



# Hazard Assessment and Derivation of Risk Based Remedial Targets for PFOS

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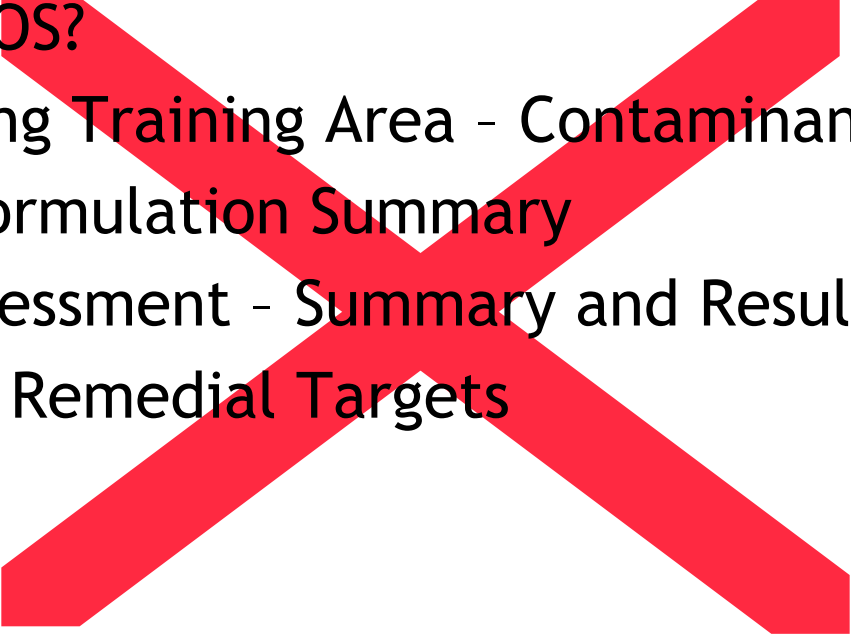
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solutions for today's environment

# Presentation Outline

- What is PFOS?
  - Fire-Fighting Training Area - Contaminant of Concern
  - Problem Formulation Summary
  - Hazard Assessment - Summary and Results
  - Risk-Based Remedial Targets
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# What is PFOS?

- PFOS (Perfluorooctane Sulfonate) belongs to a class of chemicals called perfluorinated alkyl compounds (PFCs)
- Recent research indicates PFCs are globally distributed in humans, wildlife and the environment
- PFCs manufactured for > 50 years to make products that resist heat, oil, stains and water
- PFCs include several compounds that contain the perfluorooctylsulfonyl ( $C_8F_{17}SO_2$ ,  $C_8F_{17}SO_3$  or  $C_8F_{17}SO_2N$ ) moiety → degrade to PFOS in the environment

# PFOS Chemical Structure

- PFOS is an eight carbon chain saturated by fluorine; C-F bond is a strong, high-energy bond

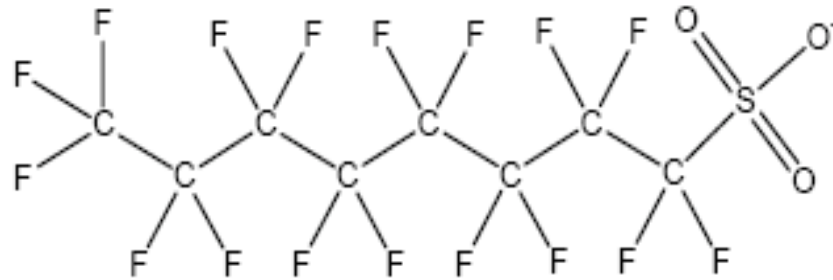


Figure 1. Chemical structure of PFOS anion (OECD, 2002).

- PFOS does not hydrolyze, photolyze or biodegrade; estimated half life in environment > 41 years (EC, 2004)
- PFOS can exist as an anion, acid or salt; anion most common form in the environment

# PFOS Physicochemical Properties

- Solubility of ~ 550 mg/L
- Non-volatile
- $K_{ow}$  cannot be determined based on surface-active properties
- Does not partition to lipids, binds to serum proteins
- Bioaccumulates → reported BAFs and BCFs vary
- Half-life in humans ~ 4-6 years

# PFCs - Contaminants of Concern?

- In 2005, PFOS and associated PFCs identified as PCOCs at fire training area in BC interior
- PFOS and other PFCs associated with use of aqueous film forming foam (AFFF)
- Investigation conducted 2005 - 2007 → PFOS and other PFCs in soil and groundwater (source zone concentrations of 1700 ug/L)
- No existing Canadian environmental standards or guidelines → risk based approach required
- Why focus on PFOS?
  - Present among the highest concentrations
  - Most toxic of PFCs
  - Final degradation product of precursors
  - Available literature for PFOS and PFOA

# Problem Formulation

- Based on existing and probable future land use (CL/IL)
- Drinking water wells present with 1.5 km of the Site
- Primary human receptors of concern and complete exposure pathways:
  - Commercial Workers (soil ingestion, dermal contact and inhalation of soil particulate)
  - Construction Workers (as for Commercial Workers)
  - Off-Site Residents Using Groundwater as Drinking Water



# Hazard Assessment - Literature Review

- No existing TRVs for PFOS
- Detailed literature review of scientific journals, EPA Dockets and toxicological summaries prepared by OECD (OECD, 2002), Environment Canada (EC, 2004) and Health Canada (HC, 2004)
- Four Key Studies identified:
  - 26-Week Cynomolgus Monkey Study (Seacat et al., 2002a)
  - 104-Week Chronic Toxicity and Carcinogenicity Study in Rats (Seacat et al., 2002b)
  - 2-Generation Reproductive Toxicity Study in Rats (Christian et al., 1999)
  - 2-Generation Reproduction and Cross-Foster Studies in Rats (Luebker et al., 2005)
- Several Supporting Studies identified

## Summary of PFOS Toxicity

- Non-cancer effects: hepatic effects, gastrointestinal effects and weight loss
- Liver is primary target organ, liver cell hypertrophy and reduction in serum cholesterol early responses to PFOS exposure
- Two-year chronic toxicity and carcinogenicity study (Seacat et al., 2002b) → PFOS has the potential to be carcinogenic at high doses
- Reproductive and developmental toxicity observed

## 26-Week Cynomolgus Monkey Study (Seacat et al., 2002; Covance Laboratories, 2000 )

- Animals administered PFOS K<sup>+</sup> salt by gastric intubation at doses of 0, 0.03, 0.15 and 0.75 mg/kg-day
- Animals observed for 52 weeks following 26 week dosing period
- Statistically significant effects observed in 0.75 mg/kg-day dosing group only - lowered cholesterol levels and thyroid hormone levels, liver effects, decreased body weights, and death of two animals
- LOAEL - 0.75 mg/kg-day; minimal LOAEL - 0.15 mg/kg-day

# Derivation of Reference Dose

- Derived from minimal LOAEL of 0.15 mg/kg-day for 26-Week Cynomolgus Monkey Study
- Critical Effect - Decreased cholesterol and thyroid hormone (T3) levels
- Uncertainty factor of 2000 used:
  - 10 for interspecies variation (half life 20x's longer in humans)
  - 10 for intraspecies variation
  - 10 for subchronic to chronic
  - 2 for use of minimal LOAEL instead of NOAEL
- $RfD = NOAEL \text{ (or LOAEL)} / UF = (0.15 \text{ mg/kg-day} / 2000)$
- ***RfD = 7E-05 mg/kg-day***

# Human Health Risk-Based Remedial Targets

- Derived for identified receptors of concern:
  - Commercial Workers (direct soil exposures)
  - Construction Workers (direct soil exposures)
  - Off-Site Residents using gw as drinking water source
- Health Canada (2007-Draft) intake equations and exposure assumptions used (including Dillon, 2005)
- Dermal Absorption Factor of 50% conservatively used
- Acceptable HQ of 1E+00 (provincially regulated)
- 20% Allocation Factor used

## Summary of Derived Human Health Target for PFOS

Receptor	Soil Remedial Target
Commercial Worker	20 mg PFOS/kg
Construction Worker	<b>4 mg PFOS/kg</b>
Receptor	Groundwater Remedial Target (ug/L)
Off-Site Resident	<b>0.4 ug PFOS/L</b>

# Final Targets

Final Soil Remedial Target	1.3 mg PFOS/kg (for plants)
Final Groundwater Remedial Target	0.4 ug PFOS/L

- Drinking Water Guidelines From Other Jurisdictions:
  - **Minnesota Department of Health (Aug, 2007)**
    - PFOS: 0.3 ug/L (based on MDH RfD of 7.5E-05 mg/kg-day)
    - **PFOA: 0.5 ug/L (Draft of 0.3 ug/L)**
    - **PFBS and PFHxS - 0.6 ug/L**
    - **PFPeA, PFHxA - 1.0 ug/L**
    - **PFBA - 7.0 ug/L (raised from 1.0 ug/L in Feb 08)**

# Recommendations

- Adopt MDH DW guidelines for other PFCs
- Continue to review literature and update PFOS RfD as required → PFOS/PFOA on US EPA's priority list for this year
- Consider using reported serum levels (vs. administered doses) to derive RfD
- Soil invertebrate and plant tissue sampling to refine targets for wildlife

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