new pavements. To address these gaps, NAPA has partnered with the University of Florida and Auburn University in a two-stage investigation. Stage 1, findings from which are detailed in this report, provides a proof of concept for the encapsulation potential of AFFF-impacted pavement materials into newly constructed pavements. For this work, non-impacted RCA and RAP were artificially spiked with a legacy formulation of AFFF under controlled laboratory conditions, then incorporated into new pavement mixtures and leached under various conditions. Three leaching procedures were examined: EPA Method 1315, MIST, and EPA Method 1316 at L/S 10. Leached concentrations were conservatively contextualized using available federal thresholds, including EPA's primary drinking water standards. The achieved rate of encapsulation through each leaching procedure was also assessed, derived from measured "total" available concentrations in fabricated pavements.

Under intact, monolithic conditions (EPA Method 1315), new pavements fabricated with artificially spiked RCA and RAP exhibited over 95 percent encapsulation of the total spiked PFAS mass, respectively, and demonstrated 95 percent mass retention of PFOS within both pavement materials. PFOA was not detected above instrument limits of quantitation during the entire leaching procedure. Notably, PFAS leaching observed from asphalt pavement increased throughout the leaching duration, whereas the inverse was observed for concrete, with higher release observed in earlier leaching intervals.

While not intended as a leaching procedure, liquids remaining from monolithic MIST testing represent potential leaching from weathered materials over time. New pavements fabricated with artificially spiked RCA and RAP exhibited 87 and 81 percent encapsulation of the total PFAS mass, respectively. Concrete demonstrated 95 percent PFOS and 20 percent PFOA mass encapsulation, while asphalt demonstrated comparable PFOS and higher PFOA mass encapsulation, with 85 percent of spiked PFOS and 72 percent of spiked PFOA masses retained.

Under batch leaching conditions (EPA Method 1316), new pavements fabricated with artificially spiked RCA and RAP exhibited 50 and 44 percent encapsulation of the total spiked PFAS mass, respectively. In a granular state, 29 percent of spiked PFOA and 63 percent of spiked PFOS masses were retained within concrete. Asphalt demonstrated similar encapsulation, with 36 percent of spiked PFOA and 63 percent of spiked PFOS masses retained.

In addition to releases through the leaching pathway, spiked asphalt was preliminarily investigated for releases to the gaseous pathway through the HMA process. From this preliminary evaluation, less than 0.02 percent of the total available PFAS mass was

measured in emissions. Measured compounds were primarily PFCAs of shorter chain length (PFHxA, PFOA, and PFDA), as well as 10:2FTO and 12:2FTO.

Overall, work from Stage 1 demonstrates that PFAS encapsulation can be achieved during the reincorporation of AFFF-impacted pavements into new pavement mixtures, both for concrete and asphalt. Major findings across the examined leaching and environmental assessments are summarized here:

- Monolithic leaching procedures demonstrate higher overall PFAS mass encapsulation compared to batch leaching.
- PFAS from the carboxylate subclass (i.e., PFOA) are more readily leached than sulfonate subclass (i.e., PFOS) compounds, regardless of pavement type.
- Based on existing federal regulatory thresholds for PFAS in drinking water, PFOS was the most limiting compound associated with leachate from impacted pavements in all examined leaching conditions except MIST.
- PFAS mass emission from HMA exhausts poses lower risk for regulatorily relevant PFAS compared to releases through leaching.
- Pavement characteristics, while not the primary focus of this initial investigation, impact leaching dynamics (i.e., leaching over time and compound type released), such as age, organic carbon and salt content, and porosity.

While these findings demonstrate the ability for PFAS from artificially impacted pavements to be encapsulated into new pavements, these data are limited to controlled conditions where freshly impacted materials were immediately incorporated into new pavement, conditions that may not fully represent field-impacted pavements. For example, pavement age or degradation of surfactants within AFFF in pavements exposed to environmental conditions could yield a new pavement with typical air contents, unlike the freshly spiked aggregate in this work, which significantly increased the air content of fabricated concrete. Further, the degree to which a material stockpile would be impacted by the addition of AFFF-impacted pavements warrants further investigation, as stockpile turnover and homogeneity play a role in eventual reuse. Stage 2 (Phases II–IV) of this study seeks to investigate these gaps using a similar approach to Stage 1 but with field-impacted pavements. These findings provide fundamental data for future encapsulation efforts and support the safe future management of these large-volume material streams.

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APPENDIX A – SUPPLEMENTARY DATA

Table A-1. Particle Size Distribution of Limerock, RCA, and the Limerock/RCA Blend Used Compared to the No. 57 Stone Requirements

Sieve Size	% Passing			
	Limerock	RCA	80/20 Limerock/ RCA Blend	No. 57 Stone Requirements
1.5 inch	100	100	100	100
1 inch	100	84.60	96.92	95–100
1/2 inch	54.9	19.50	47.82	25–60
No. 4	3.3	0.980	2.84	0–10
No. 8	2	0.788	1.76	0–5

RCA = recycled concrete aggregate.

Table A-2. Particle Size Distribution of Collected RAP

Sieve Size	% Passing
	RAP
3/4 inch	100
1/2 inch	99
3/8 inch	97
No. 4	82
No. 8	66
No. 16	54
No. 30	43
No. 50	31
No. 100	16
No. 200	9

RAP = reclaimed asphalt pavement.

Table A-3. Concentrations in Legacy AFFF Used to Artificially Spike RCA and RAP

Compound	Concentration (mg/L)
PFBA	1.43
PFPeA	1.12
PFHxA	4.66
PFHpA	0.781
ΣPFOA	5.60
ΣPFNA	<LOQ
PFDA	0.435
PFUdA	<LOQ
PFDoA	0.189
PFTrDA	<LOQ
PFTeDA	0.117

Compound	Concentration (mg/L)
PFBS	3.19
PFPeS	ND
ΣPFHxS	11.9
PFHpS	4.04
ΣPFOS	96.0
PFNS	ND
PFDS	ND
PFDoS	ND
ΣFOSA	<LOQ
ΣN-Me-FOSA	ND
ΣN-EtFOSA	<LOQ
ΣN-MeFOSAA	ND
ΣN-EtFOSAA	<LOQ
ΣN-MeFOSE	<LOQ
ΣN-EtFOSE	<LOQ
3:3FTCA	ND
5:3FTCA	<LOQ
7:3FTCA	<LOQ
4:2FTS	<LOQ
6:2FTS	65.6
8:2FTS	12.3
NaDONA	<LOQ
9Cl-PF3ONS	ND
11Cl-PF3OUdS	<LOQ
PFEESA	ND
HFPO-DA	ND
PF4OPeA (PFMPA)	ND
PF5OHxA (PFMBA)	<LOQ
3,6-OPFHpA (NFDHA)	ND

AFFF = aqueous film forming foam; RCA = recycled concrete aggregate; RAP = reclaimed asphalt pavement.

Table A-4. EPA Regional Screening Levels for PFAS in Tap Water [28]

PFAS Analyte	Acronym	Tap Water RSL (ng/L)
Hexafluoropropylene oxide dimer acid	HFPO-DA	15.0
Perfluorobutanesulfonic acid	PFBS	6,000
Perfluorobutanoic acid	PFBA	18,000
Perfluorodecanoic acid	PFDA	0.040
Perfluorododecanoic acid	PFDoA	1,000
Perfluorohexanesulfonic acid	PFHxS	390
Perfluorohexanoic acid	PFHxA	9,900
Perfluorononanoic acid	PFNA	59.0
Perfluorooctadecanoic acid	PFODA	800,000
Perfluorooctanesulfonic acid	PFOS	2.00
Perfluorooctanoic acid	PFOA	0.0027
Perfluoropropanoic acid	PFPrA	9,800
Perfluorotetradecanoic acid	PFTeDA	2,000
Perfluoroundecanoic acid	PFUDA	6,000

RSL = regional screening level.

Table A-5. EPA Method 1315 Sampling Log for Unspiked Concrete

Sample ID	Date Started	Time Started	Original Cylinder Mass (g)	Average Diameter (cm)	Average Length (cm)	Surface Area (cm^2)	Liquid:Area Ratio	Calculated Eluent Volume
Unspiked Concrete	6/2/2025	17:45	3753.0	10.2	20.4	818	9	7364

Time Interval	Date Started	Time Started	Water Added (g)	Date Sampled	Time Sampled	Cylinder Mass (g)	pH	ORP (mV)	Conductivity (µS/cm)	Temp. (°C)
T01	6/2/2025	17:45	7499.5	6/2/2025	19:31	3758.0	12.14	145.5	932	23.8
T02	6/2/2025	19:47	7568.0	6/3/2025	18:45	3765.5	12.15	200.6	1344	20.6
T03	6/3/2025	19:00	7495.5	6/4/2025	18:19	3768.0	11.98	352.4	847	20.6
T04	6/3/2025	18:34	7564.5	6/9/2025	17:27	3773.5	12.32	155.7	1852	20.5
T05	6/9/2025	17:41	7542.5	6/16/2025	17:40	3775.5	12.10	125.4	1498	24.6
T06	6/16/2025	17:54	7528.0	6/30/2025	18:20	3778.0	12.25	111.2	1711	20.8
T07	6/30/2025	18:33	7520.0	7/14/2025	16:05	3779.0	12.45	101.4	1337	20.6
T08	7/14/2025	17:08	7502.0	7/21/2025	17:33	3778.0	12.00	128.4	805	20.5
T09	7/21/2025	17:45	7530.5	8/4/2025	16:00	3777.5	12.34	125.4	1144	20.5

Table A-6. EPA Method 1315 Sampling Log for Spiked Concrete

Sample ID	Date Started	Time Started	Original Cylinder Mass (g)	Average Diameter (cm)	Average Length (cm)	Surface Area (cm^2)	Liquid:Area Ratio	Calculated Eluent Volume
Spiked Concrete	6/11/2025	17:59	3212.5	10.2	20.5	825	9	7422

Time Interval	Date Started	Time Started	Water Added (g)	Date Sampled	Time Sampled	Cylinder Mass (g)	pH	ORP (mV)	Conductivity (µS/cm)	Temp. (°C)
T01	6/11/2025	17:59	7569.0	6/11/2025	20:09	3219.5	11.99	255.9	985	23.9
T02	6/11/2025	20:24	7511.0	6/12/2025	19:03	3228.5	12.06	198.0	1631	20.6
T03	6/12/2025	19:18	7526.5	6/13/2025	18:11	3234.0	12.18	121.2	1087	20.7
T04	6/13/2025	18:24	7583.5	6/18/2025	18:21	3245.0	12.38	290.1	1092	20.8
T05	6/18/2025	18:33	7534.0	6/25/2025	19:03	3254.0	12.11	124.1	1678	20.7
T06	6/25/2025	19:18	7445.0	7/9/2025	17:36	3264.5	12.32	115.3	1858	20.6
T07	7/9/2025	17:51	7507.5	7/23/2025	17:43	3272.0	12.21	221.9	1504	20.6
T08	7/23/2025	18:01	7499.5	7/30/2025	17:01	3274.5	12.08	330.9	895	20.7
T09	7/30/2025	17:15	7521.0	8/13/2025	17:49	3279.5	12.13	119.6	1166	20.6

Table A-7. EPA Method 1315 Sampling Log for Unspiked Asphalt

Sample ID	Date Started	Time Started	Original Cylinder Mass (g)	Average Diameter (cm)	Average Length (cm)	Surface Area (cm^2)	Liquid:Area Ratio	Calculated Eluent Volume
Unspiked Asphalt	6/4/2025	13:15	4024.5	15.0	10.0	824	9	7418

Time Interval	Date Started	Time Started	Water Added (g)	Date Sampled	Time Sampled	Cylinder Mass (g)	pH	ORP (mV)	Conductivity (µS/cm)	Temp. (°C)
T01	6/4/2025	13:15	7491.5	6/4/2025	15:12	4039.0	10.1	329.4	11.3	23.0
T02	6/4/2025	15:28	7571.0	6/5/2025	14:36	4046.5	9.92	328.2	11.1	20.5
T03	6/5/2025	14:50	7519.5	6/6/2025	13:42	4048.5	9.89	362.3	98.6	20.5
T04	6/6/2025	13:57	7552.0	6/11/2025	13:37	4058.0	9.77	229.5	105.4	20.4
T05	6/11/2025	13:55	7542.0	6/18/2025	14:22	4064.5	9.76	205.5	22.1	20.7
T06	6/18/2025	14:36	7550.5	7/2/2025	14:08	4078.0	9.56	226.6	30.7	20.7
T07	7/2/2025	14:23	7456.5	7/14/2025	17:14	4086.5	9.59	210.0	28.7	20.5
T08	7/14/2025	17:40	7459.5	7/23/2025	13:27	4088.0	9.61	197.1	24.8	20.6
T09	7/23/2025	13:59	7509.0	8/6/2025	13:00	4089.0	9.65	276.3	29.4	20.5

Table A-8. EPA Method 1315 Sampling Log for Spiked Asphalt

Sample ID	Date Started	Time Started	Original Cylinder Mass (g)	Average Diameter (cm)	Average Length (cm)	Surface Area (cm^2)	Liquid:Area Ratio	Calculated Eluent Volume
Spiked Asphalt	6/11/2025	18:10	4025.5	15.0	10.0	825	9	7422

Time Interval	Date Started	Time Started	Water Added (g)	Date Sampled	Time Sampled	Cylinder Mass (g)	pH	ORP (mV)	Conductivity (µS/cm)	Temp. (°C)
T01	6/11/2025	18:10	7474.5	6/11/2025	20:25	4042.0	10.00	382.0	87.7	23.7
T02	6/11/2025	20:37	7562.5	6/12/2025	19:21	4047.0	9.99	246.0	93.7	20.7
T03	6/12/2025	19:33	7541.5	6/13/2025	18:27	4051.0	10.06	213.3	11.0	20.7
T04	6/13/2025	18:39	7499.5	6/18/2025	18:35	4059.5	9.84	406.9	12.3	20.8
T05	6/18/2025	18:46	7551.5	6/25/2025	19:20	4072.0	9.80	296.5	21.7	20.8
T06	6/25/2025	19:34	7411.5	7/9/2025	17:53	4088.0	9.66	198.1	31.6	20.7
T07	7/9/2025	18:08	7484.0	7/23/2025	18:03	4092.5	9.62	478.1	29.2	20.7
T08	7/23/2025	18:29	7599.0	7/30/2025	17:17	4094.5	9.84	382.4	19.0	20.6
T09	7/30/2025	17:27	7494.5	8/13/2025	17:54	4097.5	9.78	191.5	31.3	20.6

APPENDIX B – PORTLAND CEMENT CONCRETE

NAPA Concrete Mix - DATA AND CALCULATIONS

Specification					Date:	April 28th, 2025	
Cement Content:	490	lbs			Project:	NAPA	
W/CM (lbs/lbs):	0.550						
C. A. Gradation:	-				Weights by:	NMB	
Air Content (%):	3.00%				Mixing By:	NMB	
Slump Range (in):	,-				Design By:	CCF	
Fine Agg. Abs. %	0.20	Lab =	0.00		Witness By:		
Coarse Abs. %	5.07	Lab =	2.24				
Recycled Agg Abs. %	7.79	Lab =	6.38				
Batch Size (ft3):	1.5000	(yd3):	0.0556				
	I						

MATERIAL	SOURCE	WT. PER YD3 (LB)	SPECIFIC GRAVITY	VOL. PER YD3 (CF)	CALC. WT. PER BATCH (LB)	REAL. WT. PER BATCH (LB)	ADJUST. WT (LB)
CEMENT	Lab	490	3.09	2.54	**27.22**	**27.22**	
WATER	Local	270	1.00	4.32	**14.97**	**17.73**	**2.75**
FINE AGG.	CEMEX 16-078	1116	2.64	6.77	**61.99**	**61.87**	
COARSE AGG.	CEMEX 87-090	1488	2.45	9.73	**82.65**	**80.31**	**-2.34**
RECYCLED AGG.	Gainesville	372	2.11	2.82	**20.66**	**20.37**	**-0.29**
AIR ENTRAINER	Daravair 1000			0.81	8.0 ml	8.0 ml	
ADMIXTURE	WRDA60			0.00	0.0 ml	0.0 ml	
TOTAL		3735		27.00		138.33	

Time	10 a.m.
Slump (in)	6"
Air Content (%)	1.1%
Unit weight (lb/ft3)	140.57
Temperature (°F)	72

Source: Airport Asphalt Pavement Technology Program

Figure B-1. Unspiked Concrete Mix Design Sheet and Mix Quality Data

NAPA Concrete Mix - DATA AND CALCULATIONS

Specification					Date:	May 8th, 2025	
Cement Content:	490	lbs			Project:	NAPA	
W/CM (lbs/lbs):	0.550						
C. A. Gradation:	-				Weights by:	NMB	
Air Content (%):	3.00%				Mixing By:	NMB	
Slump Range (in):	,-				Design By:	CCF	
Fine Agg. Abs. %	0.20	Lab =	0.00		Witness By:		
Coarse Abs. %	5.07	Lab =	2.24				
Recycled Agg Abs. %	7.79	Lab =	6.38				
Batch Size (ft3):	1.5000	(yd3):	0.0556				
	I						

MATERIAL	SOURCE	WT. PER YD3 (LB)	SPECIFIC GRAVITY	VOL. PER YD3 (CF)	CALC. WT. PER BATCH (LB)	REAL. WT. PER BATCH (LB)	ADJUST. WT (LB)
CEMENT	Lab	490	3.09	2.54	**27.2**	**27.2**	
WATER	Local	270	1.00	4.32	**15.0**	**17.7**	**2.75**
FINE AGG.	CEMEX 16-078	1116	2.64	6.77	**62.0**	**61.9**	
COARSE AGG.	CEMEX 87-090	1488	2.45	9.73	**82.7**	**80.3**	**-2.34**
RECYCLED AGG.	Gainesville	372	2.11	2.82	**20.7**	**20.4**	**-0.29**
AIR ENTRAINER	Daravair 1000			0.81	8.0 ml	8.0 ml	
ADMIXTURE	WRDA60			0.00	0.0 ml	0.0 ml	
TOTAL		3735		27.00		138.33	

Time	10 a.m.
Slump (in)	8.75
Air Content (%)	13.0%
Unit weight (lb/ft3)	140.58
Temperature (°F)	70

Source: Airport Asphalt Pavement Technology Program

Figure B-2. Spiked Concrete Mix Design Sheet and Mix Quality Data

APPENDIX C – HOT MIX ASPHALT

National Center for Asphalt Technology
at AUBURN UNIVERSITY

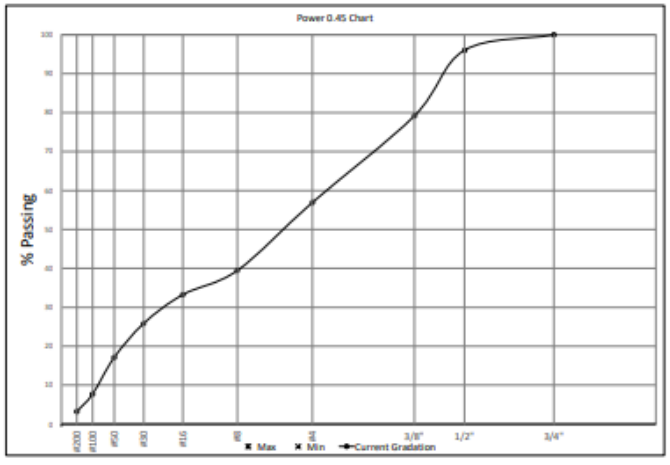
National Center for Asphalt Technology
Job-Mix Formula

NCAT Project ID:	NAPA PFAS	NCAT Mix ID:	0
Principal Investigator:	Randy West	Mix Design Engineer:	Zane Hartzog
Producer:	0	Design Completion Date:	1/1/2025
Intended Use:	0	Intended Section:	N/A
Mix Type:	Dense-Graded Superpave	Virgin Binder Grade:	PG 76-22
Nom. Max Agg. (NMAS):	12.5mm (1/2")	Virgin Binder Specific Gravity:	1.03
Max Agg. Size (MAS):	19.0mm (3/4")	Anti-Strip:	Evotherm
Mixing Temp, °F :	325	Anti-Strip Dosage (TOTAL Binder):	0.40%
Compaction Temp, °F :	2hrs at 275	A.S. Dose Rate for Virgin Binder:	0.52%
		Other Binder Additives:	0.00%

AASHTO Superpave Volumetric Mix Design

Cold Feed %	Aggregate Description	Pile ID	Source	Gsb	Gsa	% Abs.
23	#7 Stone			2.715		0.7
8	#89 Stone			2.715		1.2
35	Screenigns			2.660		0.50
14	Sand			2.635		0.20
20	RAP			2.603		

Job Mix			Mix Design Information			Aggregate Information		Criteria
Sieve	Sieve	% Passing	% Total AC Required	5.30	--	Agg. Bulk Gravity (Gsb)	2.665	--
1 1/2"	(37.5 mm)	100.0	Max Spec. Gravity Mix (Gmm)	2.480	--	Agg. Effective Gravity (Gse)	2.692	--
1"	(25 mm)	100.0	Bulk Spec. Gravity Mix (Gmb)	2.393	--	Agg. Apparent Gravity (Gsa)	--	--
3/4"	(19.0 mm)	100.0	Design Air Voids (Va)	3.5		Agg. Absorption (Abs)	0.58	--
1/2"	(12.5 mm)	96.0	VMA	15.0		Coarse Agg. Angularity (1)	100	95 min
3/8"	(9.5 mm)	79.2	VFA	76.6		Coarse Agg. Angularity (2+)	100	90 min
#4	(4.75 mm)	56.9	Dust/Asphalt Ratio	0.66		Fine Agg. Angularity (FAA)	45	45 min
#8	(2.36 mm)	39.5	Effective AC (Pbe)	4.93		Flat and Elongated 5:1 (F & E)	3	10 max
#16	(1.18 mm)	33.3	Absorbed AC (Pba)	0.39		Sand Equivalency (SE)	--	45 min
#30	(600 µm)	25.8	% AC Contribution from RAP	1.23		Other Information		
#50	(300 µm)	17.1	% AC Contribution from RAS	0.00		Ndes Gyrations	70	
#100	(150 µm)	7.7	% Virgin Binder	4.07		Ignition Oven CF	--	
#200	(75 µm)	3.3	% Recycled AC Replacement	23.2		Design Sample Mass, g	2650	
						RAP % AC (Ignition)	6.14	
						Corrected RAS % AC (TCE)	NA	
						Assumed RAS AC Contribution	NA	
						Uncorrected RAS % AC (TCE)	NA	
						RAP Binder True Grade	--	
						RAS Binder True Grade	--	
						TSR	92.9	
						Uncond. Tensile Strength, psi	--	
						Cond. Tensile Strength, psi	--	
						Cantabro % Loss	--	
						Additional Notes		



Source: Auburn University

Figure C-1. HMA Mix Design Followed for Spiked and Unspiked Asphalt Specimens

Table C-1. Bulk Specific Gravity and Percent Air Voids of Compacted Bituminous Mixtures (AASHTO T166 and T269) of Unspiked Asphalt Specimens

Project:	NAPA PFAS	Date:	5/12/2025
Tested By:	ZH	Calculated By:	ZH
Sample Identification:	NAPA PFAS CONTROL		

Sample Number	Dry Weight, g A	Submerged Weight, g B	SSD Weight, g C	Bulk Specific Gravity G_{mb} D=A/(C-B)	Theor. Max Specific Gravity, G_{mm} E	Percent Air Voids, V_a 100(1-D/E)	% Absorption Absorption Abs ≤1% (C-A)/(C-B)100
T1	4021.4	2290.7	4031.6	2.310	2.485	7.0	0.6
2	4024.1	2290.7	4030.1	2.313	2.485	6.9	0.3
3	4024.0	2293.1	4032.1	2.314	2.485	6.9	0.5
4	4023.5	2291.0	4030.4	2.313	2.485	6.9	0.4
5	4022.9	2293.3	4030.4	2.316	2.485	6.8	0.4
6	4021.5	2290.3	4027.9	2.314	2.485	6.9	0.4

Table C-2. Bulk Specific Gravity and Percent Air Voids of Compacted Bituminous Mixtures (AASHTO T166 and T269) of Spiked Asphalt Specimens

Project:	NAPA PFAS	Date:	5/12/2025
Tested By:	ZH	Calculated By:	ZH
Sample Identification:	NAPA PFAS SPIKED		

Sample Number	Dry Weight, g A	Submerged Weight, g B	SSD Weight, g C	Bulk Specific Gravity G_{mb} D=A/(C-B)	Theor. Max Specific Gravity, G_{mm} E	Percent Air Voids, V_a 100(1-D/E)	% Absorption Absorption Abs ≤1% (C-A)/(C-B)100
1	4011.8	2287.9	4020.8	2.315	2.485	6.8	0.5
2	4024.1	2296.1	4031.8	2.318	2.485	6.7	0.4
3	4025.2	2293.1	4031.8	2.315	2.485	6.8	0.4
4	4023.2	2292.1	4029.2	2.316	2.485	6.8	0.3
5	4024.5	2298.8	4034.4	2.319	2.485	6.7	0.6

APPENDIX D – PFAS EXTRACTION AND ANALYSIS

Table D-1. Extraction Internal Standard (EIS) Analyte List

Mass-Labeled PFAS Extraction Standard	Acronym 1	Acronym 2
Perfluoro-n-(13 C4)butanoic acid	$13C_4$-PFBA	MPFBA
Perfluoro-n-(13 C5)pentanoic acid	$13C_5$-PFPeA	M5PFPeA
Perfluoro-n-(1,2,3,4,6-13C 5)hexanoic acid	$13C_5$-PFHxA	M5PFHxA
Perfluoro-n-(1,2,3,4-13C4)heptanoic acid	$13C_4$-PFHpA	M4PFHpA
Perfluoro-n-(13 C8)octanoic acid	$13C_8$-PFOA	M8PFOA
Perfluoro-n-(13 C9)nonanoic acid	$13C_9$-PFNA	M9PFNA
Perfluoro-n-(1,2,3,4,5,6-13C 6)decanoic acid	$13C_6$-PFDA	M6PFDA
Perfluoro-n-(1,2,3,4,5,6,7-13C7)undecanoic acid	$13C_7$-PFUdA	M7PFUdA
Perfluoro-n-(1,2-13C 2)dodecanoic acid	$13C_2$-PFDoA	MPFDoA
Perfluoro-n-(1,2-13C 2)tetradecanoic acid	$13C_2$-PFTeDA	M2PFTeDA
Perfluoro-1-(13 C 8)octanesulfonamide	$13C_8$-FOSA	M8FOSA
N-methyl-d3-perfluoro-1-octanesulfonamide	D_3-NMeFOSA	d-N-MeFOSA
N-ethyl-d 5-perfluoro-1-octanesulfonamide	D_5-NEtFOSA	d-N-EtFOSA
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	D_3-NMeFOSAA	d3-N-MeFOSAA
N-ethyl-d 5-perfluoro-1-octanesulfonamidoacetic acid	D_5-NEtFOSAA	d5-N-EtFOSAA
2-(N-methyl-d3-perfluoro-1-octanesulfonamido)ethan-d4-ol	D_7-NMeFOSE	d7-N-MeFOSE
2-(N-ethyl-d5-perfluoro-1-octanesulfonamido)ethan-d4-ol	D_9-NEtFOSE	d9-N-EtFOSE
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)(13C3)propanoic acid	$13C_3$-HFPO-DA	M3HFPO-DA
Sodium perfluoro-1-(2,3,4-13 C3)butanesulfonate	$13C_3$-PFBS	M3PFBS
Sodium perfluoro-1-(1,2,3-13 C3)hexanesulfonate	$13C_3$-PFHxS	M3PFHxS
Sodium perfluoro-1-(13C8)octanesulfonate	$13C_8$-PFOS	M8PFOS
Sodium 1H,1H,2H,2H-perfluoro(1,2-13C2) hexanesulfonate	$13C_2$-4:2FTS	M2-4:2FTS
Sodium 1H,1H,2H,2H-perfluoro(1,2-13C2) octanesulfonate	$13C_2$-6:2FTS	M2-6:2FTS
Sodium 1H,1H,2H,2H-perfluoro(1,2-13C2) decanesulfonate	$13C_2$-8:2FTS	M2-8:2FTS

Table D-2. Non-Extracted Internal Standard (NIS) Analyte List

Mass-Labeled PFAS Injection Standard (non-extracted)	Acronym 1	Acronym 2
Perfluoro-n-(2,3,4-13C 3)butanoic acid	$13C_3$-PFBA	M3PFBA
Perfluoro-n-(1,2-13C 2)hexanoic acid	$13C_2$-PFHxA	MPFHxA
Perfluoro-n-(1,2,3,4-13C4)octanoic acid	$13C_4$-PFOA	MPFOA
Perfluoro-n-(1,2,3,4,5-13C 5)nonanoic acid	$13C_5$-PFNA	MPFNA
Perfluoro-n-(1,2-13 C 2)decanoic acid	$13C_2$-PFDA	MPFDA
Sodium perfluoro-1-hexane(18O2)sulfonate	$18O_2$-PFHxS	MPFHxS
Sodium perfluoro-1-(1,2,3,4-13C4)octanesulfonate	$13C_4$-PFOS	MPFOS

Table D-3. Target PFAS Analyte List for EPA Method 1633

Native PFAS Analyte	Acronym	Mass-Labeled Reference Standard
Perfluoroalkyl carboxylic acids		
Perfluoro-n-butanoic acid	PFBA	MPFBA
Perfluoro-n-pentanoic acid	PFPeA	M5PFPeA
Perfluoro-n-hexanoic acid	PFHxA	M5PFHxA
Perfluoro-n-heptanoic acid	PFHpA	M4PFHpA
Perfluorooctanoic acid (linear and branched isomers)	ΣPFOA	M8PFOA
Perfluorononanoic acid (linear and branched isomers)	ΣPFNA	M9PFNA
Perfluoro-n-decanoic acid	PFDA	M6PFDA
Perfluoro-n-undecanoic acid	PFUdA	M7PFUdA
Perfluoro-n-dodecanoic acid	PFDoA	MPFDoA
Perfluoro-n-tridecanoic acid	PFTrDA	M2PFTeDA
Perfluoro-n-tetradecanoic acid	PFTeDA	M2PFTeDA
Perfluoroalkyl sulfonic acids		
Potassium perfluoro-1-butanesulfonate	PFBS	M3PFBS
Sodium perfluoro-1-pentanesulfonate	PFPeS	M3PFHxS
Potassium perfluorohexanesulfonate (linear and branched isomers)	ΣPFHxS	M3PFHxS
Sodium perfluoro-1-heptanesulfonate	PFHpS	M8PFOS
Potassium perfluorooctanesulfonate (linear and branched isomers)	ΣPFOS	M8PFOS
Sodium perfluoro-1-nonanesulfonate	PFNS	M8PFOS
Sodium perfluoro-1-decanesulfonate	PFDS	M8PFOS
Sodium perfluoro-1-dodecanesulfonate	PFDoS	M8PFOS

Native PFAS Analyte	Acronym	Mass-Labeled Reference Standard
Perfluorooctane sulfonamides		
Perfluorooctanesulfonamide (linear and branched isomers)	ΣFOSA	M8FOSA
N-Methylperfluorooctanesulfonamide (linear and branched isomers)	ΣNMeFOSA	d-N-MeFOSA
N-Ethylperfluorooctanesulfonamide (linear and branched isomers)	ΣNEtFOSA	d-N-EtFOSA
Perfluorooctane sulfonamidoacetic acids		
N-Methylperfluorooctanesulfonamidoacetic acid (linear and branched isomers)	ΣNMeFOSAA	d3-N-MeFOSAA
N-Ethylperfluorooctanesulfonamidoacetic acid (linear and branched isomers)	ΣNEtFOSAA	d5-N-EtFOSAA
Perflurooctane sulfonamide ethanols		
2-(N-Methylperfluorooctanesulfonamido)ethanol (linear and branched isomers)	ΣNMeFOSE	d7-N-MeFOSE
2-(N-Ethylperfluorooctanesulfonamido)ethanol (linear and branched isomers)	ΣNEtFOSE	d9-N-EtFOSE
Per- and Polyfluoroether carboxylic acids		
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoroproproxy)propanoic acid	HFPO-DA	M3HFPO-DA
Perfluoro-4-oxapentanoic acid	PF4OPeA	M5PFPeA
Perfluoro-5-oxahexanoic acid	PF5OHxA	M5PFPeA
Perfluoro-3,6-dioxaheptanoic acid	3,6-OPFHpA	M5PFHxA
Sodium dodecafluoro-3H-4,8-dioxanonanoate	NaDONA	M3HFPO-DA
Fluorotelomer carboxylic acids		
3-Perfluoropropyl propanoic acid	FPrPA (3:3 FTCA)	M5PFPeA
3-Perfluoropentyl propanoic acid	FPePA (5:3 FTCA)	M5PFPeA
3-Perfluoroheptyl propanoic acid	FHpPA (7:3 FTCA)	M4PFHpA
Fluorotelomer sulfonic acids		
Sodium 1H,1H,2H,2H-perfluorohexanesulfonate	4:2FTS	M2-4:2FTS
Sodium 1H,1H,2H,2H-perfluorooctanesulfonate	6:2FTS	M2-6:2FTS
Sodium 1H,1H,2H,2H-perfluorodecanesulfonate	8:2FTS	M2-8:2FTS
Ether sulfonic acids		
Potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate	9Cl-PF3ONS	M3HFPO-DA
Potassium 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate	11Cl-PF3OUdS	M3HFPO-DA

Native PFAS Analyte	Acronym	Mass-Labeled Reference Standard
Potassium perfluoro(2-ethoxyethane)sulfonate	PFEESA	M5PFPeA

Note: "Σ" indicates that both linear and branched isomers are to be analyzed and concentrations for that analyte will be reported as the sum of the linear and branched isomers.

Table D-4. Limit of Quantitation Concentrations of Dominant PFAS Compounds Observed in Solid Samples

Sample ID	LOQ Concentration (ng/g)							
	PFPeA	PFHxA	PFHpA	PFOA	PFHxS	PFOS	6:2FTS	8:2FTS
Unspiked RCA	0.049	0.064	0.024	0.064	0.332	0.238	0.242	0.379
Unspiked Concrete	0.049	0.064	0.024	0.064	0.332	0.238	0.242	0.379
Unspiked RAP (coarse)	0.049	0.064	0.024	0.064	0.332	0.238	0.242	0.379
Unspiked RAP (fine)	0.049	0.064	0.024	0.064	0.332	0.238	0.242	0.379
Unspiked Asphalt	0.049	0.064	0.024	0.064	0.332	0.238	0.242	0.379
Spiked RCA	1.58	0.789	0.508	0.789	0.719	2.70	3.00	3.03
Spiked Concrete	0.098	0.127	0.049	0.127	0.663	0.476	0.483	0.757
Spiked RAP (coarse)	1.58	0.789	0.508	0.789	0.719	4.76	3.00	3.02
Spiked RAP (fine)	0.978	1.27	0.489	1.27	6.63	4.76	4.83	7.57
Spiked Asphalt	0.394	0.197	0.127	0.197	0.180	0.675	0.750	0.757

LOQ = Limit of quantitation.

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Table D-5. Limit of Quantitation Concentrations of Dominant PFAS Compounds Observed in Aqueous Samples

Leachate Type	Sample ID	LOQ Concentrations (ng/mL)							
		PFPeA	PFHxA	PFHpA	PFOA	PFOS	PFHxS	6:2FTS	8:2FTS
Batch Leachates	Unspiked RCA	0.002	0.002	0.001	0.002	0.008	0.011	0.008	0.012
	Unspiked Concrete	0.002	0.002	0.001	0.002	0.008	0.011	0.008	0.012
	Unspiked RAP (coarse)	0.002	0.002	0.001	0.002	0.008	0.011	0.008	0.012
	Unspiked RAP (fine)	0.002	0.002	0.001	0.002	0.008	0.011	0.008	0.012
	Unspiked Asphalt	0.002	0.002	0.001	0.002	0.008	0.011	0.008	0.012
	Spiked RCA	0.039	0.051	0.020	0.051	0.190	0.265	0.193	0.303
	Spiked Concrete	0.008	0.010	0.004	0.010	0.038	0.053	0.039	0.061
	Spiked RAP (coarse)	0.039	0.051	0.020	0.051	0.190	0.265	0.193	0.303
	Spiked RAP (fine)	0.039	0.051	0.020	0.051	0.190	0.265	0.193	0.303
	Spiked Asphalt	0.008	0.010	0.004	0.010	0.038	0.053	0.039	0.061
EPA Method 1315 Leachates	Unspiked Concrete (T01-T05)	0.002	0.002	0.001	0.002	0.008	0.011	0.008	0.012
	Unspiked Concrete (T06-T09)	0.006	0.003	0.002	0.003	0.011	0.003	0.012	0.012
	Unspiked Asphalt (T01-T05)	0.002	0.002	0.001	0.002	0.008	0.011	0.008	0.012
	Unspiked Asphalt (T06-T09)	0.006	0.003	0.002	0.003	0.011	0.003	0.012	0.012
	Spiked Concrete	0.016	0.008	0.005	0.008	0.027	0.007	0.030	0.030
	Spiked Asphalt (T01-T05)	0.016	0.008	0.005	0.008	0.027	0.007	0.030	0.030
	Spiked Asphalt (T06-T09)	0.006	0.003	0.002	0.003	0.011	0.003	0.012	0.012
MIST Leachates	Unspiked Concrete	0.004	0.005	0.002	0.005	0.019	0.027	0.019	0.030
	Spiked Concrete	0.016	0.008	0.005	0.008	0.027	0.007	0.030	0.030
	Unspiked Asphalt	0.004	0.005	0.002	0.005	0.019	0.027	0.019	0.030
	Spiked Asphalt	0.016	0.008	0.005	0.008	0.027	0.007	0.030	0.030

LOQ = Limit of quantitation

Table D-6. Pre-Sampling Internal Standard Analyte List

Mass-Labeled Internal Standard	Acronym 1	Acronym 2
Perfluoro-n-(1,2,3,4-13C4)octanoic acid	$13C_4$-PFOA	MPFOA
Sodium perfluoro-1-(1,2,3,4-13C4)octanesulfonate	$13C_4$-PFOS	MPFOS

Table D-7. LC Pre-Extraction Internal Standard Analyte List

Mass-Labeled Internal Standard	Acronym 1	Acronym 2
Perfluoro-n-(13 C4)butanoic acid	$13C_4$-PFBA	MPFBA
Perfluoro-n-(13 C5)pentanoic acid	$13C_5$-PFPeA	M5PFPeA
Perfluoro-n-(1,2,3,4,6-13C 5)hexanoic acid	$13C_5$-PFHxA	M5PFHxA
Perfluoro-n-(1,2,3,4-13C4)heptanoic acid	$13C_4$-PFHpA	M4PFHpA
Perfluoro-n-(13 C8)octanoic acid	$13C_8$-PFOA	M8PFOA
Perfluoro-n-(13 C9)nonanoic acid	$13C_9$-PFNA	M9PFNA
Perfluoro-n-(1,2,3,4,5,6-13C 6)decanoic acid	$13C_6$-PFDA	M6PFDA
Perfluoro-n-(1,2,3,4,5,6,7-13C7)undecanoic acid	$13C_7$-PFUnA	M7PFUdA
Perfluoro-n-(1,2-13C 2)dodecanoic acid	$13C_2$-PFDoA	MPFDoA
Perfluoro-n-(1,2-13C 2)tetradecanoic acid	$13C_2$-PFTeDA	M2PFTeDA
Perfluoro-1-(13 C 8)octanesulfonamide	$13C_8$-PFOSA	M8FOSA
N-methyl-d3-perfluoro-1-octanesulfonamide	D_3-NMeFOSA	d-N-MeFOSA
N-ethyl-d 5-perfluoro-1-octanesulfonamide	D_5-NEtFOSA	d-N-EtFOSA
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	D_3-NMeFOSAA	d3-N-MeFOSAA
N-ethyl-d 5-perfluoro-1-octanesulfonamidoacetic acid	D_5-NEtFOSAA	d5-N-EtFOSAA
2-(N-methyl-d3-perfluoro-1-octanesulfonamido)ethan-d4-ol	D_7-NMeFOSE	d7-N-MeFOSE
2-(N-ethyl-d5-perfluoro-1-octanesulfonamido)ethan-d4-ol	D_9-NEtFOSE	d9-N-EtFOSE
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)(13C3)propanoic acid	$13C_3$-HFPO-DA	M3HFPO-DA
Sodium perfluoro-1-(2,3,4-13 C3)butanesulfonate	$13C_3$-PFBS	M3PFBS
Sodium perfluoro-1-(1,2,3-13 C3)hexanesulfonate	$13C_3$-PFHxS	M3PFHxS
Sodium perfluoro-1-(13C8)octanesulfonate	$13C_8$-PFOS	M8PFOS
Sodium 1H,1H,2H,2H-perfluoro(1,2-13C2)hexanesulfonate	$13C_2$-4:2FTS	M2-4:2FTS
Sodium 1H,1H,2H,2H-perfluoro(1,2-13C2)octanesulfonate	$13C_2$-6:2FTS	M2-6:2FTS
Sodium 1H,1H,2H,2H-perfluoro(1,2-13C2)decanesulfonate	$13C_2$-8:2FTS	M2-8:2FTS
2-Perfluorohexyl (1,2-13C2)ethanoic acid	$13C_2$-FHEA	M2FHEA

Mass-Labeled Internal Standard	Acronym 1	Acronym 2
2-Perfluorooctyl (1,2-13C2)ethanoic acid	$13C_2$-FOEA	M2FOEA
2-Perfluorodecyl (1,2-13C2)ethanoic acid	$13C_2$-FDEA	M2FDEA
Perfluoro-n-(1,2-13C2)hexadecanoic acid	$13C_2$-PFHxDA	M2PFHxDA
2H-Perfluoro-(1,2-13C2)-2-octenoic acid	$13C_2$-FHUEA	MFHUEA
2H-Perfluoro-(1,2-13C2)-2-decenoic acid	$13C_2$-FOUEA	MFOUEA
2H-Perfluoro-(1,2-13C2)-2-dodecenoic acid	$13C_2$-FDUEA	MFDUEA
Sodium 1H,1H,2H,2H-(1,2-13C2)perfluorooctyl phosphate	$13C_2$-6:2monoPAP	M2-6:2monoPAP
Sodium 1H,1H,2H,2H-(1,2-13C2)perfluorodecyl phosphate	$13C_2$-8:2monoPAP	M2-8:2monoPAP
Sodium bis[1H,1H,2H,2H-(1,2-13C2)perfluorooctyl] phosphate	$13C_4$-6:2diPAP	M4-6:2diPAP
Sodium bis[1H,1H,2H,2H-(1,2-13C2)perfluorodecyl] phosphate	$13C_4$-8:2diPAP	M4-8:2diPAP

LC = liquid chromatography

Table D-8. Pre-Analysis Internal Standard Analyte List

Mass-Labeled Internal Standard	Acronym 1	Acronym 2
Perfluoro-n-(2,3,4-13C 3)butanoic acid	$13C_3$-PFBA	M3PFBA
Perfluoro-n-(1,2-13C2)octanoic acid	$13C_2$-PFOA	M2PFOA

Table D-9. Target PFAS Analyte List for Anionic Gas Compounds

Class	PFAS Analyte	Acronym	Mass-Labeled Reference Standard
PFCA	Perfluorobutanoic acid	PFBA	M4PFBA
	Perfluoropentanoic acid	PFPeA	M5PFPeA
	Perfluorohexanoic acid	PFHxA	M5PFHxA
	Perfluoroheptanoic acid	PFHpA	M4PFHpA
	Perfluorooctanoic acid	∑PFOA	M8PFOA
	Perfluorononanoic acid	∑PFNA	M9PFNA
	Perfluorodecanoic acid	PFDA	M6PFDA
	Perfluoroundecanoic acid	PFUdA	M7PFUdA
	Perfluorododecanoic acid	PFDoA	M2PFDoA
	Perfluorotridecanoic acid	PFTrDA	M2PFTeDA
	Perfluorotetradecanoic acid	PFTeDA	M2PFTeDA
	Perfluorohexadecanoic acid	PFHxDA	M2PFTeDA
PFSA	Perfluoropropanesulfonic acid	PFPrS	M4PFBA
	Perfluorobutanesulfonic acid	PFBS	M3PFBS
	Perfluoropentanesulfonic acid	PFPeS	$13C_3$-PFHxS

Class	PFAS Analyte	Acronym	Mass-Labeled Reference Standard
	Perfluorohexanesulfonic acid	∑PFHxSK	$13C_3$-PFHxS
	Perfluoroheptanesulfonic acid	PFHpS	$13C_8$-PFOS
	Perfluorooctanesulfonic acid	∑PFOSK	$13C_8$-PFOS
	Perfluorononanesulfonic acid	PFNS	$13C_8$-PFOS
	Perfluorodecanesulfonic acid	PFDS	$13C_8$-PFOS
	Perfluorododecanesulfonic acid	PFDoS	$13C_8$-PFOS
H-PFCA	5H-Perfluoropentanoic acid	5H-PFPeA	M5PFPeA
	7H-Dodecafluoroheptanoic acid	7H-PFHpA	M4PFHpA
	8H-Perfluorooctanoic acid	8H-PFOA	M8PFOA
	9H-Hexadecafluorononanoic acid	9H-PFNA	M9PFNA
	11H-Perfluoroundecanoic acid	11H-PFUdA	M7PFUdA
PFECA	Hexafluoropropylene oxide dimer acid	HFPO-DA (Gen-X)	$13C_3$-HFPO-DA
	Perfluoro-4-oxapentanoic acid	PFMPA (PF4OPeA)	M5PFPeA
	Perfluoro-5-oxahexanoic acid	PFMBA (PF5OHxA)	M5PFPeA
	Perfluoro-3,6-dioxaheptanoic acid	NFDHA (3,6-OPFHpA)	M5PFHxA
	Sodium 4,8-dioxa-3H-perfluorononanoate	NaDONA	$13C_3$-HFPO-DA
FTCA	3:3 fluorotelomer carboxylic acid	FPrPA (3:3 FTCA)	M5PFPeA
	5:3 fluorotelomer carboxylic acid	FPePA (5:3 FTCA)	M5PFHxA
	7:3 fluorotelomer carboxylic acid	FHpPA (7:3 FTCA)	M5PFHxA
	8:3 fluorotelomer carboxylic acid	8:3 FTCA	M6PFDA
	6:2 fluorotelomer carboxylic acid	FHEA (6:2 FTCA)	M2FHEA
	8:2 fluorotelomer carboxylic acid	FOEA (8:2 FTCA)	M2FOEA
	10:2 fluorotelomer carboxylic acid	FDEA (10:2 FTCA)	M2FDEA
FTUCA	6:2 fluorotelomer unsaturated carboxylic acid	FHUEA (6:2 FTUCA)	MFHUEA
	8:2 fluorotelomer unsaturated carboxylic acid	FOUEA (8:2 FTUCA)	MFOUEA

Class	PFAS Analyte	Acronym	Mass-Labeled Reference Standard
	10:2 fluorotelomer unsaturated carboxylic acid	FDUEA (10:2 FTUCA)	MFDUEA
PFESA	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS (6:2 Cl-PFEESA)	$13C_3$-HFPO-DA
	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS (8:2 Cl-PFEESA)	$13C_3$-HFPO-DA
	Potassium perfluoro(2-ethoxyethane)sulfonate	PFEESA	M5PFHxA
	8-chlorohexadecafluoro-3-oxaoctane-1-sulfonic acid	8CL-PFOS	$13C_3$-HFPO-DA
PFECHS	n-decafluoro-4 ethylcyclohexanesulfonic acid	PFECHS	M8PFOA
FASA	Perfluoro-1-octanesulfonamide	∑PFOSA	$13C_8$-PFOSA
	N-methylperfluorooctane sulfonamide	∑N-Me-FOSA	D_3-NMeFOSA
	N-ethylperfluorooctane sulfonamide	∑N-EtFOSA	D_5-NEtFOSA
FASAA	N-methylperfluoro-1-octanesulfonamidoacetic acid	∑N-MeFOSAA	d3-N-MeFOSAA
	N-ethylperfluoro-1-octanesulfonamidoacetic acid	∑N-EtFOSAA	d5-N-EtFOSAA
FTS	4:2 fluorotelomer sulfonic acid	4:2FTS	M2-4:2FTS
	6:2 fluorotelomer sulfonic acid	6:2FTS	M2-6:2FTS
	8:2 fluorotelomer sulfonic acid	8:2FTS	M2-8:2FTS
	10:2 fluorotelomer sulfonic acid	10:2FTS	M2-8:2FTS
PFPi	Sodium bis(perfluorohexyl)phosphinate	6:6 PFPi	M2PFTeDA
	Sodium perfluorohexylperfluorooctylphosphinate	6:8 PFPi	M2PFTeDA
PAP	6:2 fluorotelomer phosphate diester	6:2diPAP	M4-6:2diPAP
	6:2/8:2 fluorotelomer phosphate diester	6:2/8:2diPAP	M4-6:2diPAP
	8:2 fluorotelomer phosphate diester	8:2diPAP	M4-8:2diPAP
	10:2 fluorotelomer phosphate diester	10:2diPAP	M4-8:2diPAP
	Sodium 2-(N-ethylperfluorooctane-1-sulfonamido)ethyl phosphate	SamPAP	M2-6:2monoPAP
	Sodium bis-[2-(N-ethylperfluorooctane-1-sulfonamido)ethyl] phosphate	diSAmPAP	M4-8:2diPAP

Table D-10. GC Pre-Extraction Internal Standard Analyte List

Mass-Labeled PFAS Injection Standard	Acronym(s)
2-Perfluorobutyl-[1,1,2,2-2H4]-ethanol(4:2)	d_4-4:2FTOH (MFBET)
1D,1D,2H,2H-1-hydroxyperfluorooctane	d_2-6:2FTOH (MFHET)
2-Perfluorooctyl-[1,2-13C2]-ethanol(8:2)	d_2-8:2FTOH (M2FOET)
2-Perfluorodecyl-[1,1-2H2]-[1,2-13C2]-ethanol(10:2)	d_2-10:2FTOH (MFDET)
1H,1H,2H,2H-perfluoro-n-octyl methacrylate-d5	d_5-6:2FTMAc
d3-N-Methyl perfluorooctanesulfonamide	d_3-N-MeFOSA-M
N-ethyl -d5-perfluoro-1-octanesulfonamide	d_5-N-EtFOSA-M
2-(N-ethyl-d5-perfluoro-1-octanesulfonamido)ethan-d4-ol	d_9-N-EtFOSE-M

GC = gas chromatography

Table D-11. Target PFAS Analyte List for Neutral Gas Compounds

Class	PFAS Analyte	Acronym	Mass-Labeled Reference Standard
FTOH	1H,1H,2H,2H-Perfluorohexan-1-ol	4:2 FTOH	d_4-4:2 FTOH
	1H,1H,2H,2H-Perfluorooctan-1-ol	6:2 FTOH	d_2-6:2 FTOH
	1H,1H,2H,2H-Perfluorodecan-1-ol	8:2 FTOH	d_2-8:2FTOH
	1H,1H,2H,2H-Perfluorododecan-1-ol	10:2 FTOH	d_2-10:2FTOH
	1H,1H,2H,2H-Perfluorotetradecan-1-ol	12:2 FTOH	d_2-10:2FTOH
sFTOH	1-Perfluoropentyl ethanol(5:2 secondary)	5:2s FTOH	d_4-4:2 FTOH
	1-Perfluoroheptyl ethanol(7:2 secondary)	7:2s FTOH	d_2-6:2 FTOH
FTO	1H,1H,2H-Perfluoro-1-decene	8:2 FTO	d_4-4:2 FTOH
	(Perfluorodecyl)ethylene	10:2 FTO	d_4-4:2 FTOH
	1H,1H,2H-Perfluoro-1-tetradecene	12:2 FTO	d_2-6:2 FTOH
FTOAc	1H, 1H, 2H, 2H-Perfluorodecyl acetate	8:2 FTOAc	d_5-6:2 FTMAc
	1H, 1H, 2H, 2H-Perfluorododecyl acetate	10:2 FTOAc	d_5-6:2 FTMAc
FTAC	1H,1H,2H,2H-Perfluorohexyl acrylate	4:2 FTAc	d_2-8:2FTOH
	1H,1H,2H,2H-Perfluorooctyl acrylate	6:2 FTAc	d_2-10:2FTOH
	1H, 1H, 2H, 2H-Perfluorodecyl acrylate	8:2 FTAc	d_5-6:2 FTMAc
	1H, 1H, 2H, 2H-Perfluorododecyl acrylate	10:2 FTAc	d_5-6:2 FTMAc
FTMAc	1H,1H,2H,2H-Perfluorooctyl methacrylate	6:2 FTMAc	d_5-6:2 FTMAc
	1H,1H,2H,2H-Perfluorodecyl methacrylate	8:2 FTMAc	d_5-6:2 FTMAc
FTI	1-Iodo-1H,1H,2H,2H-nonafluorohexane	4:2 FTI	d_4-4:2 FTOH
	1-Iodo-1H,1H,2H,2H-perfluorooctane	6:2 FTI	d_2-6:2 FTOH
	1-Iodo-1H,1H,2H,2H-perfluorodecane	8:2 FTI	d_2-8:2FTOH
	1-Iodo-1H,1H,2H,2H-perfluorododecane	10:2 FTI	d_5-6:2FTMAc
FASA	N-Methyl perfluorooctanesulfonamide	ΣMeFOSA	d_3-N-MeFOSA-M
	N-Ethyl perfluorooctylsulfonamide	EtFOSA	d_5-N-EtFOSA-M

Class	PFAS Analyte	Acronym	Mass-Labeled Reference Standard
FASE	N-Ethyl-N-(2-hydroxyethyl)perfluorooctylsulfonamide	ΣEtFOSE	d9-N-EtFOSE-M
Other	1-Iodoperfluorooctane	PFOI	d4-4:2 FTOH
	1-Iodoperfluorodecane	PFDI	d2-6:2 FTOH

APPENDIX E – COMPLETE DATA SET FOR STAGE 1

Table E-1. Average of Triplicate Concentrations of Unspiked Solid Pavement Material

PFAS	Unspiked (Control) Solids (ng/g)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
PFBA	ND	ND	ND	<LOQ	ND
PFPeA	ND	ND	ND	ND	ND
PFHxA	<LOQ	ND	ND	<LOQ	ND
PFHpA	<LOQ	ND	ND	<LOQ	ND
ΣPFOA	<LOQ	ND	ND	<LOQ	ND
ΣPFNA	ND	ND	ND	ND	ND
PFDA	ND	ND	ND	ND	ND
PFUdA	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND	ND
PFTrDA	ND	<LOQ	ND	ND	<LOQ
PFTeDA	ND	ND	ND	ND	ND
PFBS	ND	ND	ND	ND	ND
PFPeS	ND	ND	ND	ND	ND
ΣPFHxS	ND	ND	ND	ND	ND
PFHpS	ND	ND	ND	ND	ND
ΣPFOS	ND	ND	ND	ND	ND
PFNS	ND	ND	ND	ND	<LOQ
PFDS	ND	ND	ND	ND	ND
PFDoS	ND	ND	ND	ND	ND
ΣFOSA	<LOQ	ND	ND	<LOQ	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	<LOQ	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	<LOQ	<LOQ
ΣN-EtFOSE	ND	ND	ND	ND	ND
3:3FTCA	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND	ND
6:2FTS	ND	ND	ND	ND	ND
8:2FTS	ND	ND	<LOQ	ND	ND
NaDONA	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND

PFAS	Unspiked (Control) Solids (ng/g)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
PFEESA	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND

Notes: Concrete refers to concrete fabricated using unspiked RCA, and asphalt refers to asphalt fabricated using unspiked RAP. Concentrations were reported as <LOQ if two of the three triplicates were <LOQ.

Table E-2. Average of Triplicate Concentrations of Spiked Solid Pavement Material

PFAS	Spiked Solids (ng/g)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
PFBA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFPeA	<LOQ	0.424	<LOQ	2.68	<LOQ
PFHxA	6.83	1.29	4.69	12.5	0.843
PFHpA	1.72	0.298	<LOQ	2.22	<LOQ
ΣPFOA	12.7	2.00	7.45	11.6	0.732
ΣPFNA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFDA	2.03	0.378	2.37	2.84	<LOQ
PFUdA	ND	ND	ND	ND	ND
PFDoA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFTrDA	ND	<LOQ	<LOQ	<LOQ	ND
PFTeDA	<LOQ	0.073	0.525	0.771	<LOQ
PFBS	3.20	<LOQ	2.49	<LOQ	<LOQ
PFPeS	4.16	<LOQ	2.68	<LOQ	<LOQ
ΣPFHxS	40.8	6.47	34.5	58.8	2.74
PFHpS	7.60	1.13	10.2	12.9	<LOQ
ΣPFOS	513	82.6	627	807	41.6
PFNS	ND	<LOQ	ND	<LOQ	ND
PFDS	ND	<LOQ	ND	<LOQ	ND
PFDoS	ND	ND	ND	<LOQ	ND
ΣFOSA	ND	<LOQ	ND	<LOQ	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	<LOQ	ND
ΣN-EtFOSE	ND	ND	ND	<LOQ	ND

PFAS	Spiked Solids (ng/g)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
3:3FTCA	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND
4:2FTS	ND	<LOQ	ND	<LOQ	ND
6:2FTS	262	46.1	197	331	22.9
8:2FTS	78.4	18.6	84.0	118	7.48
NaDONA	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND

Notes: Concrete refers to concrete fabricated using spiked RCA, and asphalt refers to asphalt fabricated using spiked RAP. Concentrations were reported as <LOQ if two of the three triplicates were <LOQ.

Table E-3. Average of Triplicate Concentrations of Batch Leachates from Unspiked Pavement Material

PFAS	Unspiked (Control) Batch Leachates (ng/mL)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
PFBA	<LOQ	ND	ND	ND	ND
PFPeA	ND	<LOQ	ND	ND	ND
PFHxA	<LOQ	<LOQ	ND	ND	ND
PFHpA	<LOQ	<LOQ	ND	ND	ND
ΣPFOA	<LOQ	ND	ND	ND	ND
ΣPFNA	ND	ND	ND	ND	ND
PFDA	ND	ND	ND	ND	ND
PFUdA	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND	ND
PFTrDA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFTeDA	ND	ND	ND	ND	ND
PFBS	ND	ND	ND	ND	ND
PFPeS	ND	ND	ND	ND	ND
ΣPFHxS	ND	ND	ND	ND	ND
PFHpS	ND	ND	ND	ND	ND
ΣPFOS	ND	ND	ND	ND	ND
PFNS	ND	ND	<LOQ	<LOQ	ND
PFDS	ND	ND	<LOQ	<LOQ	ND

PFAS	Unspiked (Control) Batch Leachates (ng/mL)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
PFDoS	ND	ND	ND	ND	<LOQ
ΣFOSA	<LOQ	<LOQ	<LOQ	ND	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	ND	ND
ΣN-EtFOSE	<LOQ	ND	<LOQ	ND	ND
3:3FTCA	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND	ND
6:2FTS	ND	ND	<LOQ	ND	<LOQ
8:2FTS	ND	ND	ND	ND	ND
NaDONA	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND

Concrete refers to concrete fabricated using unspiked RCA, and asphalt refers to asphalt fabricated using unspiked RAP. Concentrations were reported as <LOQ if two of the three triplicates were <LOQ.

Table E-4. Average of Triplicate Concentrations of Batch Leachates from Spiked Pavement Material

PFAS	Spiked Batch Leachates (ng/mL)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
PFBA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFPeA	0.154	0.042	0.099	0.349	0.022
PFHxA	0.720	0.110	0.613	1.86	0.094
PFHpA	0.162	0.024	0.079	0.277	0.011
ΣPFOA	0.880	0.142	0.514	1.36	0.047
ΣPFNA	<LOQ	<LOQ	<LOQ	<LOQ	ND
PFDA	<LOQ	0.011	<LOQ	0.072	0.011
PFUdA	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	<LOQ	ND
PFTrDA	<LOQ	<LOQ	<LOQ	<LOQ	ND

PFAS	Spiked Batch Leachates (ng/mL)				
	RCA	Concrete	RAP (coarse)	RAP (fine)	Asphalt
PFTeDA	ND	ND	ND	0.030	ND
PFBS	<LOQ	<LOQ	<LOQ	0.881	<LOQ
PFPeS	<LOQ	<LOQ	<LOQ	0.922	<LOQ
ΣPFHxS	3.01	0.463	2.43	6.34	0.161
PFHpS	<LOQ	0.080	0.429	0.831	<LOQ
ΣPFOS	3.87	3.03	6.28	21.7	1.54
PFNS	ND	ND	ND	<LOQ	ND
PFDS	<LOQ	<LOQ	<LOQ	<LOQ	ND
PFDoS	ND	ND	ND	ND	ND
ΣFOSA	ND	<LOQ	<LOQ	<LOQ	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	ND	ND
ΣN-EtFOSE	ND	ND	ND	ND	ND
3:3FTCA	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND
4:2FTS	<LOQ	<LOQ	<LOQ	<LOQ	ND
6:2FTS	18.8	3.68	16.1	32.1	2.01
8:2FTS	0.288	0.417	0.804	2.95	0.438
NaDONA	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND

Notes: Concrete refers to concrete fabricated using spiked RCA, and asphalt refers to asphalt fabricated using spiked RAP. Concentrations were reported as <LOQ if two of the three triplicates were <LOQ.

Table E-5. Unspiked Concrete EPA Method 1315 Leachate Concentrations

PFAS	Unspiked (Control) Concrete 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
PFBA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFPeA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHxA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHpA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFOA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFUdA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTrDA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	ND	ND	ND	ND
PFTeDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFBS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFPeS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFHxS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHpS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFOS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDS	<LOQ	ND	<LOQ	<LOQ	<LOQ	ND	ND	ND	ND
PFDoS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣFOSA	ND	ND	ND	<LOQ	<LOQ	ND	ND	ND	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSE	<LOQ	ND	ND	ND	ND	ND	ND	ND	ND

PFAS	Unspiked (Control) Concrete 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
3:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND
6:2FTS	ND	ND	<LOQ	ND	ND	ND	ND	ND	ND
8:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND
NaDONA	ND	ND	ND	ND	ND	<LOQ	<LOQ	<LOQ	<LOQ
9Cl-PF3ONS	ND	<LOQ	ND	ND	<LOQ	ND	ND	ND	ND
11Cl-PF3OUdS	ND	<LOQ	ND	ND	ND	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Singular samples were taken at each of the nine time intervals.

Table E-6. Spiked Concrete EPA Method 1315 Leachate Concentrations

PFAS	Spiked Concrete 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
PFBA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFPeA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFHxA	<LOQ	<LOQ	<LOQ	0.015	0.017	0.022	0.016	<LOQ	<LOQ
PFHpA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFOA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDA	<LOQ	<LOQ	ND	<LOQ	ND	ND	ND	ND	ND
PFUdA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTrDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTeDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFBS	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFPeS	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFHxS	0.025	0.030	<LOQ	0.038	0.036	0.041	0.030	<LOQ	0.023
PFHpS	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	ND	ND	ND	ND
ΣPFOS	0.107	0.272	0.146	0.226	0.180	0.122	0.118	<LOQ	0.082
PFNS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND

PFAS	Spiked Concrete 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
3:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND
6:2FTS	0.269	0.366	0.139	0.348	0.320	0.274	0.209	0.098	0.152
8:2FTS	<LOQ	0.067	0.051	0.069	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
NaDONA	ND	ND	ND	ND	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes: Singular samples were taken at each of the nine time intervals.

Table E-7. Unspiked Asphalt EPA Method 1315 Leachate Concentrations

PFAS	Unspiked (Control) Asphalt 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
PFBA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFPeA	ND	ND	ND	ND	ND	ND	ND	ND	<LOQ
PFHxA	ND	ND	ND	ND	ND	ND	ND	ND	<LOQ
PFHpA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFOA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFUdA	ND	ND	ND	ND	ND	ND	ND	ND	ND

PFAS	Unspiked (Control) Asphalt 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
PFDoA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTrDA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	ND	ND	ND	ND
PFTeDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFBS	ND	ND	ND	ND	ND	ND	ND	ND	<LOQ
PFPeS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFHxS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFHpS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFOS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFNS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDS	<LOQ	<LOQ	<LOQ	<LOQ	ND	ND	ND	ND	ND
PFDoS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣFOSA	ND	ND	ND	ND	<LOQ	ND	ND	ND	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	<LOQ	<LOQ	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	<LOQ	<LOQ	ND	ND	ND	ND
ΣN-EtFOSE	<LOQ	<LOQ	<LOQ	ND	<LOQ	ND	ND	ND	ND
3:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	<LOQ	ND	ND	ND	ND	ND
6:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND
8:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND
NaDONA	ND	ND	ND	ND	ND	ND	ND	ND	ND
9Cl-PF3ONS	<LOQ	ND	ND	ND	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	<LOQ	ND	ND	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND	ND	ND	ND	ND	ND

PFAS	Unspiked (Control) Asphalt 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Singular samples were taken at each of the nine time intervals.

Table E-8. Spiked Asphalt EPA Method 1315 Leachate Concentrations

PFAS	Spiked Asphalt 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
PFBA	ND	ND	ND	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFPeA	ND	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFHxA	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.017	0.015	0.007	0.012
PFHpA	ND	ND	ND	ND	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFOA	ND	ND	ND	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFNA	ND	ND	ND	ND	ND	<LOQ	ND	ND	ND
PFDA	ND	ND	ND	ND	ND	<LOQ	<LOQ	<LOQ	<LOQ
PFUdA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTrDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFTeDA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFBS	ND	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
PFPeS	ND	ND	ND	ND	ND	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFHxS	ND	<LOQ	ND	<LOQ	<LOQ	0.014	0.014	0.007	0.013
PFHpS	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣPFOS	<LOQ	<LOQ	<LOQ	0.067	0.059	0.095	0.090	0.041	0.080
PFNS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFDoS	ND	ND	ND	ND	ND	ND	ND	ND	ND

PFAS	Spiked Asphalt 1315 Leachates (ng/mL)								
	T01	T02	T03	T04	T05	T06	T07	T08	T09
ΣFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-Me-FOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND
ΣN-EtFOSE	ND	ND	ND	ND	ND	ND	ND	ND	ND
3:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND	ND	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND	ND	ND	ND	ND	ND
6:2FTS	ND	ND	ND	0.092	0.159	0.181	0.169	0.083	0.139
8:2FTS	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.018	<LOQ	0.018
NaDONA	ND	ND	ND	ND	ND	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND	ND	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND	ND	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Singular samples were taken at each of the nine time intervals.

Table E-9. MIST Leachate Concentrations for Unspiked Concrete and Unspiked Asphalt Specimens

PFAS	Unspiked (Control) MIST Leachates (ng/mL)			
	Concrete – 1	Concrete – 2	Asphalt – 1	Asphalt – 2
PFBA	ND	<LOQ	ND	ND
PFPeA	<LOQ	<LOQ	ND	ND
PFHxA	<LOQ	<LOQ	<LOQ	<LOQ
PFHpA	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFOA	<LOQ	<LOQ	<LOQ	<LOQ
ΣPFNA	ND	ND	ND	ND
PFDA	ND	ND	ND	<LOQ
PFUdA	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND
PFTrDA	<LOQ	<LOQ	<LOQ	<LOQ
PFTeDA	ND	ND	ND	ND
PFBS	ND	<LOQ	ND	ND
PFPeS	ND	ND	ND	ND
ΣPFHxS	ND	<LOQ	ND	ND
PFHpS	ND	ND	ND	ND
ΣPFOS	ND	ND	ND	ND
PFNS	ND	ND	ND	ND
PFDS	ND	ND	ND	<LOQ
PFDoS	ND	ND	ND	ND
ΣFOSA	ND	ND	<LOQ	<LOQ
ΣN-Me-FOSA	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	ND
ΣN-EtFOSE	<LOQ	ND	ND	ND
3:3FTCA	ND	ND	ND	ND
5:3FTCA	ND	<LOQ	ND	ND
7:3FTCA	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND
6:2FTS	ND	ND	ND	ND
8:2FTS	<LOQ	ND	ND	ND
NaDONA	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	<LOQ
PFEESA	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND

PFAS	Unspiked (Control) MIST Leachates (ng/mL)			
	Concrete – 1	Concrete – 2	Asphalt – 1	Asphalt – 2
PF4OPeA (PFMPA)	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND

Note: Two of each specimen type underwent MIST, and the respective leachate was sampled.

Table E-10. MIST Leachate Concentrations for Spiked Concrete and Spiked Asphalt Specimens

PFAS	Spiked MIST Leachates (ng/mL)			
	Concrete – 1	Concrete – 2	Asphalt – 1	Asphalt – 2
PFBA	0.411	0.223	0.161	0.136
PFPeA	0.202	0.128	0.077	0.068
PFHxA	5.98	5.25	0.394	0.321
PFHpA	0.052	0.026	0.022	0.023
ΣPFOA	1.05	0.740	0.102	0.113
ΣPFNA	<LOQ	<LOQ	<LOQ	<LOQ
PFDA	0.108	0.020	0.014	0.016
PFUdA	<LOQ	<LOQ	<LOQ	<LOQ
PFDoA	<LOQ	ND	<LOQ	<LOQ
PFTrDA	<LOQ	<LOQ	<LOQ	<LOQ
PFTeDA	ND	ND	ND	ND
PFBS	0.021	0.026	0.043	0.044
PFPeS	0.018	0.017	0.037	0.034
ΣPFHxS	0.177	0.161	0.290	0.277
PFHpS	<LOQ	<LOQ	0.057	0.055
ΣPFOS	0.896	1.00	3.06	3.44
PFNS	ND	ND	ND	ND
PFDS	ND	ND	ND	ND
PFDoS	ND	ND	ND	ND
ΣFOSA	ND	ND	ND	ND
ΣN-Me-FOSA	ND	ND	ND	ND
ΣN-EtFOSA	ND	ND	ND	ND
ΣN-MeFOSAA	ND	ND	ND	ND
ΣN-EtFOSAA	ND	ND	ND	ND
ΣN-MeFOSE	ND	ND	ND	ND
ΣN-EtFOSE	ND	ND	ND	ND
3:3FTCA	ND	ND	ND	ND
5:3FTCA	ND	ND	ND	ND
7:3FTCA	ND	ND	ND	ND
4:2FTS	ND	ND	ND	ND

PFAS	Spiked MIST Leachates (ng/mL)			
	Concrete – 1	Concrete – 2	Asphalt – 1	Asphalt – 2
6:2FTS	1.57	1.43	2.46	2.53
8:2FTS	0.462	0.313	0.616	0.736
NaDONA	ND	ND	ND	ND
9Cl-PF3ONS	ND	ND	ND	ND
11Cl-PF3OUdS	ND	ND	ND	ND
PFEESA	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND
PF4OPeA (PFMPA)	ND	ND	ND	ND
PF5OHxA (PFMBA)	ND	ND	ND	ND
3,6-OPFHpA (NFDHA)	ND	ND	ND	ND

Note: Two of each specimen type underwent MIST, and the respective leachate was sampled.