



STATE OF NEW HAMPSHIRE

Date: December 11, 2019

At (OFFICE): DES-EHP

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To: Karlee Kenison, P.G.
DES-WMD

Subject: *Direct Contact Risk-Based Soil Concentrations:*

Perfluorooctanoic acid (PFOA)	(S-1 = 0.2 mg/kg)	(S-2 = 1.3 mg/kg)
Perfluorooctane sulfonate (PFOS)	(S-1 = 0.1 mg/kg)	(S-2 = 0.6 mg/kg)
Perfluorohexane sulfonic acid (PFHxS)	(S-1 = 0.1 mg/kg)	(S-2 = 0.9 mg/kg)
Perfluorononanoic acid (PFNA)	(S-1 = 0.1 mg/kg)	(S-2 = 0.9 mg/kg)

The Environmental Health Program (EHP) has revised the November 20, 2019 memo regarding the development of direct contact risk-based (DCRB) soil concentrations for four (4) Per- and Polyfluoroalkyl Substances (PFASs) considered protective of potential exposure in residential (S-1) and maintenance worker (S-2) scenarios. This revision is being issued to correct the units for the soil ingestion rate to mg/day as listed in Table 2. The November 20, 2019 memo incorrectly showed the units as mg/kg. This unit correction does not change the DCRB concentrations identified in the November 20, 2019 EHP memo. All other aspect of the November 20, 2019 remain unchanged.

The DCRB soil concentration is not anticipated to present an appreciable increased health risk to individuals who are exposed through direct contact with impacted soil. The concentration accounts for exposure that may result from incidental ingestion and dermal contact with impacted soil. The DCRB concentration does not account for potential exposure via inhalation, indirect exposure pathways such as migration via runoff to nearby surface water bodies or bioaccumulation in the food chain.

The DCRB concentration was derived using the methodology described in Appendix A (*Methodology for Calculating Direct Contact Risk-Based Soil Concentrations*) contained in the NHDES Risk Characterization and Management Policy (RCMP, 1998). In summary, dose-response information provides a quantitative evaluation of toxicity and describes the relationship between the dose of a chemical and the potential for adverse health effects in the exposed population. EHP developed reference dose (RfD) values for the four (4) PFAS compounds¹ (Table 1) that were used to calculate the DCRB concentrations to protect against non-carcinogenic health effects. The U.S. Environmental Protection Agency (USEPA) defines the reference dose as an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.²

Table 1: Select PFAS Reference Doses (RfDs) and S-1 and S-2 DCRB Soil Concentrations.³

	CAS #	RfD (mg/kg-d)	S-1 (mg/kg)	S-2 (mg/kg)
Perfluorooctanoic acid (PFOA)	335-67-1	6.1E ⁻⁶	0.2	1.3
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	3.0E ⁻⁶	0.1	0.6
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	4.0E ⁻⁶	0.1	0.9
Perfluorononanoic acid (PFNA)	375-95-1	4.3E ⁻⁶	0.1	0.9

The methodology described in Appendix A was used to calculate the DCRB concentration for the most sensitive receptor, young children aged 2 – 6 years in a residential scenario. The methodology contains a 20% relative source contribution factor (RSCF) for non-carcinogenic compounds. The RSCF is applied when the contribution from other potential sources of exposure (i.e. drinking water, food and air) to the compound is unknown. The DCRB methodology also assumes 100% absorption of PFAS from incidental ingestion of soil and 10% dermal absorption. PFAS are not well absorbed through the skin^{4,5,6} so dermal contact is not expected to be an important exposure route for the general public compared to other exposure pathways. However, the USEPA Regional Screening Level (RSL) Calculator assumes 10% dermal absorption for PFOA and PFOS.⁹ As a conservative measure it is assumed that the dermal absorption of PFHxS and PFNA are also 10% to avoid underestimating exposure from impacted soil. If additional studies provide information regarding dermal absorption, EHP will review the information to determine if recalculation of DCRB values are necessary.

Example DCRB calculation for PFOA:

$$\text{Concsoil (mg/kg)} = \frac{\text{RSCF} \times \text{RfD} \times \text{CF}}{[(\text{IR} \times \text{RAF}_o) + (\text{SA} \times \text{AF} \times \text{RAF}_d)] \times [(\text{EF} \times \text{ED}) / (\text{AT} \times \text{BW})]}$$

$$\text{S-1} = 0.2 \text{ mg/kg} = \frac{0.20 \times 6.1\text{E}^{-6} \text{ mg/kg-day} \times 1.0\text{E}^{+6} \text{ mg/kg}}{[(200 \text{ mg/day} \times 1) + (2632 \text{ cm}^2 \times 0.36 \text{ mg/cm}^2 \times 0.1)] \times [(160 \text{ days/year} \times 5 \text{ years}) / (1,825 \text{ days} \times 17 \text{ kg})]}$$

$$\text{S-2} = 1.3 \text{ mg/kg} = \frac{0.20 \times 6.1\text{E}^{-6} \text{ mg/kg-day} \times 1.0\text{E}^{+6} \text{ mg/kg}}{[(100 \text{ mg/day} \times 1) + (3104 \text{ cm}^2 \times 0.20 \text{ mg/cm}^2 \times 0.1)] \times [(146 \text{ days/year} \times 25 \text{ years}) / (9,125 \text{ days} \times 70 \text{ kg})]}$$

Table 2: Parameters used for the Calculation of Direct Contact Risk-Based Concentrations (DCRB) for Select PFAS Compounds in Soil.

Parameter	Description	S-1	S-2
Sensitive receptor	Parameter	Young child (residential)	Outdoor Maintenance worker
RSCF	Relative Source Contribution Factor	0.20	0.20
RfD (mg/kg-day)	Reference Dose	Compound specific	Compound specific
CF (mg/kg)	Units Conversion Factor	1.0E ⁺⁶	1.0E ⁺⁶
IR (mg/day)	Daily soil ingestion rate	200 ⁷	100 ⁸
RAF _o (unitless)	Relative Absorption Factor for soil ingestion	1	1
RAF _d (unitless)	Relative Absorption Factor for dermal contact	0.1	0.1
SA (cm ²)	Skin Surface Area available	2,632	3,104

	for soil contact		
AF (mg/cm ²)	Soil-to-skin Adherence Factor	0.36	0.20
EF (days/year)	Exposure Frequency	160	146
ED (years)	Exposure Duration	5	25
AT (days)	Averaging Time for non-carcinogens (ED x 365 days)	1,825	9,125
BW (kg)	Body Weight	17	70

Please contact me at 271-4773 if you have any questions regarding this memo.

EC: Patricia North, EHP Administrator

¹ NHDES. 2019. June 2019 Report. Retrieved from <https://www4.des.state.nh.us/nh-pfas-investigation/wp-content/uploads/June-PFAS-MCL-Technical-Support-Document-FINAL>.

² U.S. Environmental Protection Agency (USEPA). 2014. Risk Assessment Glossary. Retrieved from: https://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&vocabName=Risk%20Assessment%20Glossary.

³ The listed compounds and associated CAS numbers are for the acid forms of these PFAS compounds. The information presented in Table 1 are also applicable to the respective anionic forms of these compounds. These anions may form salts with any of a number of cations resulting in a variety of possible chemical species, each having a unique CAS number.

⁴ Agency for Toxic Substances and Disease Registry (ATSDR). 2019. “How can I be exposed to PFAS?”, webpage updated April 25, 2019. Retrieved from <https://www.atsdr.cdc.gov/pfas/pfas-exposure.html>.

⁵ U.S. Environmental Protection Agency (USEPA). 2016. Health Effects Support Document for Perfluorooctane Sulfonate (PFOS). Document # EPA 822-R-16-002. May 2016. Retrieved from https://www.epa.gov/sites/production/files/2016-05/documents/pfos_hesd_final_508.pdf.

⁶ U.S. Environmental Protection Agency (USEPA). 2016a. Health Effects Support Document for Perfluorooctanoic acid (PFOA). Document # EPA 822-R-16-003. May 2016. Retrieved from https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_hesd_final_508.pdf.

⁷ Resident soil ingestion rate-child. USEPA 2011A (Table 5-1); “Upper-bound values” accounting for both soil and dust ingestion. OSWER Directive 9200.1-120. Human Health Evaluation, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Retrieved from: https://epa-prgs.ornl.gov/chemicals/help/documents/OSWER_Directive_corrected.pdf.

⁸ Outdoor worker soil ingestion rate. USEPA 1991a (pg. 15); OSWER Directive 9200.1-120. Human Health Evaluation, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Retrieved from: https://epa-prgs.ornl.gov/chemicals/help/documents/OSWER_Directive_corrected.pdf.

⁹ U.S. Environmental Protection Agency (USEPA). 2019. Regional Screening Level (RSL) Calculator. Updated May 16, 2019. Retrieved from: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.