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Leah J. Smith
District and Business Support Program
Division of Waste Management
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Development of alternative soil and groundwater cleanup target levels for vinyl chloride under the utility worker scenario

Dear Ms. Smith:

At your request, we have developed alternative soil and groundwater cleanup target levels for vinyl chloride under the utility worker scenario. A default utility worker scenario is not currently available from the Florida Department of Environmental Protection (FDEP) or the United States Environmental Protection Agency (USEPA). Therefore, we developed equations and exposure assumptions for the calculation of utility worker cleanup target levels based on the construction worker risk-based equations and assumptions developed by the USEPA and the Virginia Department of Environmental Quality (VDEQ). The methodology for the derivation of utility worker cleanup target levels is explained in detail below.

The vinyl chloride alternative soil cleanup target level (ASCTL) for utility workers was calculated using the USEPA equation for the development of risk-based concentrations in soil for carcinogens for the construction worker. Although vinyl chloride is mutagenic and has a child-specific oral cancer slope factor, the mutagenic equations were not used because children are not exposed under the utility worker scenario. The equation is provided in Figure 1 and the exposure parameters are listed in Table 1. For the development of a utility worker-specific ASCTL, it was assumed that utility work is similar to construction work in that it involves soil intensive activities and may include exposure to subsurface soil and groundwater. Therefore, body weight (BW), the volatilization factor (VF), and the incidental soil ingestion rate (IR) were taken from the USEPA's Regional Screening Level (RSL) Calculator for construction workers (Table 1). However, the exposure frequency and duration of a utility worker is likely to differ from a construction worker. To account for this difference, we chose an exposure frequency of 20 d/y for a utility worker. At some sites, utility workers may have more or less frequent exposure than the 20 d/y used to derive this ASCTL. In those situations, an ASCTL can be developed using site-specific utility worker exposure frequency and the equation in Figure 1. An exposure duration of 10 years was chosen for the utility worker. The exposure duration of 10 years is based on professional judgement. If available, site-specific exposure durations can be used to calculate utility worker cleanup target levels. Toxicity values were obtained from the USEPA's RSL Table.

The USEPA considers dermal absorption of vinyl chloride to be negligible and does not calculate a dermal screening level for this chemical. Therefore, we removed the dermal component from the equation. This is equivalent to setting the dermal absorption to zero. Using the equation in Figure 1 and the exposure parameters listed in Table 1, we calculated a **utility worker ASCTL of 34 mg/kg vinyl chloride** (rounded to two significant figures).

The alternative groundwater cleanup target level (AGCTL) for utility workers was calculated using the VDEQ model for exposure to groundwater contaminants in a construction/utility trench. The equation is provided in Figure 2 and the exposure parameters are listed in Table 1. Based on the negligible dermal absorption of vinyl chloride, the dermal component of the equation was also removed for the derivation of an AGCTL. The exposure parameters used in the calculation of the AGCTL were obtained from the VDEQ model except for the exposure frequency and duration. Two separate volatilization factors exist for this model. The first assumes that groundwater is less than or equal to 15 feet deep and the worker has direct exposure to groundwater. This is the scenario used in the development of utility worker GCTLs. In this scenario, the trench is conservatively assumed to be 3 feet wide, 8 feet long, and 8 feet deep. If the trench at a site is expected to differ significantly from the area and volume proposed, a site-specific value should be calculated. The fraction of the trench floor through which the groundwater can enter is assumed to be 1. The air changes in the trench are assumed to be 2 per hour based on measured ventilation rates in buildings (VDEQ, 2020). Similar to the ASCTL equation, an exposure frequency of 20 d/y and an exposure duration of 10 years were used to calculate an AGCTL specific to the utility worker. Additionally, body weight and surface area were updated to reflect current USEPA exposure assumptions (OSWER Directive 9200.1-120). Using the equation in Figure 2 and the exposure parameters in Table 1, we calculated a **utility worker AGCTL of 16 μg/L** (rounded to two significant figures).

Please let us know if you have any questions regarding the development of these ACTLs.

Sincerely,

Leah D. Stuchal, Ph.D.

Stephen M. Roberts, Ph.D.

Reference:

VDEQ. 2020. Virginia Unified Risk Assessment Model – VURAM User Guide for Risk Assessors. Virginia Department of Environmental Quality, Richmond, VA. Updated June 2020.

Figure 1 – Alternative soil cleanup target level equation for carcinogens under the utility worker scenario:

$$ASCTL_{ingestion} = \frac{TR \times AT \times BW}{EF \times ED \times CSF_o \times RBA \times IR \times 10^{-6}(kg/mg)}$$

$$ASCTL_{inhalation} = \frac{TR \times AT}{EF \times ED \times ET \times \left(\frac{1\ d}{24\ hr}\right) \times IUR \times \left(\frac{1}{VF} + \frac{1}{PEF}\right) \times 1000(\mu g/mg)}$$

$$ASCTL\ (mg/kg) = \frac{1}{\frac{1}{ASCTL_{ingestion}} + \frac{1}{ASCTL_{inhalation}}}$$

Figure 2 – Alternative groundwater cleanup target level equation for carcinogens under the utility worker scenario:

$$AGCTL_{ingestion} = \frac{TR \times AT \times BW \times 1000(\mu g/mg)}{EF \times ED \times CSF_o \times IR_w}$$

$$AGCTL_{inhalation} = \frac{TR \times AT}{EF \times ED \times ET \times \left(\frac{1\ d}{24\ hr}\right) \times IUR \times VF_{lt}}$$

$$VF_{lt} = \frac{K_i \times A \times F \times 10^{-3}(L/cm^3) \times 10^4(cm^2/m^2) \times 3600(s/hr)}{ACH \times V}$$

$$K_i = \frac{1}{\frac{1}{k_{iL}} + \frac{R \times T}{H_i \times k_{iG}}}$$

$$k_{iL} = \left(\frac{MW_{O2}}{MW_i}\right)^{0.5} \times \frac{T}{298} \times k_{L,O2}$$

$$k_{iG} = \left(\frac{MW_{H2O}}{MW_i}\right)^{0.335} \times \left(\frac{T}{298}\right)^{1.005} \times k_{G,H2O}$$

$$AGCTL(\mu g/L) = \frac{1}{\frac{1}{AGCTL_{ingestion}} + \frac{1}{AGCTL_{inhalation}}}$$

Table 1 – Exposure parameters for the utility worker alternative cleanup target levels for vinyl chloride

Abbreviation	Definition	Value
A	Area of the Trench	2.22 m^2
ACH	Air Changes per Hour	2 h^{-1}
AGCTL	Utility Worker Groundwater Cleanup Target Level	Calculated (μg/L)
ASCTL	Utility Worker Soil Cleanup Target Level	Calculated (mg/kg)
AT	Carcinogenic Averaging Time	25550 d
BW	Body Weight	80 kg
CSF_o	Oral Cancer Slope Factor	7.2E-01 $(mg/kg\text{-}d)^{-1}$
ED	Exposure Duration	10 y
EF	Exposure Frequency	20 d/y
ET	Exposure Time	4 hr/d
F	Fraction of Floor through which Contaminant Enters	1
H_i	Henry's Law Constant of i	2.8E-02 (atm-m^3/mol-K)
IR	Soil Incidental Ingestion Rate	330 mg/d
IR_w	Water Incidental Ingestion Rate	0.02 L/d
IUR	Inhalation Unit Risk	4.4E-06 $(\mu g/m^3)^{-1}$
$k_{G,H2O}$	Gas Phase Mass Transfer Coefficient of Water at 25° C	0.833 cm/s
K_i	Mass Transfer Coefficient	Calculated (cm/s)
k_{iG}	Gas Phase Mass Transfer Coefficient of i	Calculated (cm/s)
k_{iL}	Liquid Phase Mass Transfer Coefficient of i	Calculated (cm/s)
$k_{L,O2}$	Liquid Phase Mass Transfer Coefficient of Oxygen at 25° C	0.002 cm/s
MW_{H2O}	Molecular Weight of Water	18 g/mol
MW_i	Molecular Weight of i	62.5 g/mol
MW_{O2}	Molecular Weight of Oxygen	32 g/mol
PEF	Particulate Emission Factor	1.24E+09 m^3/kg
R	Ideal Gas Constant	8.2E-05 atm-m^3/mol-K
RBA	Relative bioavailability	1
T	Average System Absolute Temperature	298 K
TR	Target Cancer Risk	1.00E-06
V	Volume of the Trench	5.44 m^3
VF	Volatilization Factor	9.56E+02 (m^3/kg)
VF_{lt}	Volatilization Factor for Groundwater Less than or Equal to 15 Feet Deep	Calculated (L/m^3)