Figure: 30 TAC §350.75(b)(1)

Groundwater Ingestion PCL Equation: $^{GW}GW_{Ing}$
Exposure Pathway Description: Ingestion of groundwater Source Medium: Groundwater Exposure Medium: Groundwater $^{GW}GW_{Ing} = {}^{GW}RBEL_{Ing}$ *(See Eq. RBEL-4, Figure: 30 TAC §350.74(a))*
Class 3 Groundwater PCL Equation: $^{GW}GW_{Class\ 3}$
Exposure Pathway Description: Class 3 groundwater Source Medium: Class 3 groundwater Exposure Medium: Class 3 groundwater $^{GW}GW_{Class\ 3} = {}^{GW}RBEL_{Class\ 3}$ *(See Eq.RBEL-5, Figure: 30 TAC §350.74(a))*
Groundwater Volatilization PCL Equation: $^{Air}GW_{Inh-V}$
Exposure Pathway Description: Inhalation of volatiles from class 1, 2, or 3 groundwater Source Medium: Class 1, 2, or 3 groundwater Exposure Medium: Outdoor air $$^{Air}GW_{Inh-V} = {}^{Air}RBEL_{Inh-}\ (See\ Eq.\ RBEL-1,\ Figure:\ 30\ TAC\ §350.74(a))$$ VF_{Wamb} $$VF_{wamb}\left[\frac{mg/m^3 - air}{mg/L - H_2O}\right] = \frac{H'}{1 + \left[\dfrac{U_{air}\delta_{air}L_{gw}}{W_g D_{ws}^{eff}}\right]} \bullet \left[10^3\ \frac{L}{m^3}\right]$$ $$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = (h_{cap} + h_v)\left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}}\right]^{-1}$$ $$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\frac{\theta_{acap}^{3.33}}{\theta_T^2} + \left[\frac{D^{wat}}{H'}\right]\left[\frac{\theta_{wcap}^{3.33}}{\theta_T^2}\right]$$ $$D_s^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2} + \left[\frac{D^{wat}}{H'}\right]\left[\frac{\theta_{ws}^{3.33}}{\theta_T^2}\right]$$

	Groundwater-to-Surface Water PCL Equation: ^{SW}GW			
	Exposure Pathway Description: Discharge of class 1, 2, or 3 groundwater to surface water Source Medium: Class 1, 2, or 3 groundwater Exposure Medium: Surface water			

$$^{SW}GW = \frac{^{SW}SW}{DF}$$

(See Eq. RBEL-6, Figures: 30 TAC §350.74(a); and 30 TAC §350.75(i)(4))

Term	*COC Chemical/Physical and Affected Property Parameters Definition*	*Tier 1 Defaults*	*Change to Tier 1 Default Allowed?*	*Rule Citation Regarding Change*
ρ_b	Soil bulk density (g/cm^3)	1.67	Tier 2, 3	§350.75(c) and (d)
θ_{ws}	Volumetric water content of vadose zone soils (cm^3-water/cm^3-soil)	0.16	Tier 2, 3	§350.75(c) and (d)
θ_{as}	Volumetric air content of vadose zone soils (cm^3-air/cm^3-soil) = θ_T-θ_{ws}	0.21	Tier 2, 3	§350.75(c) and (d)
θ_T	Total soil porosity = 1 - (ρ_b/ρ_s) (cm^3-pore space/cm^3-soil)	0.37	Tier 2, 3	§350.75(c) and (d)
ρ_s	Particle density (g/cm^3)	2.65	Tier 2, 3	§350.75(c) and (d)
H′	Dimensionless Henry's Law Constant	(Figure: 30 TAC §350.73(f))	No	NA
H	Henry's Law Constant (atm-m^3/mole) (H=H′RT)	(Figure: 30 TAC §350.73(f))	No	NA
R	Universal Gas Constant (atm m^3 mol^{-1} °K^{-1})	8.206 x 10^{-5}	No	NA
T	Temperature (°K) = 273 + °C	293	No	NA
U_{air}	Windspeed above ground surface in ambient mixing zone (cm/s)	240	Tier 2, 3	§350.75(c) and (d)
δ_{air}	Ambient air mixing zone height (cm)	200	No	NA
L_{gw}	Depth to groundwater = h_{cap} + h_v (cm)	305	Tier 2, 3	§350.75(c) and (d)
D^{eff}_{ws}	Effective diffusivity above water table (cm^2/s)	COC and affected property specific	Tier 2, 3	§350.73(f) and §350.75(c) and (d)
D^{eff}_{cap}	Effective diffusivity in the capillary fringe (cm^2/s)	COC and affected property specific	Tier 2, 3	§350.73(f) and §350.75(c) and (d)

Term	COC Chemical/Physical and Affected Property Parameters Definition	Tier 1 Defaults	Change to Tier 1 Default Allowed?	Rule Citation Regarding Change
D^{eff}_s	Effective diffusivity in vadose zone soils (cm^2/s)	COC and affected property specific	Tier 2,3	§350.73(f) and §350.75(c) and (d)
h_{cap}	Thickness of capillary fringe (cm)	5	Tier 2, 3	§350.75(c) and (d)
h_v	Thickness of vadose zone (cm)	300	Tier 2, 3	§350.75(c) and (d)
W_g	Width of groundwater source in the direction to the closest off-site property line from the groundwater source (cm)			§350.75(c) and (d)
	• 0.5 acre source	4,500	Tier 2, 3	
	• 30 acre source	34,800	Tier 2, 3	
θ_{acap}	Volumetric air content of capillary fringe soils (cm^3-air/cm^3-soil)	0.037	Tier 2, 3	§350.75(c) and (d)
θ_{wcap}	Volumetric water content of capillary fringe soils (cm^3-water/cm^3-soil)	0.333	Tier 2, 3	§350.75(c) and (d)
D^{air}	Diffusion coefficient in air (cm^2/s)	(Figure: 30 TAC §350.73(f))	No	NA
D^{wat}	Diffusion coefficient in water (cm^2/s)	(Figure: 30 TAC §350.73(f))	No	NA
DF	Surface Water Dilution Factor	NA	Tier 2, 3	§350.75(i)(4)

Soil PCL Equation: $^{Tot}\text{Soil}_{Comb}$

Exposure Pathway Description: Combined equation for ingestion of surface soil + dermal contact with surface soil + inhalation of surface soil volatiles and particulates + consumption of garden vegetables grown in contaminated surface soil

Source Medium: Surface soils

Exposure Medium: Surface soil and air (and vegetables for residential land use only).

Residential

$$^{Tot}Soil_{Comb} = \cfrac{1}{[\cfrac{1}{^{Air}Soil_{Inh-VP}}]+[\cfrac{1}{^{Soil}Soil_{Derm}}]+[\cfrac{1}{^{Soil}Soil_{Ing}}]+\left[\left(\cfrac{1}{^{Veg}Soil_{Ing-Inorg}}\right)or\left(\cfrac{1}{^{Veg}Soil_{Ing-Org}}\right)\right]}$$

Commercial/Industrial Worker

$$^{Tot}Soil_{Comb} = \cfrac{1}{\left(\cfrac{1}{^{Air}Soil_{Inh-VP}}\right)+\left(\cfrac{1}{^{Soil}Soil_{Derm}}\right)+\left(\cfrac{1}{^{Soil}Soil_{Ing}}\right)}$$

Soil PCL Equation: $^{Air}\text{Soil}_{Inh-VP}$

Exposure Pathway Description: Inhalation of surface soil volatiles and particulates

Source Medium: Surface soils

Exposure Medium: Air

$$^{Air}Soil_{Inh-VP} = \frac{^{Air}RBEL_{Inh}}{VF_{ss} + PEF} \qquad \textit{(See Eq. RBEL-1, Figure: 30 TAC §350.74(a))}$$

Soil PCL Equation: $^{Soil}\text{Soil}_{Derm}$

Exposure Pathway Description: Dermal contact with surface soil

Source Medium: Surface soil

Exposure Medium: Surface soil

$$^{Soil}Soil_{Derm} = {}^{Soil}RBEL_{Derm} \qquad \textit{(See Eq. RBEL-2, Figure: 30 TAC §350.74(a))}$$

Exposure Pathway Description: Ingestion of surface soil

Source Medium: Surface soil

Exposure Medium: Surface soil

$$^{Soil}Soil_{Ing} = {}^{Soil}RBEL_{Ing} \qquad \textit{(See Eq. RBEL – 3, Figure: 30 TAC §350.74(a))}$$

Soil PCL Equation: $^{Veg}Soil_{Ing\text{-}Inorg}$, & $^{Veg}Soil_{Ing\text{-}Org}$
(for residential land use only).

Exposure Pathway Description: Consumption of garden vegetables grown in contaminated surface soil
Source Medium: Surface soil
Exposure Medium: Vegetables

$$^{Veg}Soil_{Ing-Inorg} = \frac{1}{\dfrac{Br_{abg}}{^{AbgVeg}RBEL_{Ing}} + \dfrac{Br_{bg}}{^{bgVeg}RBEL_{Ing}}} \quad \textit{(See Eq. RBEL – 7, Figure: 30 TAC §350.74(a))}$$

$$^{Veg}Soil_{Ing-Org} = \frac{\left(^{BgVeg}RBEL_{Ing}\right)\left(Ks_{Veg}\right)}{\left(RCF\right)\left(VG_{bg}\right)} \quad \textit{(See Eq. RBEL – 7, Figure: 30 TAC §350.74(a))}$$

Soil PCL Equation: $^{Air}Soil_{Inh\text{-}V}$

Exposure Pathway Description: Inhalation of subsurface soil volatiles
Source Medium: Subsurface soils
Exposure Medium: Air

$$^{Air}Soil_{Inh-V} = \frac{^{Air}RBEL_{Inh}}{VF_{ss}} \quad \textit{(See Eq. RBEL – 1, Figure: 30 TAC §350.74(a))}$$

Volatilization Factor: VF_{ss}

Where VF_{ss} is the smaller of the two following VF_{ss} values

$$VF_{ss}\left[\frac{mg/m^3 - air}{mg/kg - Soil}\right] = \frac{2\rho_b D_A}{(Q/C)\left[3.14 D_A^{\ \tau}\right]^{\frac{1}{2}}} \cdot \left(\frac{10^4 cm^2}{m^2}\right)$$

$$D_A = \left[\frac{\theta_{as}^{3.33} D^{air} H' + \theta_{ws}^{3.33} D^{wat}}{\left[\theta_{ws} + K_d \rho_b + \theta_{as} H'\right]\theta_T^2}\right]$$

or

$$VF_{ss}\left[\frac{mg/m^3 - air}{mg/kg - soil}\right] = \frac{\rho_b d_s}{(Q/C)\tau} \cdot \left(\frac{10^4 cm^2}{m^2}\right)$$

Particulate Emission Factor: PEF
$$PEF\left[\frac{mg/m^3 - air}{mg/kg - soil}\right] = \frac{(0.036)(1-V)\left(\dfrac{U_m}{U_1}\right)^3 F(x)}{(Q/C)(3600s/hr)}$$

Soil-to-Groundwater PCL Equation: ^{GW}Soil
Exposure Pathway Description: Soil leachate to groundwater Source Medium: Surface and subsurface soils Exposure Medium: Groundwater $$^{GW}Soil = \frac{\left(GroundwaterPCL^*\right) \cdot LDF}{K_{sw}}$$ $$K_{sw}\left[\frac{(mg/L - H_2O)}{(mg/kg - soil)}\right] = \frac{\rho_b}{\theta_{ws} + K_d\rho_b + H'\theta_{as}}$$ *Critical groundwater PCL as determined in accordance with §350.78 of this title (relating to Determination of Critical PCLs) or attenuation action level as determined in accordance with §350.33(f)(4)(D) of this title (relating to Remedy Standard B).
Theoretical Residual Soil Saturation Limit PCL (Soil$_{Res}$)
$$Soil_{Res}(mg/kg) = \left(\frac{Res.sat \times \theta_\tau \times p}{\rho_b}\right) \text{ x } 1{,}000{,}000 \text{ mg/kg}$$

Term	COC Chemical/Physical and Affected Property Parameters Definition	Tier 1 Defaults	Change to Tier 1 Default Allowed?	Rule Citation Regarding Change
Br_{Abg}	Soil-to-above ground plant biotransfer factor (g soil/g dry weight plant tissue)	(Figure: 30 TAC §350.73(f))	Tier 2, 3	§350.73(f)(2)
Br_{Bg}	Soil-to-below ground plant biotransfer factor (g soil/g dry weight plant tissue)	(Figure: 30 TAC §350.73(f))	Tier 2, 3	§350.73(f)(2)
RCF	Ratio of concentration in roots to concentration in soil pore water (mg/kg) (μg/ml)	$\dfrac{(10^{((0.77 \times \log K_{ow})-1.52)} + 0.82)}{0.222}$	Special Consideration	§350.73(f)
$\log K_{ow}$	Octanol-water partition coefficient	(Figure: 30 TAC §350.73(f))	Special Consideration	§350.73(f)
Ks_{Veg}	Soil-water partition coefficient (mL/g) = $K_{oc} \times f_{oc}$	chemical specific	Tier 2, 3	§350.73(f) and §350.75(c) and (d)
VG_{bg}	Below ground vegetable correction factor (unitless)	0.01	No	NA
D_A	Apparent diffusivity (cm^2/sec)	chemical specific	Tier 2, 3	§350.73(f) and §350.75(c) and (d)
ρ_b	Soil bulk density (g/cm^3)	1.67	Tier 2, 3	§350.75(c) and (d)
Q/C	Inverse of mean concentration in air at center of affected soil area ([g/m^2-s]/[kg/m^3])			§350.75(c) and (d)
	Default location assumed:	Houston	Tier 2, 3	
	• 0.5 acre source	79.25	Tier 2, 3	
	• 30 acre source	40.76	Tier 2, 3	
	Tier 2, 3 may estimate Q/C from the following equation for Houston: Q/C=-9.3087 ln (x) + 69.989, (where x = source area acreage), or other equation representative of Q/C for other city more representative of the affected property conditions and acceptable to the executive director (see USEPA Soil Screening Level Guidance: Technical Background Document, May 1996, EPA/540/R-95/128)			
τ	Exposure interval (s)	9.5×10^8	Tier 2, 3	§350.74(j)(2)
θ_{ws}	Volumetric water content of vadose zone soils (cm^3-water/cm^3-soil)	0.16	Tier 2, 3	§350.75(c) and (d)
θ_{as}	Volumetric air content of vadose zone soils (cm^3-air/cm^3-soil) = θ_T-θ_{ws}	0.21	Tier 2, 3	§350.75(c) and (d)
D^{air}	Diffusion coefficient in air (cm^2/s)	(Figure: 30 TAC §350.73(f))	No	NA

D^{wat}	Diffusion coefficient in water (cm^2/s)	(Figure: 30 TAC §350.73(f))	No	NA
H'	Dimensionless Henry's Law Constant	(Figure: 30 TAC §350.73(f))	No	NA
H	Henry's Law Constant (atm-m^3/mole) ($H = H'RT$)	(Figure: 30 TAC §350.73(f))	No	NA
K_d	Soil-water partition coefficient (cm^3-water/g-soil) • for organics • for inorganic	(Figure: 30 TAC §350.73(f)) $k_d = K_{oc} f_{oc}$ k_d = pH dependent value	Tier 2, 3	§350.73(f)and (Figures: 30 TAC §350.73(f)(1)(A), (B), (C))
K_{oc}	Soil organic carbon-water partition coefficient (cm^3-water/g-carbon)	(Figure: 30 TAC §350.73(f))	Tier 2, 3	§350.73(f)and (Figure: 30 TAC §350.73(f)(1)(B))
f_{oc}	Fraction of organic carbon in soil (g-carbon/g-soil) • VF_{ss} • Ks_{veg} • K_{sw}	0.008 0.008 0.002	Tier 2, 3 Tier 2, 3	§350.75(c) and (d) §350.75(c) and (d)
θ_T	Total soil porosity $= 1 - (\rho_b/\rho_s)$ (cm^3-pore space/cm^3-soil)	0.37	Tier 2, 3	§350.75(c) and (d)
ρ_s	Particle density (g/cm^3)	2.65	Tier 2, 3	§350.75(c) and (d)
d_s	Thickness of affected surficial soil (cm)	305	Tier 2, 3	§350.75(c) and (d)
V	Fraction vegetative cover (unitless)	0.5	Tier 2, 3	§350.75(c) and (d)
U_m	Mean annual windspeed at 7 m height (m/s)	4.8	Tier 2, 3	§350.75(c) and (d)
U_t	Equivalent threshold value of windspeed at 7 m height (m/s)	11.32	Tier 2, 3	§350.75(c) and (d)

Term	COC Chemical/Physical and Affected Property Parameters Definition	Tier 1 Defaults	Change to Tier 1 Default Allowed?	Rule Citation Regarding Change
F(x)	Function dependent on (U_t/U_m) derived using Cowherd et. al. (1985) (unitless)	0.224	Tier 2, 3	§350.75(c) and (d)
R	Universal Gas Constant (atm m^3 mol^{-1} ^{o}K^{-1})	8.206 x 10^{-5}	No	NA
T	Temperature (^{o}K) = 273 + $^\circ$C	293	No	NA
K$_{sw}$	Soil-leachate partition factor for COC (mg/L-water/mg/kg-soil)	property-specific	Tier 2, 3	§350.73(f)and §350.75(c) and (d)
LDF	Leachate Dilution Factor			
	0.5 acre source area	20	Tier 2, 3	§350.75(c) and (d)
	30 acre source area	10	Tier 2, 3	§350.75(c) and (d)
Res.sat	The residual saturation limit where the NAPL becomes mobile (cm^3/cm^3) Res.sat = $\dfrac{10{,}000 \text{ mg/kg x } \rho_b}{1{,}000{,}000 \text{ mg/kg x } p \text{ x } \theta_T}$	0.04514	Tier 2, 3	§350.75(c) and (d)
p	The density of the NAPL (g/cm^3)	1	Tier 2, 3	§350.75(c) and (d)

Air Source Medium Exposure Pathway PCL Equation
PCL Eq.:^{Air}Air$_{Inh}$ Exposure Pathway Description: Inhalation of air   Source Medium: Air   Exposure Medium: Air $$^{Air}Air_{Inh} = {}^{Air}RBEL_{Inh}$$ *(See Eq. RBEL-1, Figure: 30 TAC §350.74(a))*

Surface Water Exposure Pathway PCL Equation
PCL Eq.:^{SW}SW Exposure Pathway Description: Aquatic life and human health protection (^{SW}RBEL) and ecological protection (^{SW}SW$_{Eco}$) Source Medium: Surface water Exposure Medium: Surface water $$^{SW}SW = \textit{the lesser of } {}^{SW}RBEL \textit{ and } {}^{SW}SW_{ECO}$$ (see RBEL-6, Figure 30 TAC §350.74(a), §350.74(h), and §350.77(a))