Health Risk Limits for Groundwater 2008 Rule Revision
Health Risk Assessment Unit, Environmental Health Division
651-201-4899
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Note: Water guidance for this chemical was updated in May 2017. Please see http://www.health.state.mn.us/divs/eh/risk/guidance/gw/table.html#pfos

Web Publication Date: 5/4/2009

Chemical Name: Perfluorooctane Sulfonate

Synonym: PFOS

CAS: 1763-23-1 (acid)
29081-56-9 (ammonium salt)
70225-14-8 (diethanolamine salt)
2795-39-3 (potassium salt)
29457-72-5 (lithium salt)

Serum concentrations appear to be the best dose-metric for extrapolating to humans. At the present time the information necessary to estimate less than chronic doses (i.e., acute, short-term or subchronic) that would result in a given serum concentration is not available. Additional uncertainty exists regarding toxicokinetics in early life. Therefore, acute, short-term and subchronic HRLs will not be derived at this time.

Acute Non-Cancer Health Risk Limit ($nHRL_{acute}$) = Not Derived (Insufficient Data)

Short-term Non-Cancer Health Risk Limit ($nHRL_{short\text{-}term}$) = Not Derived (Insufficient Data)

Subchronic Non-Cancer Health Risk Limit ($nHRL_{subchronic}$) = Not Derived (Insufficient Data)

Chronic Non-Cancer Health Risk Limit ($nHRL_{chronic}$) = 0.3 ug/L

$$= \frac{\text{(Reference Dose, mg/kg/d) x (Relative Source Contribution) x (Conversion Factor)}}{\text{(Chronic intake rate, L/kg/d)}}$$

$$= \frac{\text{(0.00008 mg/kg/d) x (0.2) x (1000 ug/mg)}}{\text{(0.049* L/kg-d)}}$$

= 0.327 rounded to **0.3 ug/L**

* Intake rate used corresponds to the time-weighted average 95th% intake rate over first 27 years of life. Twenty-seven years represents the estimated duration to achieve steady-state serum concentration, based on a half-life of 5.4 years.

Reference Dose: 0.00008 mg/kg-d (Cynomolgus monkeys)
Source of toxicity value: MDH

Point of Departure:	35 mg/L serum concentration (BMDL) (Thomford et al 2002 as cited by OECD 2002 and Seacat et al 2002)
Human Equivalent Dose Adjustment:	0.0025 mg/kg-d [Dose mg/kg-d = (Ln2/1971 day half-life$_{human}$) x 35 mg/L x 0.2 L/kg (Vd)]
Total uncertainty factor:	30
UF allocation:	3 interspecies extrapolation for potential differences in toxicodynamics and 10 intraspecies variability
Critical effect(s):	decreased HDL cholesterol, decreased total T3, increased TSH
Co-critical effect(s):	decreased body weight and body weight gain in offspring
Additivity endpoint(s):	Development (body weight/weight gain), Hepatic (liver) system, Thyroid (E)
Secondary effect(s):	changes in immune function, delayed development (e.g., body weight gain, eye opening), decreased adult body weight gain & loss of fat tissue, increased severity of liver effects (e.g., histological changes), disruption of estrus cycle, decreased sperm count & increased sperm deformities, decreased serum leptin levels, increased incidence of neoplasms (e.g., liver, thyroid, mammary gland), increased mortality (offspring and adults)

Cancer Health Risk Limit (cHRL) = Not Applicable

Volatile: No

Summary of changes since 1993/1994 HRL promulgation:
No 1993/94 HRL value exists for PFOS. The chronic HRL (0.3 ug/L) is the same as the Good-cause exception HRL (0.3 ug/L) adopted August 1, 2007.

Summary of toxicity testing for health effects identified in the Health Standards Statute:

	Endocrine	Immunotoxicity	Development	Reproductive	Neurotoxicity
Tested?	Sec. Observations[1]	Yes	Yes	Yes	Yes
Effects?	Yes	Yes[2]	Yes[3]	Yes[4]	Yes[5]

Note: Even if testing for a specific health effect was not conducted for this chemical, information about that effect may be available from studies conducted for other purposes. Most chemicals have been subject to multiple studies in which researchers identify a dose where no effects were observed, and the lowest dose that caused one or more effects. A toxicity value based on the effect observed at the lowest dose across all available studies is considered protective of all other effects that occur at higher doses.

Comments on extent of testing or effects:
Note – comparisons based on HED LOAEL or HED BMDLs are associated with higher uncertainty than comparisons based on serum levels.

[1] Thyroid hormonal perturbations have been observed in laboratory animals at serum levels and human equivalent dose (HED) levels similar to the critical study point of departure (serum BMDL) and HED-LOAEL. Alterations in thyroid hormone levels have been identified as a critical effect.
[2] Short-term immunotoxicity studies have shown that PFOS exposure alters several immunologic parameters (suppression of SRBC-specific IgM production and T-cell proliferation, increased natural killer cell activity) at HED levels below the critical study HED LOAEL. The biological significance of these effects is not entirely clear. Further study is needed to determine whether PFOS poses potential health risks to humans as a result of alterations in immune function, however, the MDH will include immune system as a secondary effect at this time.
[3] Lower body weight, decreased total T4 and free T4, and increased relative liver weight have been reported at serum levels similar to the critical study point of departure (serum BMDL). These effects have been identified at co-critical effects. At serum levels approximately 2-fold higher than the critical study point of departure additional developmental effects (decreased pup viability, developmental delays) are observed. These additional effects are listed as secondary effects.
[4] Increased incidence of abortions was noted in female rabbits at serum levels ~ 2-fold higher than the critical study point of departure (serum BMDL), however, these were associated with significant loss in body weights. Disruption of estrus cycling in female rats has also been noted at serum levels ~ 2-fold higher than the critical study BMDLserum levels. A male reproductive study in rats reported decreases in sperm count and increases in sperm deformities at HED levels 3-fold higher than the critical study HED LOAEL. Disruption of estrus cycling and spermatozoal effects are listed among the secondary effects.
[5] Increased norepinephrine concentrations in the paraventricular nucleus of the hypothalamus have been reported in female rats at serum levels ~2-fold higher than the critical study point of departure (serum BMDL). These effects have been noted as secondary effects.

Hypoactive responses to nicotine has been observed in neonatal mice acutely exposed to HED levels > 30-fold higher than the critical study HED LOAEL, however, these effects were not observed at levels 3-fold higher. Convulsions, severe rigidity and body trembling have been observed in Rhesus monkeys exposed to HED levels approximately 30-fold higher than the critical study HED LOAEL.

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