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May 10, 1990

MEMORANDUM

Subject: Remediation Goals for the Arkwood site

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This memorandum derives the remediation goals for carcinogenic polynuclear aromatic hydrocarbons (PAHs) for the Arkwood Superfund site. The Endangerment Assessment indicated that the majority of the excess cancer risk at the site is attributable to PAHs, and chlorinated dibenzo-p-dioxins and dibenzofurans.

The current and most probable future land use of the site is industrial. The remediation goal considers the protection of a worker at an industrial facility. Implicit in this assumption is that during the nonwork portion of their lifes, they are not exposed to site related contaminants.

In addition, the remediation goal for carcinogenic PAHs is developed using the Risk Assessment Guidance for Superfund, Human Health Manual, Volume 1, Part A (RAGS), Exposure Factors Handbook (Handbook) and Region 6 Standard Exposure Scenarios (SES). The oral slope factor for benzo(a)pyrene (B(a)P) is used as the representative carcingogenic PAH. The oral slope factor for B(a)P is under review by the Carcinogenic Risk Assessment Verification Endeavor (CRAVE) workgroup. The remediation goal accounts for the ingestion of potentially contaminated soils.

Ingestion of potentially contaminated soil:

IF = (SI * ABS * EF * ED) / (BW * AT)

Where:
- IF = Intake Factor from soil ingestion
- SI = Soil Ingestion Rate (RAGS and OSWER Directive 9850.4) 0.1 g/d
- ABS = Absorption Fraction from Soil (RAGS, Appendix A)
- EF = Exposure Frequency (SES)
- ED = Exposure Duration (SES)
- BW = Body Weight (RAGS)
- AT = Averaging Time (RAGS)

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IF = (SI * ABS * EF * ED) / (BW * AT)

50 wk / 45

= (0.0001 kg/day * 0.05 * 5 days/7 days * 9 years) / (70 kg * 70 years)

= 6.6E-9 kg/kg-day

Inherent Toxicity of Ingested Soil:

Inherent Toxicity = IF * Oral Slope Factor for B(a)P

= 6.6E-9 kg/kg-day * 11.5/mg/kg-day

= 7.6E-8 kg/mg

Target remediation goal for contaminated soil:

Remediation Goal = Target Risk Level / Inherent Toxicity

= 1E-6 / 7.6E-8 kg/mg

= 13 mg/kg

The 1E-6, 1E-5 and 1E-4 target remediation goals are 13, 130 and 1300 mg/kg B(a)P equivalents, respectively.

Non Cancer Risk: $HI = \frac{Dose}{AIC}$

Worker Soil Injestion $HI(AIC) = Dose$ 0

Subchronic Rd (AIC)		Soil ingestion?		HI	
	ingestion mg/kg/day	A	M	A	M
PCP	3×10^{-2}	4.4×10^{-4}	7.8×10^{-4}	1.5×10^{-4}	2.6×10^{-3}
Naph	4×10^{-1}	2.2×10^{-6}	9.3×10^{-4}		
Nc PNA	1.2×10^{-3}	2.1×10^{-6}	4.8×10^{-3}		4.0

only nc that presents a risk is Nc PNA at the max concentrat

$HI \overset{si}{=} \frac{Dose}{AIC}$

$HI * AIC \overset{si}{=} Dose$

$(1.2 \times 10^{-3})(4.9 \times 10^{-7}) = 1.2 \times 10^{-3}$

$SiD = C_{soil}(4.9 \times 10^{-7})$

$\frac{SiD}{4.9 \times 10^{-7}} = C_{soil}$

$\frac{1.2 \times 10^{-3}}{4.9 \times 10^{-7}} = 2448.97$ mg/kg

$PAH_{total} \Rightarrow 2450$ ppm

Risk

Work soil ingestion

$$SID = \frac{C_{soil}}{} \left| \frac{.050\,g}{day} \right| \frac{5\,day}{week} \left| \frac{50\,week}{yr} \right| \frac{yr}{365\,day} \left| \frac{}{70\,kg} \right| \frac{kg}{1000\,g}$$

$$SID = C_{soil} \left(4.9 \times 10^{-7}\ day^{-1}\right)$$

Compound	$C_{soil\ Average}$ (mg/Kg)	$C_{soil\ Max}$	PF
C. PAHs	3.26	1.4×10^{3}	11.5
Napthalenes	4.58	1.9×10^{3}	
PCP	8.93	1.60×10^{3}	
+ PAHs	4.29	1×10^{4}	

(mg/Kg/day)

Compound	SID AVG	SID MAX	
C. PAHs	1.6×10^{-6}	6.8×10^{-4}	11.5
Napth	2.2×10^{-6}	9.3×10^{-4}	
PCP	4.4×10^{-6}	7.8×10^{-4}	
+ PAHs	2.1×10^{-6}	4.8×10^{-3}	

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Carcinogenic Risk:

$$Risk_A = SID \times EDA \times PF$$

$$= \frac{1.6 \times 10^{-6}\ mg}{Kg \cdot day} \left| \frac{9\,yrs}{70\,yrs} \right| 11.5 \qquad \frac{1.6 \times 10^{-6}}{} \left| \frac{40}{70} \right| 11.5$$

$$risk_A = 2.4 \times 10^{-6} \qquad risk = 1.0 \times 10^{-5}$$

$$Risk_M = \frac{6.8 \times 10^{-4}}{} \left| \frac{9}{70} \right| 11.5 \qquad 6.8 \times 10^{-4}\ \frac{40}{70}\ 11.5$$

$$= 1 \times 10^{-3} \qquad = 4.47 \times 10^{-3}$$

By EPA

Worker Soil Injestion C. PAH ⇒ TARGET ACTION

$Risk = S_{ID} \times EDA \times DF$

$S_{ID} = \frac{Risk}{EDA \times DF}$

$= \frac{1 \times 10^{-5}}{} \left| \frac{70\,yr}{40\,yr} \right| \frac{mg}{11.5\ kg\text{-}day}$

$S_{ID} = 1.5 \times 10^{-6}$

$S_{ID} = C_{soil}(4.9 \times 10^{-7})$

$\frac{S_{ID}}{4.9 \times 10^{-6}} = C_{soil}$

$\frac{1.5 \times 10^{-6}}{4.9 \times 10^{-7}} = C_{soil}$

$3.1\ \frac{mg}{kg} = C_{soil}$ @ 10^{-5}

30 mg/kg @ 10^{-4}

~~4 mg/day~~ 12/24 hrs

$\frac{.1\,g}{day}$

~~.001~~ .1 g/DAY

Computed by Weston

$$Risk = SID \times EDA \times PF$$

$$SID = \frac{Risk}{EDA \times PF}$$

$$= \frac{2.5 \times 10^{-6}}{} \left| \frac{70}{\frac{40}{9}} \right| \frac{}{11.5}$$

$$= 3.8 \times 10^{-7} \qquad 1.6908 \times 10^{-6}$$

$C_{soil_{40}} = .77761$

$C_{soil_9} = 3.45$

Soil Remediation Goals

PAH_{Total} ⇒ 24.50 mg/kg

$PAH_{carcinogenic}$ (as BaP) ⇒ 3.11 mg/kg

PCP ⇒ did not present a th. hazard to prot gw → 150 ppm

Ground Water / Surface Water Remediation Goals

PCP → proposed MCL → 0.2 mg/l

PNA (as BAP) → Water Quality Criteria → 2.8 ng/l → practical quantitation limit

" " → draft proposed MCL → 2.0 ng/l

200 ng/l 10 µg/l

.2 µg/l

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