LSASD Project ID: 19-0457

Sample and Analysis Plan

Assessment of Resuspended Sediments as a Source of PFAS to the Upper Coosa River Basin

Conasauga, Oostanaula, & Coosa Rivers

Georgia

Project Date(s): September 16th – 20th, 2019

Final SAP Approval Date: September 6, 2019

Project Leader: Nathan Barlet
Environmental Sampling Section
Applied Science Branch
Laboratory Services & Applied Science Division
USEPA – Region 4
980 College Station Road
Athens, Georgia 30605-2720

The activities depicted in this Sampling and Analysis Plan (SAP) are accredited under the US EPA Region 4 Laboratory Services & Applied Science Division ISO/IEC 17025 accreditation issued by the ANSI-ASQ National Accreditation Board. Refer to certificate and scope of accreditation AT-1644.

ED_005067B_00010568-00001

THIS PAGE IS LEFT INTENTIONALLY BLANK

ED_005067B_00010568-00002

Project Requestor:

Brian Smith, Chief
Safe Drinking Water Branch
Water Division
USEPA – Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960

Analytical Support:

Laboratory Services Branch
Laboratory Services & Applied Science Division
USEPA – Region 4
980 College Station Road
Athens, GA 30605-2720

Approvals:

LSASD Project Leader:

9-6-2019

Nathan Barlet
Environmental Sampling Section
Applied Science Branch

Date

Approving Officials:

9/6/2019

Greg White, Technical Reviewer
Environmental Sampling Section
Applied Science Branch

Date

9/6/19

John Deatrick, Chief
Applied Science Branch

Date

This Sample and Analysis Plan (SAP) is designed to be used in conjunction with the *Applied Science Branch Quality Assurance Project Plan* (USEPA, 2019*a*).

Table of Contents

SECTION A: Project Planning Elements **5**
A1. Distribution List 5
A2. Project Personnel 5
A3. Site Description and Background Information 6
A4. Problem Definition 6
A5. Project Description, Goals, and Study Boundaries 7
Study Goal: 7
Study Objectives: 7
Study Area: 8
Study Design/Approach: 8
Project Timeline: 9
A6. Applicable Regulatory Information 10
A7. Decision(s) to be made based on data 10
SECTION B: Data Generation, Acquisition, and Reporting **11**
B1. Sampling Design/Information Inputs 11
B2. Sampling Handling and Custody 11
B3. Quality Control 12
B4. Analytical Methods and Support 13
B5. Sampling and Measurement Procedures 14
Section C: Reporting **15**
C1. Reporting **15**
References **15**
Table 1: List of Study Sites **17**
Table 2: PFAS Target Analyte List **18**
Table 3: Inorganics Target Analyte List **19**
Table 4: *In-Situ* Water Quality Parameters **19**
Table 5: Sample Collection, Preservation and Holding Times **19**
Appendix A: Site Maps **20**
Appendix B: Regional Screening Level Calculation **25**

SECTION A: Project Planning Elements		
A1. Distribution List		
Recipient	**Organization**	**Address/Email**
Brian Smith	US EPA Region 4 Water Division	64 Forsyth St. SW Atlanta, Georgia 30303-8960 Smith.Brian@epa.gov
Becky Allenbach	US EPA Region 4 Water Division	64 Forsyth St. SW Atlanta, Georgia 30303-8960 Allenbach.Becky@epa.gov
Shawneille Campbell-Dunbar	US EPA Region 4 Water Division	64 Forsyth St. SW Atlanta, Georgia 30303-8960 Campbell-Dunbar.Shawneille@epa.gov
Renea Hall	US EPA Region 4 Water Division	64 Forsyth St. SW Atlanta, Georgia 30303-8960 Hall.Renea@epa.gov
Danny France	US EPA Region 4 Laboratory Services & Applied Science Division	980 College Station Road Athens, Georgia 30605-2720 France.Danny@epa.gov
Sandra Aker	US EPA Region 4 Laboratory Services & Applied Science Division	980 College Station Road Athens, Georgia 30605-2720 Aker.Sandra@epa.gov
John Deatrick	US EPA Region 4 Laboratory Services & Applied Science Division	980 College Station Road Athens, Georgia 30605-2720 Deatrick.John@epa.gov
A2. Project Personnel		
Team Members[1,2]	**Organization**	**Responsibilities**
Nathan Barlet	EPA/R4/LSASD	Project Leader
Greg White	EPA/R4/LSASD	Safety Officer/Sampler
Jerry Ackerman	EPA/R4/LSASD	Sampler

[1] Project team members subject to change due to scheduling conflicts.

[2] Project Leader and all Task Leaders assisting with this project have been deemed competent by LSASD management, under ISO 17025 accreditation, to conduct the tasks required to fulfill the prescribed goals.

A3. Site Description and Background Information

The headwaters of the Coosa River basin begin in Tennessee and the North Georgia Mountains as the Conasauga, Coosawattee, and Etowah Rivers. The confluence of the Conasauga and the Coosawattee form the Oostanaula River south of Dalton Georgia before converging with the Etowah River forming the Coosa River in Rome Georgia. The Coosa River flows west across the Alabama-Georgia state line and is then impounded in Leesburg Alabama to form Weiss Lake.

The Conasauga, Oostanaula, and Coosa Rivers have historically tested positive for the presence of per- and polyfluoroalkyl substances (PFASs) via monitoring studies conducted by the Georgia Environmental Protection Division (GAEPD). PFASs have also been detected in the receiving waters of Alabama on the Coosa River and Weiss Lake by the Alabama Department of Environmental Management (ADEM), and the U.S. EPA Region 4's Laboratory Services & Applied Science Division (LSASD).

PFASs are man-made chemicals that do not occur in nature and have been found to be persistent and accumulate in both the environment and the human body via exposure pathways such as consumption of contaminated food and drinking water. PFASs have been extensively used in industry, manufacturing of commercial products, and most notoriously as a component in aqueous film forming foams (AFFF) used for firefighting. There is evidence that suggests exposure to PFASs can lead to adverse health effects and are an emerging concern to public health. PFAS is a generic nomenclature encompassing a broader array of chemicals, with the most studied being perfluorooctanoic acid (PFOA) and perfluorooctanesulfonate (PFOS). The U.S. EPA has issued a Recommended Health Advisory for drinking water of 70 ng/L (ppt) for combined concentrations of PFOA and PFOS compounds. Extensive information regarding PFASs can be found at http://www.epa.gov/pfas.

A4. Problem Definition

Exceedances of the U.S. EPA's Recommended Health Advisory for PFOA and PFOS have been observed at both the drinking water intakes for the City of Centre Alabama in Weiss Lake and further downstream on the Coosa River in the City of Gadsden Alabama. Data collected by ADEM from 2016 through 2019 observed elevated detections of both PFOA and PFOS in Weiss Lake and on the Coosa River (both downstream and upstream of the lake). In 2012 and 2016, elevated levels of PFOA and PFOS were detected in the receiving waters of the Oostanaula and Coosa Rivers in studies conducted by GAEPD.

The Looper's Bend land application site (LAS) operated by Dalton Utilities is located along the main stem of the Conasauga River in Dalton, Georgia. Surface water samples collected by GAEPD in both 2012 and 2016 in the Conasauga River and associated tributaries draining the Looper's Bend LAS contained elevated concentrations of both PFOA and PFOS. In 2009, an analytical data

ED_005067B_00010568-00006

report was submitted to the U.S. EPA by Dalton Utilities showing elevated levels of PFOA, PFOS, and other PFAS related compounds in groundwater, wastewater effluent, soil, and compost samples collected at the Looper's Bend LAS (MPI, 2009). Research indicates some PFAS compounds may adsorb to soils and sediments and is influenced by the presence of solid organic carbon, and that the sorption potential tends to increase with carbon chain length and is elevated for PFOS relative to PFOA (ITRC, 2018; Anderson et al., 2016; CONCAWE, 2016). Furthermore, the adsorption of certain PFASs such as perfluoroalkyl carboxylic acids (PFCAs) (e.g. PFOA) and perfluoroalkyl sulphonic acids (PFSAs) (e.g. PFOS) to positively charged suspended particles may be an important transport pathway in surface water (CONCAWE, 2016). Background concentrations of PFASs in sediments in the Coosa River Basin downstream of Looper's Bend LAS and the potential of sediment as a source of PFOA and PFOS via resuspension and transport to receiving waters is currently unknown.

This study will observe background concentrations and composition of PFASs in sediments and co-located surface water samples collected at spatially stratified scales in the Upper Coosa River Basin stemming from the Conasauga at Looper's Bend LAS. This study will also assess the instantaneous flux of PFASs attributed to resuspended sediment as a potential transport mechanism of PFOA and PFOS in the Upper Coosa River Basin and receiving waters.

A5. Project Description, Goals, and Study Boundaries

Study Goal:

Determine if PFASs are present in sediments downstream of Looper's Bend land application site (LAS) and assess the potential of sediments as a source of PFOA and PFOS in the Upper Coosa River Basin and the receiving waters of Weiss Lake.

Study Objectives:

1. Determine the concentration and composition of PFASs in stream sediments impacted by the Looper's Bend LAS along the Conasauga River in relation to the receiving waters of the Oostanaula and Coosa River via collection of sediment samples spatially stratified throughout the watershed.

2. Compare and contrast gradients of concentration and composition of PFASs between co-located surface water and sediments samples.

3. Assess the potential for downstream migration of PFAS contaminated sediments from the Conasauga River to the Upper Coosa River Basin via estimates of instantaneous suspended sediment flux.

ED_005067B_00010568-00007

Study Area:

The study area for this project includes the main stem of the Conasauga River adjacent to the Looper's Bend LAS in Dalton Georgia, the Oostanaula River from Resaca to Rome Georgia, and the receiving waters of the Coosa River from Rome Georgia to the Alabama-Georgia state line (Appendix A). A total of 8 sites will be assessed which includes 4 stations on the Conasauga River, 3 stations on the Oostanaula River, and 1 station on the Coosa River near the AL-GA border. See Table 1 for a description of all proposed sampling sites.

Study Design/Approach:

Standard Operating Procedures for all sampling and field measurement activities outlined in this study plan are referenced in Section B5: Sampling and Measurement Procedures.

Sediment Sampling

Sediment samples will be collected at each site and transported to the EPA R4 laboratory at LSASD in Athens Georgia to be analyzed for the 25 PFAS analytes listed in Table 2. To account for streambed heterogeneity, each sediment sample will consist of a composite of 3 sediment aliquots collected across a transect perpendicular to the stream flow and homogenized in a stainless-steel bowl using a stainless-steel spoon. An additional sediment sample will be analyzed by the LSASD laboratory for total organic carbon (TOC) (Table 3).

Surface Water Sampling

A surface water quality sample will be collected at each site and analyzed at the LSASD laboratory for the 25 PFAS analytes listed in Table 2. An additional surface water sample will be collected at CONA1, CONA3, OOST3, and CRI (Table 1 & Appendix A) and filtered through a 1.2µm GF/C glass microfiber membrane to be analyzed for the dissolved fraction of PFAS analytes listed in Table 2. Concentrations of total and dissolved PFASs will be used to determine the fraction of PFASs adsorbed to sediment and particulate matter suspended in the water column. Four more surface water samples will also be collected at CONA1, CONA3, OOST3, and CRI and analyzed by the LSASD laboratory for total suspended solids (TSS) and TOC (Table 3).

In-Situ Water Quality Measurements

Surface water quality measurements of temperature, dissolved oxygen, specific conductance, turbidity, and pH will be collected *in-situ* via multi-parameter data sondes at each site. See Table 4 for a detailed list of *in-situ* water quality parameters and measurement uncertainties. All multi-parameter data sondes will be maintained and calibrated in accordance with LSASD Standard Operating Procedure for Equipment Inventory and Management (SESDPROC-1009-R0) and those

ED_005067B_00010568-00008

selected in Section B.5. All equipment calibrations will be verified in accordance with LSASD Calibration and End-Check Acceptance Criteria (SESDFORM-060-R0).

Sediment Flux Estimation

The flux of suspended sediment will be calculated from concentrations of TSS and discharge data retrieved from nearby stream gages maintained by the USGS. Concentrations of PFASs derived for the suspended sediment fraction in the water column will be used to estimate the mass loading of PFAS contaminated sediments through the Upper Coosa River Basin and receiving waters. This study will target base flow conditions. The main assumption underlying base flow conditions is that suspended sediment captured at baseflow has been resuspended due to negligible runoff inputs. Approximate base flow conditions will be defined as discharges below the monthly mean for September as recorded by historical streamflow data collected at USGS gages located on the Conasauga River (USGS 02387000), Oostanaula River (USGS 02388500), and the Coosa River (USGS 02397000) over a 30-year period. These threshold values are 562 ft^3/s, 1,447 ft^3/s, and 3,145 ft^3/s for the Conasauga, Oostanaula, and Coosa Rivers, respectively. Discharges above these thresholds will be considered non-base flow conditions and the sampling event will be postponed until water levels recede to appropriate levels.

Quality Control Samples

Multiple control samples will be collected in accordance with LSASD Standard Operating Procedures and accepted trace-level contaminant sampling practices. Control samples will include trip blanks, field blanks, field equipment rinse blanks, field duplicate samples, and matrix spike/matrix spike duplicate field samples as deemed appropriate for the scope and data quality objectives of this study. Surface water and sediment samples collected for PFAS analysis will be sampled via a trace level sampling technique to avoid cross-contamination of PFAS surface water samples due to sample collection and handling. This process will require two field personnel for PFAS sample collection. A designated sampler will handle the sample media and sample container only. A second designee will operate sampling equipment and assist with sample container packaging and labeling. Sampling equipment known or suspected to contain PFASs (e.g. Teflon® and Gore-Tex®) will be avoided during sampling activities. An outline of all quality control samples is listed in Section B3: Quality Control.

Project Timeline:

The proposed field activities for this study are tentatively planned for the week of September 16th, 2019. The tentative weather contingency dates if non-base flow conditions are present is the week of October 7th, 2019. Laboratory turn-around time is 35 days from the time samples are received. The draft final report for this study is to be expected 30 days from the receipt of all laboratory analyses on December 5th, 2019 or December 20th, 2019 (weather contingency).

ED_005067B_00010568-00009

A6. Applicable Regulatory Information

The U.S. EPA has established a life-time exposure recommended health advisory level for drinking water of 70 parts per trillion for PFOA and PFOS individually or combined. There are currently no Maximum Contaminant Levels (MCLs) or enforceable standards for PFOA, PFOS, or other PFAS related compounds in any media (e.g. drinking water, surface water, soils and sediments) set by the U.S. EPA or the states of Georgia and Alabama.

In April of 2019, the U.S. EPA issued draft interim recommendations for public comment to address groundwater contamination from PFOA and PFOS (USEPA, 2019*c*). The U.S. EPA's draft interim recommendations propose that a target hazard quotient (THQ) of 0.1 and target cancer risk (TR) of one-in-a-million be used to calculate Regional Screening Levels (RSLs) for soil protective of groundwater yielding values of 40 ppt for each compound (USEPA, 2019*c*). RSLs for soil protective of groundwater of 3.78E-02 µg/kg for PFOS and 1.72E-02 µg/kg for PFOA were derived from the U.S. EPA's RSL calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) using the proposed HQ=0.1 and TR=1.00E-06 (Appendix B). For the purpose of the study, the derived RSLs will be used by LSASD scientists to make relative comparisons of PFAS concentrations in sediment between sampling sites only. Any further decisions, recommendations, and/or actions will be made at the discretion of the U.S. EPA's Region 4 Water Division.

A7. Decision(s) to be made based on data

This study will provide insight into the relative concentrations and composition of PFASs in sediments and surface water at varying scales throughout the Upper Coosa River Basin downstream of Looper's Bend LAS; as well as provide an estimate of instantaneous flux of resuspended sediments as a potential transport mechanism of PFASs to receiving waters. All further decisions, recommendations, and/or actions will be made at the discretion of the U.S. EPA's Region 4 Water Division.

ED_005067B_00010568-00010

SECTION B: Data Generation, Acquisition, and Reporting

Will samples or physical evidence be collected:	☒ **Yes –** *If yes, complete all subsections in Section B.*
	☐ **No** – *If no, no action needed for B1, B2, B3 or B4, proceed to B5.*

B1. Sampling Design/Information Inputs

Sample Media	Total Number of Samples	Analyses
Surface Water	8 samples + duplicate + 4 QC + MS/MSD	PFASs, total (See Tables 2 & 5)
Surface Water	4 samples + duplicate + 2 QC	PFASs, dissolved (See Tables 2 & 5)
Surface Water	4 samples + duplicate	Total Organic Carbon (See Tables 3 & 5)
Surface Water	4 samples + duplicate	Total Suspended Solids (See Tables 3 & 5)
Sediment	8 samples + duplicate	PFASs (See Tables 2 & 5)
Sediment	8 samples + duplicate	Total Organic Carbon (See Tables 3 & 5)

B2. Sampling Handling and Custody

As outlined in the *Applied Science Branch Quality Assurance Project Plan* (USEPA, 2019*b*), all samples will be handled and custody maintained in accordance with the LSASD Laboratory Services Branch Laboratory Operations and Quality Assurance Manual, LSASD Operating Procedure for Sample and Evidence Management, SESDPROC-005, and LSASD Operating Procedure for Packing, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209.

Will a Chain-of-Custody be produced:	☒ **Yes**
	☐ **No**

During the duration of the event, have preparations been made to ensure that custody is maintained? *Custody of a sample or physical evidence is defined as:* • *It is in the actual possession of an investigator* • *It is in the view of an investigator, after being in their physical possession* • *It was in the physical possession of an investigator and then they secured it to prevent tampering* • *It is placed in a designated secure area*	☒ **Yes** ☐ **No**

ED_005067B_00010568-00011

B3. Quality Control

Field quality control measures will be performed in accordance with the LSASD Operating Procedure for Field Sampling Quality Control, SESDPROC-011.

Field quality control (QC) samples include the following:

- Each batch of samples will contain a duplicate quality control sample for each analysis.
- Each batch of surface water samples being analyzed for PFASs will also contain an additional sample volume for matrix spike/matrix spike duplicates (MS/MSD). MS/MSD volumes will be collected at CONA1 upstream of Looper's Bend to characterize background PFAS concentrations in sediment and surface water.
- Temperature blanks will be placed in all sample coolers.

The following additional quality control (QC) samples will be collected and analyzed for PFAS contamination:

- A field blank will be collected by each sampling team at the onset of field activities. Field blanks will be stored and transported with collected samples through the duration of the study also serving as a trip blank.
- A separate field equipment rinse blank will be collected for PFAS sediment sampling equipment (e.g. stainless-steel petite Ponar sediment grabs, spoons, and bowls), PFAS surface water sampling equipment (e.g. buckets and/or bailers), and dissolved PFAS surface water filtration equipment (e.g. HDPE/PP Buchner funnel and glass microfiber filter paper).
- Recovery of PFAS target analytes filtered through glass microfiber filters will be determined via a matrix spike QC sample provided by the LSASD laboratory.
- All blank quality control (QC) samples will be prepared utilizing PFAS-free water supplied by the U.S. EPA LSASD laboratory in Athens, GA.

PFAS sampling protocol:

- A two-person trace-level sampling protocol will be used for all PFAS sample collection. One member of the sampling team will handle the sample media and sample container only. A second team member will be designated to handle sampling equipment and assist with sample packaging and labeling.
- A Buchner filter comprised of high-density polyethylene and polypropylene (HDPE/PP) equipped with a 42.5 mm diameter 1.2 µm GF/C glass microfiber filter will be used to collect surface water samples to be analyzed for the dissolved fraction of PFAS target analytes. A new clean set of HDPE/PP Buchner filters and GF/C glass microfiber filters will be used for each sample.
- All sampling equipment will be cleaned using Luminox® and warm tap-water, then rinsed in PFAS-free water before being air-dried and sealed in clean plastic sheets in preparation for field activities.
- Sampling materials and field gear known to contain PFASs (e.g. PVC and Gore-Tex®) will be avoided during sampling activities.

ED_005067B_00010568-00012

Laboratory quality control measures are specified in the *LSASD Laboratory Services Branch Laboratory Operations and Quality Assurance Manual* (USEPA, 2018*b*).

B4. Analytical Methods and Support

Samples will be analyzed by the EPA/LSASD laboratory in Athens, GA in accordance with the LSASD Laboratory Services Laboratory Operations and Quality Assurance Manual (USEPA, 2019*b*). Specific analytical methods are listed in Tables 2 through 6.

Samples submitted to a Contract Laboratory Program (CLP) laboratory will be analyzed in accordance to the current statement of work.

Laboratory Turn-Around-Time Requested: 35 Days

Reporting Levels:	☒ Non-Routine Reporting Levels **ARE NOT** Required, No Further Action. ☐ Non-Routine Reporting Levels **ARE** Required, List Below.
Non-Routine Reporting Levels:	

Waste Samples Anticipated:	☐ **Yes** ☒ **No** ☐ **Unknown**

If answer is yes, specify laboratory to receive samples:
(i.e., LSASD, commercial lab vis bank card or PR, subcontracted via START/RACS/REPA 5)

Not applicable.

B5. Sampling and Measurement Procedures

Sampling and measurement activities will be in accordance with the LSASD operating procedures. The following field procedures will be followed during this study, check all that apply. The most recent version of LSASD operating procedures can be found at https://www.epa.gov/quality/quality-system-and-technical-procedures-sesd-field-branches *(Last Update: 4/05/18)*

	Field Measurement Procedures*	**SESDPROC-**	**Revision**
☒	Field pH Measurement	100	R4
☒	Field Specific Conductance Measurement	101	R6
☒	Field Temperature Measurement	102	R5
☒	Field Turbidity Measurement	103	R4
☐	Groundwater Level and Well Depth Measurement	105	R3
☒	Field Measurement of Dissolved Oxygen	106	R4
☐	Field X-Ray Fluorescence (XRF) Measurement	107	R4
☐	Wastewater Flow Measurement	109	R4
☒	Global Positioning System	110	R4
☒	In-Situ Water Quality Monitoring	111	R4
☐	Field Measurement of Total Residual Chlorine	112	R5
☐	Field Measurement of Oxidation-Reduction Potential (ORP)	113	R2
	Field Sampling Procedures*	**SESDPROC-**	**Revision**
☒	Sediment Sampling	200	R3
☒	Surface Water Sampling	201	R4
☐	Soil Sampling	300	R3
☐	Groundwater Sampling	301	R4
☐	Waste Sampling	302	R3
☐	Ambient Air Sampling	303	R5
☐	Potable Water Supply Sampling	305	R3
☐	Wastewater Sampling	306	R4
☐	Soil Gas Sampling	307	R3
	Ecology Section Field Sampling Procedures*	**SESDPROC-**	**Revision**
☐	Hydrological Studies	501	R4
☐	Water Column Oxygen Metabolism	504	R4
☐	Reaeration Measurement by Diffusion Dome	505	R4
☐	Sediment Oxygen Demand	507	R4
☐	Multi-Habitat Macroinvertebrate Sampling in Wadeable Freshwater Streams	508	R4
☐	Marine Macroinvertebrate Field Sampling	511	R4
☐	Fish Field Sampling	512	R4
☐	Pore Water Sampling	513	R3
☐	Dye Tracer Measurements	514	R2
☐	Bottom Water Sampling for Sulfide	515	R0

***If procedures allow for different sampling and measurement methods, the utilized method(s) must be identified in the project description section. Additionally, verify procedure revision numbers before issuance of SAP.**

ED_005067B_00010568-00014

Section C: Reporting	
C1. Reporting	
Estimated Report Completion Date: 12/05/2019	
Is a Provisional Data Release Anticipated:	☒ **Yes**
	☐ **No**
Provisional data refers to final analytical and field measurement results that may be subject to further interpretation and/or data assessment by the project leader prior to the issuance of a final field investigation report. Provisional data may be provided prior to the completion of the LSASD final report only if LSASD management approves the release of the information and the analytical data have been released as final from the LSASD Laboratory Services Branch, for LSASD generated data, and/or the LSASD Quality Assurance Section, for non-LSASD generated data. Release of provisional data will be transmitted by electronic or hard copy with official correspondence from the Section Chief in accordance with the LSASD Operating Procedure for Report Preparation and Distribution (SESDPROC-003).	
Additional Comments: Provisional data may be released to EPA R4 Water Division pending issuance of final report for the purpose of planning regional priorities related to PFAS.	

References

Anderson, R.H., Long, G.C., Porter, R.C., & Anderson, J.K. (2016). Occurrence of select perfluoroalkyl substances at U.S. Air Force aqueous film-forming foam release sites other than fire-training areas: Field-validation of critical fate and transport properties. Chemosphere 150:678-685.

CONCAWE (2016). Environmental fate and effects of poly- and perfluoroalkyl substances (PFAS). Network for Industrially Contaminated Land in Europe. Report No. 8/16.

ITRC (2018). Environmental fate and transport for per- and polyfluoroalkyl substances. Interstate Technology & Regulatory Council. Fact Sheet.

LSBPROC-800-R1 (2019). Determination of Per- and Polyfluoroalkyl Substances by Liquid Chromatography Tandem Mass Spectrometry. U.S. Environmental Protection Agency, Region 4, Laboratory Services & Applied Science Division, Athens, GA.

MPI (2009). Analytical Report: Fluorochemical Characterization of Aqueous and Solid Samples. MPI Research, Inc. MPI Report No. L0018099.

SESDFORM-060-R0 (2018). SESD Calibration and End-Check Acceptance Criteria. U.S. Environmental Protection Agency, Region 4, Laboratory Services & Applied Science Division, Athens, GA.

SESDPROC-1009-R0 (2017). Standard Operating Procedure for Equipment Inventory and Management. U.S. Environmental Protection Agency, Region 4, Laboratory Services & Applied Science Division, Athens, GA.

USEPA (2019*a*). Applied Science Branch Quality Assurance Project Plan. U.S. Environmental Protection Agency, Region 4, Laboratory Services & Applied Science Division, Athens, GA.

USEPA (2019*b*). Laboratory Services Branch Laboratory Operations and Quality Assurance Manual. U.S. Environmental Protection Agency, Region 4, Laboratory Services & Applied Science Division, Athens, GA.

USEPA (2019*c*). USEPA draft interim recommendations to address groundwater contaminated with perfluorooctanoic acid and perfluorooctane sulfonate. Docket ID No. EPA-HQ-OLEM-2019-0229.

ED_005067B_00010568-00016

Table 1: **List of Study Sites**

Station ID	Water Body	Approximate Coordinates (DD.ddddd)		Site Description
		Latitude	Longitude	
CONA1*	Conasauga River	34.70865	-84.86414	Conasauga River at Airport Rd in Dalton, GA
CONA2	Conasauga River	34.71446	-84.92931	Conasauga River at Looper's Bridge Rd in Dalton, GA
CONA3*	Conasauga River	34.66705	-84.92845	Conasauga River at Tilton Bridge Rd in Dalton, GA
CONA4	Conasauga River	34.59354	-84.93367	Conasauga River at Hwy 136 near Resaca, GA
OOST1	Oostanaula River	34.57752	-84.94149	Oostanaula River at Hwy 3 in Resaca, GA
OOST2	Oostanaula River	34.49213	-85.01364	Oostanaula River at Hwy 156 near Calhoun, GA
OOST3*	Oostanaula River	34.28718	-85.16305	Oostanaula River at Armuchee Connector near Rome, GA
CRI*	Coosa River	34.24861	-85.35522	Coosa River at Hwy 100 near AL-GA State Line

*Additional surface water samples will be collected at these sites to assess PFAS loading associated with the suspended sediment fraction.

ED_005067B_00010568-00017

Table 2: **PFAS Target Analyte List**

Region IV Laboratory Per - and Polyfluoroalkyl Substances (PFAS) Target Analyte List Minimum Reporting Limits (MRLs) for Surface Water				
Analyte[1]	Water[2] µg/L (ppb)		Soil/Sediment[3] µg/kg (ppb)	
	MDL	MRL	MDL	MRL
Perfluorotetradecanoic acid (PFTeDA)*	NA	NA	0.040	0.400
Perfluorotridecanoic acid (PFTrDA)	0.039	0.040	0.040	0.100
Perfluorododecanoic acid (PFDoA)	0.029	0.040	0.040	0.100
Perfluoroundecanoic acid (PFUDA)	0.021	0.040	0.040	0.100
Perfluorodecanoic acid (PFDA)	0.096	0.160	0.040	0.100
Perfluorononanoic acid (PFNA)	0.016	0.040	0.040	0.100
Perfluorooctanoic acid (PFOA)	0.026	0.040	0.040	0.100
Perfluoroheptanoic acid (PFHpA)	0.014	0.040	0.040	0.100
Perfluorohexanoic acid (PFHxA)	0.031	0.040	0.040	0.100
Perfluoropentanoic acid (PFPeA)	0.018	0.040	0.040	0.100
Perfluorobutyric acid (PFBA)	0.022	0.040	0.040	0.100
Perfluorodecanesulfonate (PFDS)	0.032	0.039	0.040	0.096
Perfluorononanesulfonate (PFNS)	0.015	0.038	0.040	0.096
Perfluorooctanesulfonate (PFOS)	0.017	0.037	0.040	0.092
Perfluoroheptanesulfonate (PFHpS)	0.017	0.038	0.040	0.095
Perfluorohexanesulfonate (PFHxS)	0.017	0.036	0.040	0.091
Perfluoropentanesulfonate (PFPeS)	0.013	0.038	0.040	0.094
Perfluorobutanesulfonate (PFBS)	0.023	0.035	0.040	0.088
Perfluorooctanesulfonamide (FOSA)	0.031	0.040	0.040	0.100
Fluorotelomer sulfonate 8:02 (8:2 FTS)	0.034	0.038	0.040	0.096
Fluorotelomer sulfonate 6:02 (6:2 FTS)	0.029	0.038	0.040	0.095
Fluorotelomer sulfonate 4:02 (4:2 FTS)	0.021	0.037	0.040	0.094
N-ethyl-N-((heptadecafluorooctyl)sulfonyl)glycine (N-EtFOSAA)*	NA	NA	0.040	0.100
N-(Heptadecafluorooctylsulfonyl)-N-methylglycine (N-MeFOSAA)	0.110	0.160	0.040	0.100
Hexafluoropropylene oxide–dimer acid (HFPO-DA)	0.026	0.040	0.040	0.100

* Surface water samples results for N-EtFOSAA and PFTeDA will be reported as estimates and should be used for screening purposes only.

[1]PFAS analytes for both surface water and sediment/soil matrices are analyzed via the method outlined in LSBPROC-800-R1.

[2]PFAS analytes in surface water are analyzed using ASTM standard D7979-17.

[3]PFAS analytes in solids (e.g. soil, sediment, and waste) are analyzed using ASTM standard D7968-17a.

ED_005067B_00010568-00018

Table 3: **Inorganics Target Analyte List**

Region IV Laboratory Classical Inorganics Target Analyte List Minimum Reporting Limits (MRLs) for Surface Water			
Analyte	**Method**	**Water mg/L (ppm)**	**Soil/Sediment mg/kg (ppm)**
Total Suspended Solids (TSS)	USGS I-3765-85	4.0	NA
Total Organic Carbon (TOC)	SM5310/LSB 107C	1.0	12,000

Table 4: ***In-Situ*** **Water Quality Parameters**

Parameter	Units	Measurement Technology	Measurement Uncertainty
pH	SU	Glass electrode	± 0.2 SU
Dissolved Oxygen	mg/L	Luminescent DO probe	± 0.2 mg/L
Temperature	°C	LDO Thermistor	± 0.2 °C
Specific Conductance	µS/cm	Nickel electrode cell	± 0.5% of reading
Turbidity	FNU	Optical Probe	± 5% of reading

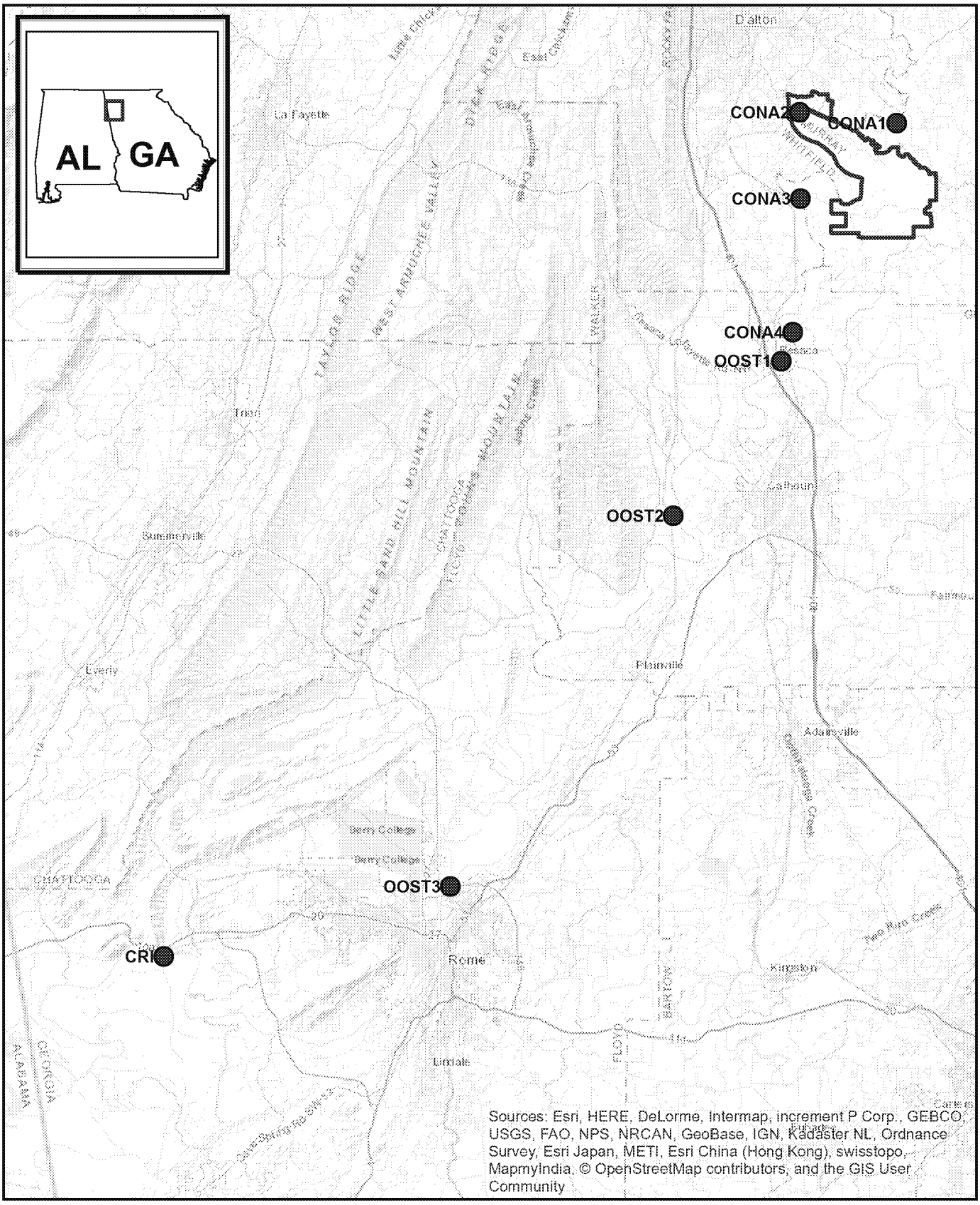
Table 5: **Sample Collection, Preservation and Holding Times**

Analyses	Media	Container	Preservation	Holding Time
PFAS	Surface Water	2 x 15mL Polypropylene Vial	Ice (≤ 4°C)	42 days
	Sediment	50mL Polypropylene	Ice (≤ 4°C)	42 days
Total Organic Carbon (TOC)	Surface Water	500mL Polyethylene	H_2SO_4 (pH < 2), Ice (≤ 4°C)	28 days
	Sediment	8oz Glass	Ice (≤ 4°C)	NA
Total Suspended Solids (TSS)	Surface Water	1-liter Polyethylene	Ice (≤ 4°C)	7 days

ED_005067B_00010568-00019

Appendix A: Site Maps

ED_005067B_00010568-00020



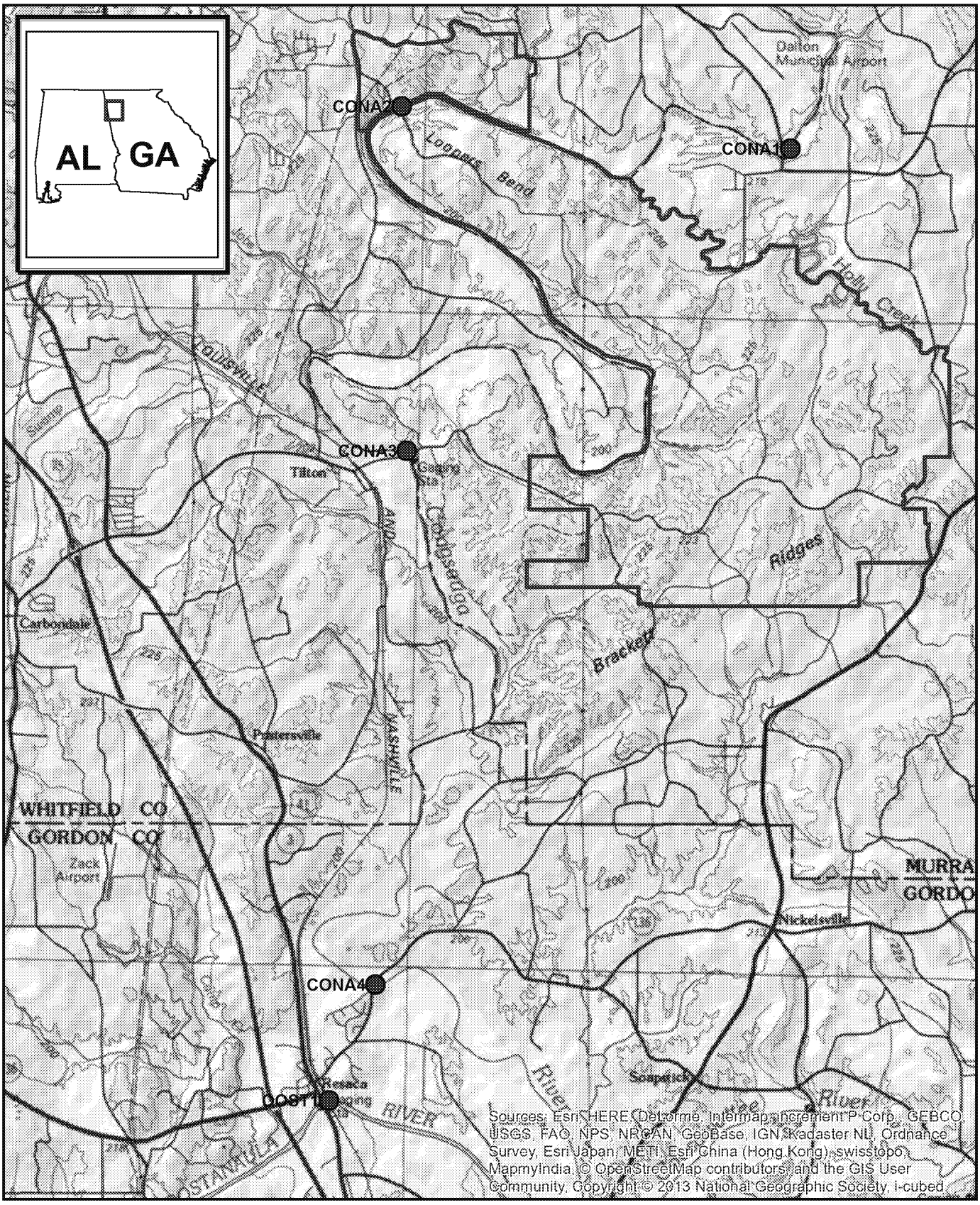
PFAS Sediment Screening: Upper Coosa River Basin

Study Area Overview

0 1.5 3 6 9 12 Miles

Sampling Locations

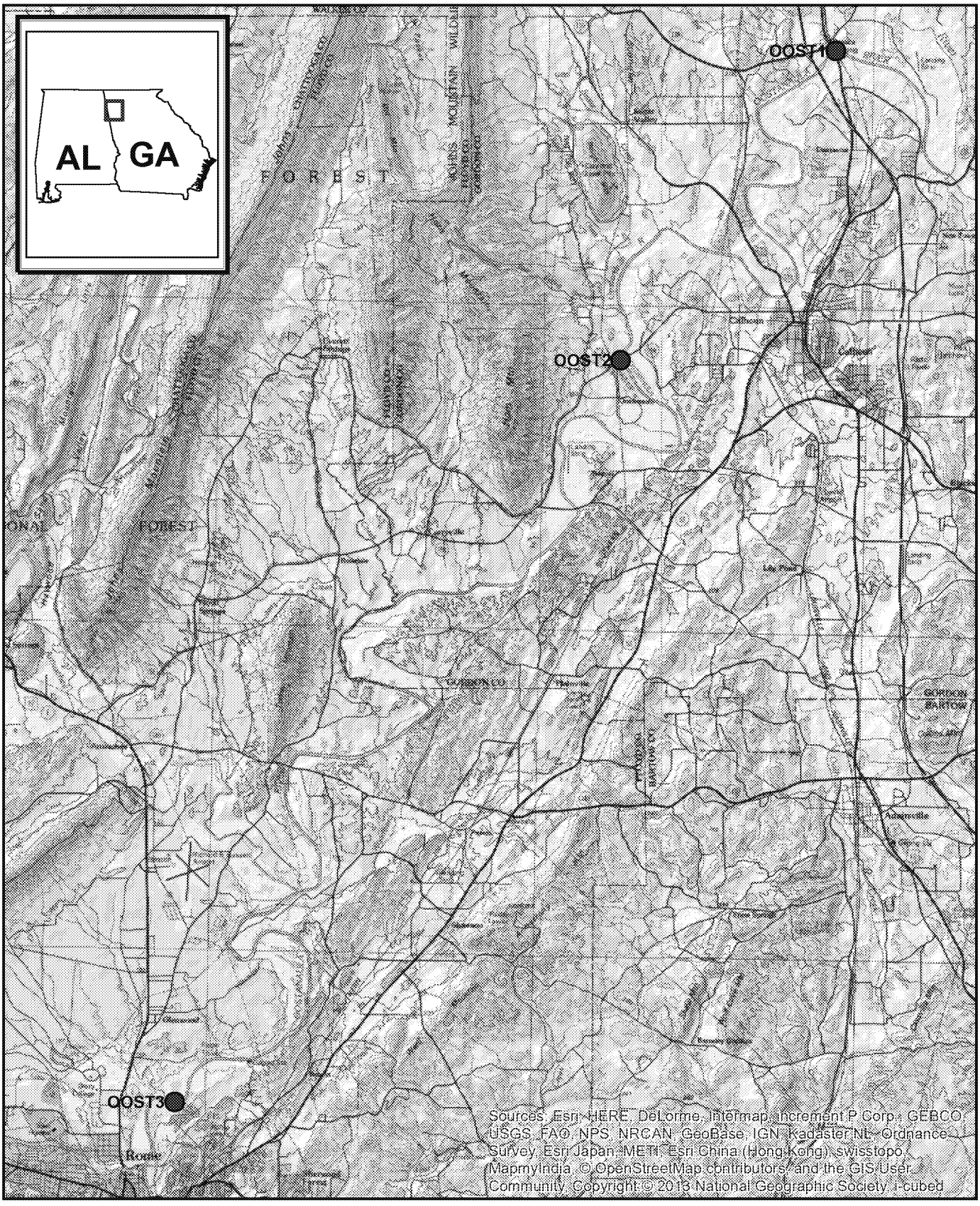
Looper's Bend LAS Boundary



PFAS Sediment Screening:
Upper Coosa River Basin
Looper's Bend Study Area

0 0.5 1 2 3 Miles

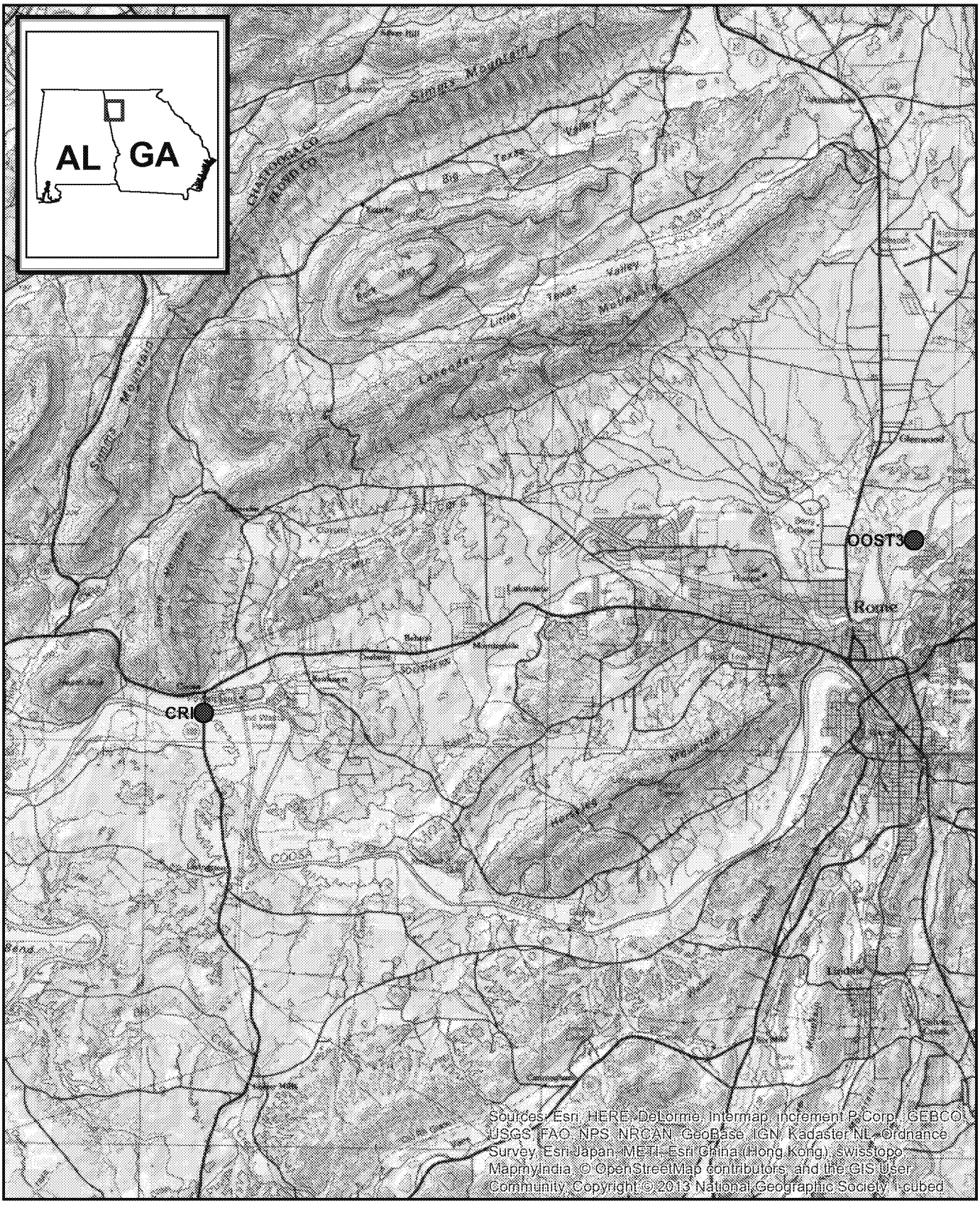
Sampling Locations
Looper's Bend LAS Boundary



PFAS Sediment Screening:
Upper Coosa River Basin
Ostanaula River Sites

0 1 2 4 6 Miles

Sampling Locations



PFAS Sediment Screening:
Upper Coosa River Basin
Ostanaula & Coosa River Sites

0 0.5 1 2 3 4 Miles

Sampling Locations

Appendix B: Regional Screening Level Calculation

ED_005067B_00010568-00025

Default
Equation Inputs for Soil to Groundwater

Variable	Value
THQ (target hazard quotient) unitless	0.1
TR (target risk) unitless	1E-06
LT (lifetime) years	70
K (volatilization factor of Andelman) L/m^3	0.5
l_{sc} (apparent thickness of stratum corneum) cm	0.001
ED_{res} (exposure duration - resident) years	26
ED_{res-c} (exposure duration - child) years	6
ED_{res-a} (exposure duration - adult) years	20
ED_{0-2} (mutagenic exposure duration first phase) years	2
ED_{2-6} (mutagenic exposure duration second phase) years	4
ED_{6-16} (mutagenic exposure duration third phase) years	10
ED_{16-26} (mutagenic exposure duration fourth phase) years	10
EF_{res} (exposure frequency) days/year	350
EF_{res-c} (exposure frequency - child) days/year	350
EF_{res-a} (exposure frequency - adult) days/year	350
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350
$ET_{event-res-adj}$ (age-adjusted exposure time) hours/event	0.67077
$ET_{event-res-madj}$ (mutagenic age-adjusted exposure time) hours/event	0.67077
ET_{res} (exposure time) hours/day	24
ET_{res-c} (dermal exposure time - child) hours/event	0.54
ET_{res-a} (dermal exposure time - adult) hours/event	0.71
ET_{res-c} (inhalation exposure time - child) hours/day	24
ET_{res-a} (inhalation exposure time - adult) hours/day	24
ET_{0-2} (mutagenic inhalation exposure time first phase) hours/day	24
ET_{2-6} (mutagenic inhalation exposure time second phase) hours/day	24
ET_{6-16} (mutagenic inhalation exposure time third phase) hours/day	24
ET_{16-26} (mutagenic inhalation exposure time fourth phase) hours/day	24
ET_{0-2} (mutagenic dermal exposure time first phase) hours/event	0.54
ET_{2-6} (mutagenic dermal exposure time second phase) hours/event	0.54
ET_{6-16} (mutagenic dermal exposure time third phase) hours/event	0.71

Output generated 20AUG2019:10:23:01

Default
Equation Inputs for Soil to Groundwater

Variable	Value
ET_{16-26} (mutagenic dermal exposure time fourth phase) hours/event	0.71
BW_{resa} (body weight - adult) kg	80
BW_{resc} (body weight - child) kg	15
BW_{0-2} (mutagenic body weight) kg	15
BW_{2-6} (mutagenic body weight) kg	15
BW_{6-16} (mutagenic body weight) kg	80
BW_{16-26} (mutagenic body weight) kg	80
IFW_{resadj} (adjusted intake factor) L/kg	327.95
IFW_{resadj} (adjusted intake factor) L/kg	327.95
$IFWM_{resadj}$ (mutagenic adjusted intake factor) L/kg	1019.9
$IFWM_{resadj}$ (mutagenic adjusted intake factor) L/kg	1019.9
IRW_{resc} (water intake rate - child) L/day	0.78
IRW_{resa} (water intake rate - adult) L/day	2.5
IRW_{0-2} (mutagenic water intake rate) L/day	0.78
IRW_{2-6} (mutagenic water intake rate) L/day	0.78
IRW_{6-16} (mutagenic water intake rate) L/day	2.5
IRW_{16-26} (mutagenic water intake rate) L/day	2.5
EV_{resa} (events - adult) per day	1
EV_{resc} (events - child) per day	1
EV_{0-2} (mutagenic events) per day	1
EV_{2-6} (mutagenic events) per day	1
EV_{6-16} (mutagenic events) per day	1
EV_{16-26} (mutagenic events) per day	1
DFW_{resadj} (age-adjusted dermal factor) cm^2-event/kg	2610650
$DFWM_{resadj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	8191633
SA_{resc} (skin surface area - child) cm^2	6365
SA_{resa} (skin surface area - adult) cm^2	19652
SA_{0-2} (mutagenic skin surface area) cm^2	6365
SA_{2-6} (mutagenic skin surface area) cm^2	6365
SA_{6-16} (mutagenic skin surface area) cm^2	19652
SA_{16-26} (mutagenic skin surface area) cm^2	19652
DAF (dilution attenuation factor) unitless	1
DAF (dilution attenuation factor) unitless	1

Output generated 20AUG2019:10:23:01

Default
Equation Inputs for Soil to Groundwater

Variable	Value
Theta$_w$ (water-filled soil porosity) L $_{water}$/L$_{soil}$	0.3
Theta$_a$ (air-filled soil porosity) L $_{air}$/L$_{soil}$ }	0.134
n (soil porosity) L $_{pore}$/L$_{soil}$	0.434
p$_b$ (dry soil bulk density) kg/L	1.5
I (infiltration rate) m/yr	0.18
ED$_{res}$ (exposure duration) yr	70
t$_{res}$ (time - resident) yr	26
foc (fraction organic carbon in soil) g/g	0.002
p$_s$ (soil particle density) kg/L	2.65
T$_w$ (groundwater temperature) Celsius	25

Output generated 20AUG2019:10:23:01

Default
Risk-Based Regional Screening Levels (RSL) for Soil to Groundwater

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Sub-chronic toxicity values will be used where available. RfC and RfD references followed by 's' indicates subchronic value; RfC and RfD references followed by 'c' indicates chronic value.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	S (mg/L)	K_d\ (cm^3/g)
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	No	No	Organics	-		-		2.00E-05	D /Chronic	-		1	0.1	680	7.43E-01
Perfluorooctanoic acid (PFOA)	335-67-1	No	No	Organics	7.00E-02	D	-		2.00E-05	D /Chronic	-		1	0.1	9500	2.30E-01

K_{oc}\ (cm^3/g)	Dilution Attenuation Factor (DAF) (unitless)	HLC (atm-m^3/mole)	Henry's Law Constant (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Noncarcinogenic SL Adult THI=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Water Concentration (Adult) (mg/L)
3.72E+02	1	-	-		532.15	PHYSPROP	-		6.67E-02	4.01E-02	-	6.67E-05
1.15E+02	1	4E-6	1.64E-04	ATSDR Draft Profile	465.55	PHYSPROP	-		6.67E-02	4.01E-02	1.11E+00	6.67E-05

Water Concentration (Child) (mg/L)	Water Concentration (Cancer) (mg/L)	Maximum Contaminant Level (MCL) (ug/L)	Water Concentration (MCL) (mg/L)	MCL-based SL (mg/kg)	Noncarcinogenic Adult SL THI=0.1 (mg/kg)	Noncarcinogenic Child SL THI=0.1 (mg/kg)	Carcinogenic SL (mg/kg)	Risk-Based SL (mg/kg)
4.01E-05	-	-	-	-	6.29E-05	3.78E-05	-	3.78E-05
4.01E-05	1.11E-03	-	-	-	2.87E-05	1.72E-05	4.78E-04	1.72E-05

Output generated 20AUG2019:10:23:01

Inhalation Unit Risk Toxicity Metadata

Chemical	CASNUM	Chemical Type	Inhalation Unit Risk (µg/m ^{3})$^{-1}$	Toxicity Source	EPA Cancer Classification	Inhalation Unit Risk Tumor Type
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	Organics				
Perfluorooctanoic acid (PFOA)	335-67-1	Organics				

Inhalation Unit Risk Target Organ	Inhalation Unit Risk Species	Inhalation Unit Risk Method	Inhalation Unit Risk Route	Inhalation Unit Risk Treatment Duration	Inhalation Unit Risk Study Reference	Inhalation Unit Risk Notes

Output generated 20AUG2019:10:23:01

Oral Slope Factor Toxicity Metadata

6

Chemical	CASNUM	Chemical Type	Oral Slope Factor (mg/kg-day) $^{-1}$	Toxicity Source	EPA Cancer Classification	Oral Slope Factor Tumor Type	Oral Slope Factor Target Organ	Oral Slope Factor Species	Oral Slope Factor Method	Oral Slope Factor Route	Oral Slope Factor Treatment Duration	Oral Slope Factor Study Reference	Oral Slope Factor Notes
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	Organics											
Perfluorooctanoic acid (PFOA)	335-67-1	Organics	7.00E-02	DWSHA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Output generated 20AUG2019:10:23:01

Oral Sub-Chronic Toxicity Metadata

Chemical	CASNUM	Chemical Type	Subchronic Oral Reference Dose (mg/kg-day)	Toxicity Source	Oral Subchronic Reference Dose Basis	Oral Subchronic Reference Dose Confidence Level	Oral Subchronic Reference Dose Critical Effect
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	Organics	-				
Perfluorooctanoic acid (PFOA)	335-67-1	Organics	-				

Oral Subchronic Reference Dose Target Organ	Oral Subchronic Reference Dose Modifying Factor	Oral Subchronic Reference Dose Uncertainty Factor	Oral Subchronic Reference Dose Species	Oral Subchronic Reference Dose Route	Oral Subchronic Reference Dose Study Duration	Oral Subchronic Reference Dose Study Reference	Oral Subchronic Reference Dose Notes

Output generated 20AUG2019:10:23:01

Inhalation Sub-Chronic Toxicity Metadata

Chemical	CASNUM	Chemical Type	Subchronic Inhalation Reference Concentration (mg/m³)	Toxicity Source	Inhalation Subchronic Reference Concentration Basis	Inhalation Subchronic Reference Concentration Confidence Level	Inhalation Subchronic Reference Concentration Critical Effect	Inhalation Subchronic Reference Concentration Target Organ
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	Organics	-					
Perfluorooctanoic acid (PFOA)	335-67-1	Organics	-					

Inhalation Subchronic Reference Concentration Modifying Factor	Inhalation Subchronic Reference Concentration Uncertainty Factor	Inhalation Subchronic Reference Concentration Species	Inhalation Subchronic Reference Concentration Route	Inhalation Subchronic Reference Concentration Study Duration	Inhalation Subchronic Reference Concentration Study Reference	Inhalation Subchronic Reference Concentration Notes

Output generated 20AUG2019:10:23:01

END OF DOCUMENT

ED_005067B_00010568-00034