

Example Calculation for Soil Risk Assessment

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Disclaimer

The values and calculations in this presentation are meant only as basic education to help the CAG understand regulatory risk assessment of dioxins in soil in the Tittabawassee River, Saginaw River & Bay Midland, MI.

MDHHS may use other scenarios or values to complete their own evaluations. This educational presentation using the local regulatory soil screening values does not represent an MDHHS endorsement of the values or the inputs used to make the calculations.

Outline

Dioxin reference dose (RfD)

- Daily exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime

Example of How soil criteria are calculated

- Site Specific Preliminary Remediation Goal (PRG)
- EGLE Part 201 Direct Contact Criteria

EXAMPLE - Dioxin reference dose

RfD for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) was developed by EPA and finalized in February of 2012.

- Used since measurements are toxic equivalents to TCDD

Based on epidemiology studies:

- Decreased sperm count and motility in men exposed to TCDD as boys (1-9-year-olds)
- Increased TSH in neonates born to mothers who were exposed to TCDD 17-29 years prior to pregnancy
- Low uncertainty factor (10 for the LOAEL and 3 for human variability)
- Very strong since its based on human evidence as opposed to animal studies

US EPA RfD = 0.7 picograms per kg per day (0.7 pg/kg/day)

EXAMPLE - Comparing soil concentration to RfD

- Calculate estimated daily dose for a defined exposure scenario

$$\text{Hazard Quotient} = \frac{\text{Calculated Dose}}{\text{Reference Dose}}$$

$$\text{Example: } 0.5 = \frac{0.35 \text{ pg/kg/day}}{0.7 \text{ pg/kg/day}}$$

$$1 = \frac{\text{Calculated Dose}}{\text{Reference Dose}} \leftarrow \text{Exposure scenario} \quad \text{Soil concentration (ng/kg or ppt)}$$

EXAMPLE - Parameters for calculating exposure

Body weight*

Skin surface area*

Soil ingestion rate*

Soil adherence factor*

Absorption efficiency (gastrointestinal and dermal)*

- Also referred to as bioavailability

Exposure frequency

Exposure duration

Dioxin concentration in each media (soil, dust, etc.)* Conservative values are chosen and barely vary between exposure scenarios

EXAMPLE - Parameters for calculating exposure

Body Weight*

Most sensitive group are young children age 1 to 6

1 to 2 years = 11.4 kilograms
2 to 3 years = 13.8 kilograms
3 to 6 years = 18.6 kilograms

Calculated Weighted Mean =

$$\frac{11.4 + 13.8 + 18.6 + 18.6 + 18.6}{5} = 16.2 \text{ kilograms}$$

Skin Surface Area*

Total weighted skin surface area = 6840 cm²

	<u>Face</u>	<u>Neck</u>	<u>Arms</u>	<u>Hands</u>	<u>Lower Legs</u>	<u>Feet</u>	
Children 1 to 6:	0.047	0.036	0.133	0.055	0.102	0.069	x 6840 sq cm = 2052 square centimeters;

*Numbers from NHANES and EPA Exposure Factor Handbook

EXAMPLE - Parameters for calculating exposure

Soil Ingestion Rate

200 mg/day is used. This is a reasonable maximum exposure (RME) for 1- to 6-year-old children and is based on the 95th percentile from various studies.

For context: (CTE = Central tendency or average)

Exposure Group	Soil/Indoor Dust or Sediment Ingestion mg/day	
	CTE ⁺	RME ⁺⁺
Birth to < 1 year	55	150
1 to < 2 years	90	200
2 to < 6 years	60	200
6 to < 11 years	60	200
Adults, ≥ 21 years	30	100

Adult Gardner CTE is 100 mg/day

EXAMPLE - Parameters for calculating exposure

Soil Adherence Factor

- PRG use 0.2 mg/cm², EGLE Part 201 uses 1 mg/cm²

Exposure Scenario	Weighted Soil Adherence Factor (mg/cm ²)	
	Geometric Mean	95th Percentile
Indoor Children	0.01	0.06
Daycare Children (playing indoors and outdoors)	0.04	0.3
Children Playing (dry soil)	0.04	0.4
Children Playing (wet soil)	0.2	3.3
Children-in-Mud	21	231
Gardeners	0.07	0.3
Farmers	0.1	0.4

EXAMPLE - Parameters for calculating exposure

Absorption efficiency

Dermal

- 3% for EGLE Part 201 and 2% for PRG
- 1% is typical for non-volatile organic compounds

Gastrointestinal

- 50% for EGLE Part 201 and 43% for PRG
- Studies were done on Tittabawassee soils that were fed to rats and swine. Average of the two species was used to derive the PRG value.

References for the EXAMPLE

EPA (2014) Site-Specific Preliminary Remediation Goals (Cleanup Goals) For Tittabawassee River Floodplain Soil

<https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Programs/MMD/Hazardous-Waste/Dow/Dioxin/dow-excerpt-of-dcc-tsd.pdf?rev=cddfe39439044ff6972142e876fe0766>

<https://www.atsdr.cdc.gov/pha-guidance/resources/ATSDR-EDG-Soil-Sediment-Ingestion-508.pdf>