



STATE OF NEW HAMPSHIRE
 Department of Environmental Services
 Environmental Health Program
 Inter-Department Communication

To: Mike Wimsatt, Waste Division Director
 Peter Sandin, Hydrogeologist
 Thomas O'Donovan, Water Division Director

Date: October 14, 2019

From: Jonathan Ali, Toxicologist
 David Gordon, Human Health Risk Assessor
 Mary Butow, Human Health Risk Assessor

Cc: Clark Freise, Assistant Commissioner
 Pat North, EHP Administrator
 Gary Milbury, PEHB Administrator

RE: *Fish, Shellfish, Recreational Swimming and Wading Screening Levels (SLs) for Five Perfluoroalkyl Substances Including: PFOA, PFOS, PFHxS, PFNA and PFBS*

I. Summary

The Environmental Health Program (EHP) has reviewed the information necessary to derive Screening Levels (SLs) for five perfluoroalkyl substances (PFAS) in select environmental media. These PFAS include Perfluorooctanoic Acid (PFOA), Perfluorooctane Sulfonic Acid (PFOS), Perfluorohexane Sulfonic Acid (PFHxS) and Perfluorononanoic Acid (PFNA) and Perfluorobutane sulfonic Acid (PFBS). **Table 1** presents recommended screening levels for the following environmental media based on associated exposure assumptions: fish tissue concentration, mg/kg, shellfish tissue concentration, mg/kg, surface water concentration, µg/L and sediment concentration, mg/kg. These SLs are derived from toxicity values and exposure assumptions described in Sections II and III of this memo.

It is important to note that these SLs are conservative estimates used as screening tools for site-specific investigations, **and are not equivalent to fish/shellfish consumption advisories or surface water swimming advisories**. Should specific PFAS concentrations exceed their respective SLs in any given media, it is recommended that the site is further assessed to determine if there are significant risks of exposure under reasonable maximum exposure scenarios.

II. PFAS Toxicity Values

The current toxicity values, or chronic oral reference doses (RfDs), for PFOA, PFOS, PFHxS and PFNA are based on chronic health effects following prolonged exposure to these compounds. RfDs are daily exposures without appreciable risk (usually expressed in milligrams per kilograms of body weight per day). The NH-specific RfDs for PFOA, PFOS, PFHxS and PFNA are 6.1 ng/kg-d, 3.0 ng/kg-d, 4.0 ng/kg-d and 4.3 ng/kg-d, respectively (NHDES, 2019). In 2017, the Provisional Peer Reviewed Toxicity Value (PPRTV) (EPA, 2014a) for PFBS, 0.02 mg/kg-d, was used by EPA in their remedial investigation of perfluorinated compounds under the Pease Air Force Base Federal Facility Agreement (EPA, 2017). The EPA's draft RfD for PFBS of 0.01 mg/kg-d (EPA, 2018) was used for development of the 2019 NHDES SLs. This more recent and conservative value of 0.01 mg/kg-d was selected over the previous value based on additional review of the available toxicity data.

Other PFAS compounds have been reported in a wide variety of environmental media that have been analyzed. Should new RfDs be developed for these and other PFAS based on emerging scientific literature, the EHP will evaluate these and the need to revise existing SLs. At this time, the EHP is not recommending a total sum of PFAS approach to screening values for PFAS in environmental media. As discussed in the 2019 supplemental report for the PFAS MCLs/AGQS, there is inadequate data to make reliable and scientifically-defensible estimates of relative potency between PFAS based on the most sensitive critical health effects (NHDES, 2019). Should new quantitative risk assessment methods arise to address PFAS as a class or subgroups, the EHP will review these methods for the development of SLs.

Table 1. Environmental Screening Levels (SLs) derived using the U.S. EPA Regional Screening Level (RSL) Calculator. Values highlighted in grey indicate the most conservative SLs for use at investigation sites.

Fish Tissue		SLs Using USEPA RfDs^a		SLs Using NHDES RfDs	
Consumption SLs	Units^b	Adult	Child	Adult	Child
PFOA	mg/kg	0.00722	0.00521	0.00220	0.00159
PFOS	mg/kg	^ combined w/ PFOA	^ combined w/ PFOA	0.00108	0.00078
PFHxS	mg/kg	-	-	0.00144	0.00104
PFNA	mg/kg	-	-	0.00155	0.00112
PFBS	mg/kg	7.22	5.21	3.61	2.61
Shellfish Tissue					
Consumption SLs		SLs Using USEPA RfDs		SLs Using NHDES RfDs	
Consumption SLs	Units	Adult	Child	Adult	Child
PFOA	mg/kg	0.00678	0.00559	0.00207	0.00170
PFOS	mg/kg	^ combined w/ PFOA	^ combined w/ PFOA	0.00102	0.00084
PFHxS	mg/kg	-	-	0.00136	0.00112
PFNA	mg/kg	-	-	0.00146	0.00120
PFBS	mg/kg	6.78	5.59	3.39	2.79
Recreational					
Surface Water SLs		SLs Using USEPA RfDs		SLs Using NHDES RfDs	
Surface Water SLs	Units	Adult	Child	Adult	Child
PFOA	µg/L	18.3	2.03	5.57	0.618
PFOS	µg/L	^ combined w/ PFOA	^ combined w/ PFOA	2.74	0.304
PFHxS	µg/L	-	-	3.66	0.406
PFNA	µg/L	-	-	3.93	0.436
PFBS	µg/L	18,300	2,030	9,139	1,014
Recreational Sediment SLs					
Sediment SLs		SLs Using USEPA RfDs		SLs Using NHDES RfDs	
Sediment SLs	Units	Adult	Child	Adult	Child
PFOA	mg/kg	-	0.609	-	0.18587
PFOS	mg/kg	-	^ combined w/ PFOA	-	0.09141
PFHxS	mg/kg	-	-	-	0.12188
PFNA	mg/kg	-	-	-	0.13103
PFBS	mg/kg	-	609	-	305

^a Based on Screening Levels and Toxicity Values presented in "Re: Remedial Investigations of Perfluorinated Compounds under the Pease Air Force Base Federal Facility Agreement"

^b 1 mg/kg = 1,000 parts-per-billion (ppb)

III. PFAS Exposure Assumptions

Exposure assumptions followed those previously used to develop SLs for fish, shellfish, surface water and sediments (EPA Region 1 Office, 2017). These include body weight, fish tissue consumption, shellfish consumption, recreational activity exposure factors (e.g. swimming and incidental water ingestion) and body surface area estimates based on U.S. EPA recommendations (EPA 2011, 2014b, 2015 and 2019).

The adult exposure scenarios consisted of fish and shellfish consumption, along with recreational swimming. Ingestion rates for the 90th percentile of Northeastern State residents (≥ 21 years and older) were assumed (EPA, 2014b; Tables 9b and 12b) which is approximately 5.7 oz. and 6.1 oz. per week of recreationally caught fish (freshwater and estuarine) and shellfish, respectively. Swimming exposure frequency was assumed to be 45 days per year, with an hour of swimming per day. A wading scenario was not developed for adults as children were determined to be the most sensitive receptor for exposure from incidental ingestion and dermal absorption. Additional details and numeric assumptions are provided in **Supplemental Tables 1 and 2**.

The child exposure scenarios consisted of fish and shellfish consumption, along with recreational swimming and wading. Ingestion rates for the 90th percentile of Northeastern State residents (< 21 years of age) were assumed (EPA, 2014b; Tables 20b and 23b) which is approximately 1.5 oz. and 1.4 oz. per week of recreationally caught fish (freshwater and estuarine) and shellfish, respectively. Swimming exposure frequency was assumed to be 45 days per year, with an hour of swimming per day. Per the previous SLs, the exposure frequency for recreational wading for a child was assumed to be 75 days of the year, with an hour duration per exposure event. Additional details and numeric assumptions are provided in **Supplemental Tables 1, 2 and 3**.

A hazard quotient of 0.10 (10%) was applied to develop the screening levels. This additional level of conservatism results in a lower SL for site investigation purposes. If other game animals (i.e., venison or waterfowl) require SLs for any of these five PFAS, the EHP currently recommends the use of the fish consumption SLs as an initial screening tool to determine if additional risk assessment or site investigation is required.

Assumptions and values used to calculate the PFOA, PFOS, PFHxS, PFNA and PFBS screening levels are presented in the **Attachment**. Please contact the NHDES Permitting & Environmental Health Bureau at (603) 271-1370 with any questions regarding this memo.

References

- Agency for Toxic Substances and Disease Registry (ATSDR). 2018. Toxicological Profile for Perfluoroalkyls – Draft for Public Comment, June 2018. <https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf>.
- Bartell SM, Calafat AM, Lyu C, et al. 2010. Rate of decline in serum PFOA concentrations after granular activated carbon filtration at two public water systems in Ohio and West Virginia. *Environ Health Perspect* 118(2):222-228.
- New Hampshire Department of Environmental Services (NHDES). 2019. Summary Report On the New Hampshire Department of Environmental Services Development of Maximum Contaminant Levels and Ambient Groundwater Quality Standards for Perfluorooctanesulfonic Acid (PFOS), Perfluorooctanoic Acid (PFOA), Perfluorononanoic Acid (PFNA), And Perfluorohexanesulfonic Acid (PFHxS). <https://www4.des.state.nh.us/nh-pfas-investigation/wp-content/uploads/June-PFAS-MCL-Technical-Support-Document-FINAL.pdf>.
- Olsen GW, Burris JM, Ehresman DJ, et al. 2007. Half-life of serum elimination of perfluorooctanesulfonate, perfluorohexanesulfonate, and perfluorooctanoate in retired fluorochemical production workers. *Environ Health Perspect* 115:1298-1305.
- U.S. Environmental Protection Agency (USEPA). 2000. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000) Documents. <https://www.epa.gov/wqc/methodology-deriving-ambient-water-quality-criteria-protection-humanhealth-2000-documents>.
- U.S. Environmental Protection Agency (USEPA). 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-090/052F. Office of Research and Development, National Center for Environmental Assessment, Washington, D.C. 1436 pp. <https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252>.
- U.S. Environmental Protection Agency (USEPA). 2014a. Provisional peer-reviewed toxicity values for perfluorobutane sulfonate (CASRN 375-73-5) and related compound potassium perfluorobutane sulfonate (CASRN 29420-49-3). Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Cincinnati, OH. https://hhprrtv.ornl.gov/issue_papers/PerfluorobutanesulfonicacidPFBS.pdf
- U.S. Environmental Protection Agency (USEPA). 2014b. Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010). U.S. Environmental Protection Agency, Office of Water, Washington, D.C. <https://www.epa.gov/sites/production/files/2015-01/documents/fish-consumption-rates-2014.pdf>.
- U.S. Environmental Protection Agency (USEPA). 2015. Human Health Ambient Water Quality Criteria: 2015 Update. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. <https://www.epa.gov/sites/production/files/2015-10/documents/human-health-2015-update-factsheet.pdf>.
- U.S. Environmental Protection Agency (USEPA). 2018. **Draft for Public Comment:** Human Health Toxicity Values for Perfluorobutane Sulfonic Acid (CASRN 375-73-5) and Related Compound Potassium Perfluorobutane Sulfonate (CASRN 29420-49-3). U.S. Environmental Protection Agency, Office of Water, Washington, D.C. https://www.epa.gov/sites/production/files/2018-11/documents/pfbs_public_comment_draft_toxicity_assessment_nov2018-508.pdf.
- U.S. Environmental Protection Agency (USEPA). 2019. Regional Screening Levels (RSLs) - User's Guide. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. <https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide#multiple>.
- U.S. Environmental Protection Agency Region 1 Office. 2017. Re: Remedial Investigations of Perfluorinated Compounds under the Pease Air Force Base Federal Facility Agreement. Pease PFAS Screening Level Development Tables 1 – 4.

Attachment: Supplemental information on the derivation of Screening Levels for PFOA, PFOS, PFHxS, PFNA and PFBS using the U.S. Environmental Protection Agency (EPA) Regional Screening Level (RSL) Calculator

Website for Online Calculator: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

Methods and Equations for SL Derivation: <https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide>

The Environmental Health Program used Supplemental Equations 1-5 to derive screening levels, as described on the EPA website above for regional screening levels (RSLs). Supplemental Tables 1-3 present all variables and references used for deriving the SLs presented in this memo.

Supplemental Equation 1:

$$SL_{\text{fish/shellfish consumption}} \text{ (mg/kg)} = \frac{\text{THQ} \times \text{AT (days/year)} \times \text{ED (years)} \times \text{BW (kg)}}{\text{EF (days/year)} \times \text{ED (years)} \times \frac{1}{\text{RfD (mg/kg-day)}} \times \text{IRF (mg/day)} \times \frac{10^{-6} \text{ kg}}{1 \text{ mg}}}$$

Supplemental Equation 2:

$$SL_{\text{recreational swimming}} \text{ (\u00b5g/L)} = \frac{\text{THQ} \times \text{AT (days/year)} \times \text{ED (years)} \times \text{BW (kg)} \times \left(\frac{10^3 \text{ \u00b5g}}{\text{mg}}\right)}{\text{EF (days/year)} \times \text{ED (years)} \times \frac{1}{\text{RfD (mg/kg-day)}} \times \text{IRW (L/hour)} \times \text{EV (events/day)} \times \text{ET (hours/event)}}$$

Supplemental Equation 3:

$$SL_{\text{sediment ingestion}} \text{ (mg/kg)} = \frac{\text{THQ} \times \text{AT (days/year)} \times \text{ED (years)} \times \text{BW (kg)}}{\text{EF (days/year)} \times \text{ED (years)} \times \frac{1}{\text{RfD (mg/kg-day)}} \times \text{IRS (mg/day)} \times \frac{10^{-6} \text{ kg}}{1 \text{ mg}}}$$

Supplemental Equation 4:

$$SL_{\text{sediment dermal contact}} \text{ (mg/kg)} = \frac{\text{THQ} \times \text{AT (days/year)} \times \text{ED (years)} \times \text{BW (kg)}}{\text{EF (days/year)} \times \text{ED (years)} \times \frac{1}{\text{RfD (mg/kg-day)}} \times \text{GIABS} \times \text{SA (cm}^2\text{/day)} \times \text{AF (mg/cm}^2\text{)} \times \text{ABS}_d \times \frac{10^{-6} \text{ kg}}{1 \text{ mg}}}$$

Supplemental Equation 5:

$$SL_{\text{total}} \text{ (mg/kg)} = \frac{1}{\frac{1}{SL_{\text{sediment ingestion}} \text{ (mg/kg)}} + \frac{1}{SL_{\text{sediment dermal contact}} \text{ (mg/kg)}}}$$

2019 PFAS Screening Levels Memo

Supplemental Table 1. Exposure assumptions and variables used to derive SLs for fish and shellfish tissues based on consumption.											
Fish/shellfish Consumption SL	Adult					Child					Reference Information
	PFOA	PFOS	PFHxS	PFNA	PFBS	PFOA	PFOS	PFHxS	PFNA	PFBS	
RfD (mg/kg-d)	6.10E-06	3.00E-06	4.00E-06	4.30E-06	1.00E-02	6.10E-06	3.00E-06	4.00E-06	4.30E-06	1.00E-02	PFOA, PFOS, PFHxS and PFNA (NHDES, 2019) PFBS (EPA 2018)
Body weight (kg)	80	80	80	80	80	15	15	15	15	15	EPA (2011, 2019)
Fish Ingestion Rate (mg/d)	23100	23100	23100	23100	23100	6000	6000	6000	6000	6000	EPA (2014b), 90 th percentile consumers estimated for the Northeast Region States
Shellfish Ingestion Rate (mg/d)	24600	24600	24600	24600	24600	5600	5600	5600	5600	5600	EPA (2014b), 90 th percentile consumers estimated for the Northeast Region States
Averaging Time (d/yr)	365	365	365	365	365	365	365	365	365	365	
Exposure Duration (yr)	26	26	26	26	26	6	6	6	6	6	EPA (2019), based on estimates from the 90 th percentile residency time from EPA (2011)
Exposure Frequency (d)	350	350	350	350	350	350	350	350	350	350	EPA (2019)
Total Hazard Quotient	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	EPA (2019)
SL fish consumption (mg/kg)	0.002203	0.001083	0.001445	0.001553	3.611626	0.001590	0.000782	0.001043	0.001121	2.607143	
SL shellfish consumption (mg/kg)	0.002069	0.001017	0.001357	0.001458	3.391405	0.001704	0.000838	0.001117	0.001201	2.793367	

Supplemental Table 2. Exposure assumptions and variables used to derive SLs for surface water based on recreational swimming.											
Recreational Swimming Water SL	Adult					Child					Reference Information
	PFOA	PFOS	PFHxS	PFNA	PFBS	PFOA	PFOS	PFHxS	PFNA	PFBS	
RfD (mg/kg-d)	6.10E-06	3.00E-06	4.00E-06	4.30E-06	1.00E-02	6.10E-06	3.00E-06	4.00E-06	4.30E-06	1.00E-02	PFOA, PFOS, PFHxS and PFNA (NHDES, 2019) PFBS (EPA 2018)
Body weight (BW)	80	80	80	80	80	15	15	15	15	15	EPA (2011, 2019)
Inc. H ₂ O Ingest (IRW) (L/hr)	0.071	0.071	0.071	0.071	0.071	0.12	0.12	0.12	0.12	0.12	EPA (2011, 2019)
Events per day (EV)	1	1	1	1	1	1	1	1	1	1	EPA (2019)
Averaging Time (d/yr)	365	365	365	365	365	365	365	365	365	365	
Exposure Duration (yr)	20	20	20	20	20	6	6	6	6	6	EPA (2019), based on estimates from the 90 th percentile residency time from EPA (2011)
Exposure Frequency (d/yr)	45	45	45	45	45	45	45	45	45	45	EPA (2019)
Exposure Time (hr/event)	1	1	1	1	1	1	1	1	1	1	EPA (2019)
Total Hazard Quotient	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	EPA (2019)
SL recreational swimming (µg/L)	5.57	2.74	3.66	3.93	9139.28	0.618	0.304	0.406	0.436	1013.89	

2019 PFAS Screening Levels Memo

Supplemental Table 3. Exposure assumptions and variables used to derive SLs for sediments based on recreational wading.

Recreational Wader Sediment SL	Child					Reference Information
	PFOA	PFOS	PFHxS	PFNA	PFBS	
RfD (mg/kg-d)	6.10E-06	3.00E-06	4.00E-06	4.30E-06	1.00E-02	PFOA, PFOS, PFHxS and PFNA (NHDES, 2019) PFBS (EPA 2018)
Body weight (BW)	15	15	15	15	15	EPA (2011, 2019)
Inc. Sed Ingest (IRS) (mg/d)	200	200	200	200	200	EPA (2019)
Events per day (EV)	1	1	1	1	1	EPA (2019)
Averaging Time (d/yr)	365	365	365	365	365	
Exposure Duration (yr)	6	6	6	6	6	EPA (2019)
Exposure Frequency (d/yr)	75	75	75	75	75	EPA (2019)
Total Hazard Quotient	0.1	0.1	0.1	0.1	0.1	EPA (2019)
Surface Area (SA) (cm ²)	1,978.61	1,978.61	1,978.61	1,978.61	1,978.61	EPA (2011, 2019)
Adherence factor (mg/cm ²)	0.2	0.2	0.2	0.2	0.2	EPA (2019)
GI Absorption ρ (GIABS)	1	1	1	1	1	EPA (2019)
Dermal Absorption Fraction (ABS _d)	0.1	0.1	0.1	0.1	0.1	EPA (2019)
SL_{sediment ingestion} (mg/kg)	0.22	0.11	0.15	0.16	365.00	
SL_{sediment dermal} (mg/kg)	1.13	0.55	0.74	0.79	1844.73	
SL_{sediment total} (mg/kg)	0.185873	0.091413	0.121884	0.131025	304.7098	