ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF SPILL PREVENTION AND RESPONSE
CONTAMINATED SITES PROGRAM

CLEANUP LEVELS GUIDANCE

June 9, 2008

TABLE OF CONTENTS

Soil and Groundwater Cleanup Standards Equations and Exposure Assumptions

Standardized default exposure parameters developed by the United States Environmental Protection Agency (EPA) were used except for exposure frequency. Conservative representative Alaskan-specific soil parameters were also developed. Under method three of 18 AAC 75.340(e), site specific parameters that may be modified are bolded in the parameter/definitions section which follows each equation. If a site-specific dry soil bulk density will be used, then the total porosity, air-filled porosity, and water-filled porosity must be calculated using the appropriate equation listed under the default section which follows each equation.

Equation 14 is informational; a standard default mixing zone depth has been adopted by the department for application to Table B1 contaminants. This value cannot be modified.

Migration to groundwater cleanup levels for Table B1 contaminants apply statewide, rather than by climate zones, unless the responsible person documents that the migration to groundwater exposure pathway is inapplicable. This will generally be the case for Arctic zone sites, but may also apply elsewhere in the state.

Equations applicable to the Petroleum Fractions in Table B2 are presented separately. While the department is in the process of evaluating current scientific petroleum data and alternate models, use equations 15 - 22 for petroleum fractions only.

For an in-depth discussion of the equations and representative EPA parameter defaults, refer to:

- "*Soil Screening Guidance*," 61 Federal Register 27349, May 31, 1996;
- "*Technical Background Document for Soil Screening Guidance*," 9355.4-17A, PB96-963502, EPA/540/R-95/128, May 1996;
- "*Soil Screening Guidance: User's Guide*," 9355.4-23, PB96-963505, EPA/540/R-96/018, April 1996;
- "*Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites*," OSWER 9355.4-24, December 2002;
- "*Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*," EPA/540/R/99/005, OSWER 9285.7-02EP, PB99-963312, July 2004.
- "*Exposure Factors Handbook*," EPA/600/P-95/002Fa, August 1997; and
- "*Child Specific Exposure Factors Handbook (Interim Report)*", EPA/600/P-00/002B, September 2002 Interim Report.

These documents can be obtained from EPA's Office of Research and Development, Washington, DC 20460.

Equation 1. **Table C: Groundwater Cleanup Level Equation for Non-Carcinogenic Contaminants**

$$\text{Cleanup Level (mg/L)} = \frac{\text{THQ x } RfD_o \text{ x BW x AT x 365 d/yr}}{\text{IR x EF x ED x A}}$$

Parameter/Definition (units)	**Default**
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	70
AT/averaging time (yr)	30
RfD_o/oral reference dose (mg/kg-d)	Chemical-specific (See Table 2)
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
IR/ ingestion rate (L/d)	2
A/absorption factor	1

For non-carcinogens, averaging time is equal to exposure duration.

Equation 2. **Table C: Groundwater Cleanup Level Equation for Carcinogenic Contaminants**

$$\text{Cleanup Level (mg/L)} = \frac{\text{TR x BW x AT x 365 d/yr}}{Sf_o \text{ x IR x EF x ED x A}}$$

Parameter/Definition (units)	**Default**
TR/target cancer risk (unitless)	10^{-5}
BW/body weight (kg)	70
AT/averaging time (yr)	70
Sf_o/oral slope factor $(mg/kg\text{-}d)^{-1}$	Chemical-specific (See Table 2)
IR/ ingestion rate (L/d)	2
EF/exposure frequency (d/yr)	350
ED/ exposure duration (yr)	30
A/absorption factor	1

Equation 3. **Table B1: Soil Cleanup Level Equation for Direct Contact of Non-Carcinogenic Contaminants in Residential Soil**

$$\text{Cleanup Level (mg/kg)} = \frac{THQ \times BW \times AT \times 365\ d/yr}{EF \times ED \times [(1/RfD_o \times 10^{-6}\ kg/mg \times IR) + (1/RfD_d \times SA_c \times AF_c \times ABS \times 10^{-6}\ kg/mg)]}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	15
AT/averaging time (yr)	6[a]
EF/exposure frequency (d/yr)	Arctic Zone = 200 d/yr Under 40 Inch Zone = 270 d/yr Over 40 Inch Zone = 330 d/yr
ED/exposure duration (yr)	6
RfD_o/oral reference dose (mg/kg-d)	Chemical specific (See Table 2)
RfD_d/dermal reference dose (mg/kg-d)	Chemical specific (See Table 2)
IR/soil ingestion rate (mg/d)	200
SA_c/surface area child (cm^2/day)	2800
AF_c/adherence factor child (mg/cm^2)	0.2 mg/cm^2
ABS/ absorption factor	Chemical specific (See Table 2)

[a] For non-carcinogens, averaging time is equal to exposure duration. Cleanup levels are calculated for 6-year childhood exposure.

Equation 4. **Table B1: Soil Cleanup Level Equation for Direct Contact of Carcinogenic Contaminants in Residential Soil**

$$\text{Cleanup Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{EF \times [(SF_o \times 10^{-6}\ kg/mg \times IF_{soil/adj}) + (SFS \times ABS \times SF_d \times 10^{-6}\ kg/mg)]}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-5}
AT/averaging time (yr)	70
SF_o/oral slope factor $(mg/kg\text{-}d)^{-1}$	Chemical-specific (See Table 2)
SF_d/dermal slope factor $(mg/kg\text{-}d)^{-1}$	Chemical-specific (See Table 2)
EF/exposure frequency (d/yr)	Arctic Zone = 200 d/yr Under 40 Inch Zone = 270 d/yr Over 40 Inch Zone = 330 d/yr
$IF_{soil/adj}$/age-adjusted soil ingestion factor (mg-yr/kg-d)	114 (See Equation 6 below)
ABS/absorption factor	Chemical-specific (See Table 2)
SFS/soil dermal factor (mg-y/kg-d)	361

Equation 5. **Table B1: Soil Dermal Factor Equation for Carcinogens**

$$SFS\ (mg\text{-}y/kg\text{-}d) = \frac{ED_c \times AF_c \times SA_c}{BW_c} + \frac{(ED_a - ED_c) \times AF_a \times SA_a}{BW_a}$$

Parameter/Definition (units)	Default
ED_c/exposure duration child (years)	6
AF_c/adherence factor child (mg/cm^2)	0.2
SA_c/surface are child (cm^2/day)	2800
BW_c/body weight child (kg)	15
ED_a/exposure duration adult (years)	30
AF_a/adherence factor adult (mg/cm^2)	0.07
SA_a/surface area adult (cm^2/day)	5700
BW_a/body weight adult (kg)	70

Equation 6. **Table B1: Derivation of Age Adjusted Soil Ingestion Factor**

$$IF_{soil/adj}(mg - yr/kg - d) = \frac{IR_{soil/age\ 1-6} \times ED_{age\ 1-6}}{BW_{age\ 1-6}} + \frac{IR_{soil/age\ 7-31} \times ED_{age\ 7-31}}{BW_{age\ 7-31}}$$

Parameter/Definition (units)	Default
$IF_{soil/adj}$/age adjusted soil ingestion factor (mg-yr/kg-d)	114
$IR_{soil/age\ 1-6}$/ingestion rate of soil age 1 - 6 (mg/d)	200
$ED_{age\ 1-6}$/exposure duration during ages 1 - 6 (yr)	6
$IR_{soil/age\ 7-31}$/ingestion rate of soil age 7 - 31(mg/d)	100
$ED_{age\ 7-31}$/exposure duration during ages 7 - 31 (yr)	24
$BW_{age\ 1-6}$/average body weight from ages 1 - 6 (kg)	15
$BW_{age\ 7-31}$/average body weight from ages 7 - 31 (kg)	70

Equation 7. **Table B1: Soil Cleanup Level Equation for Direct Inhalation of Carcinogenic Volatile Contaminants in Soil**

$$Cleanup\ Level\ (mg/kg) = \frac{TR \times AT \times 365\ d/yr}{URF \times EF \times ED \times [\ 1/VF]}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-5}
AT/averaging time (yr)	70
URF/inhalation unit risk factor $(mg/m^3)^{-1}$	Chemical-specific (See Table 2)
EF/exposure frequency (d/yr)	Arctic Zone = 200 d/yr Under 40 Inch Zone = 270 d/yr Over 40 Inch Zone = 330 d/yr
ED/exposure duration (yr)	30
VF/soil-to-air volatilization factor (m^3/kg)	Chemical specific (see equation 9 below)

Equation 8. **Table B1: Soil Cleanup Level Equation for Direct Inhalation of Non-Carcinogenic Contaminants in Soil**

$$\text{Cleanup Level (mg/kg)} = \frac{\text{THQ x AT x 365 d/yr}}{\text{EF x ED x [(1/RfC) x (1/VF)]}}$$

Parameter/Definition (units)	**Default**
THQ/target hazard quotient (unitless)	1
AT/averaging time (yr)	30
EF/exposure frequency (d/yr)	Arctic Zone = 200 d/yr Under 40 Inch Zone = 270 d/yr Over 40 Inch Zone = 330 d/yr
ED/exposure duration (yr)	30
RfC/inhalation reference concentration (mg/m^3)	Chemical-specific (See Table 2)
VF/soil-to-air volatilization factor (m^3/kg)	Chemical-specific (See Equation 9)

Equation 9. **Table B1: Derivation of the Volatilization Factor**

$$VF\ (m^3/kg) = \frac{Q/C \times (3.14 \times D_A \times T)^{1/2} \times 10^{-4} m^2/cm^2}{(2 \times \rho_b \times D_A)}$$

where

$$D_A = \frac{[(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter/Definition (units)	**Default**
VF/volatilization factor (m^3/kg)	---
Q/C/inverse of the mean conc. at the center of a 0.5 acre square source (g/m^2-s per kg/m^3)	Arctic Zone = 100.13 Under 40 Inch Zone = 90.80 Over 40 Inch Zone = 82.72
T/exposure interval (s)	9.5×10^8 s
ρ_b/dry soil bulk density (g/cm^3)	1.5
ρ_s/soil particle density (g/cm^3)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or 1 - (ρ_b/ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.15 or $w\rho_b$
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.284 or n - $w\rho_b$
D_i/diffusivity in air (cm^2/s)	Chemical-specific (See Table 2)
H'/ dimensionless Henry's law constant	Chemical-specific (See Table 2)
w/average soil moisture content $kg_{water}/kg_{soil\text{-}dry}$	0.1 (10%)
D_w/diffusivity in water (cm^2/s)	Chemical-specific (See Table 2)
K_d/soil-water partition coefficient (cm^3/g)	K_{oc} x f_{oc} (organics)
K_{oc}/organic carbon partition coefficient (cm^3/g)	Chemical-specific (See Table 2)
f_{oc}/organic carbon content of soil (g/g)	0.001 (0.1%)

Equation 10. Table B1: Derivation of the Soil Saturation Limit

Note = The Soil Saturation Limit will be used as an upper limit for volatiles for the Inhalation Pathway Calculations.

$$C_{sat}\ (mg/kg) = \frac{S}{\rho_b}\ (K_d\ \rho_b + \theta_w + H'\theta_a)$$

Parameter/Definition (units)	**Default**
C_{sat}/soil saturation concentration (mg/kg)	---
S/solubility in water (mg/L-water)	Chemical-specific (See Table 2)
ρ_b/dry soil bulk density (kg/L)	1.5
ρ_s/soil particle density (kg/L)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or 1 - (ρ_b / ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.15 or wρ_b
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.284 or n - wρ_b
K_d/soil-water partition coefficient (L/kg)	K_{oc} x f_{oc}
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	Chemical-specific (See Table 2)
f_{oc}/fraction organic carbon of soil (g/g)	0.001 (0.1%)
w/average soil moisture content $kg_{water}/kg_{soil\text{-}dry}$	0.1 (10%)
H'/Henry's law constant (unitless)	Chemical-specific (See Table 2)

Equation 11. Table B1: Inorganic Contaminants-- Soil-Water Partitioning Equation for Migration to Groundwater

Note = Values are pH dependant and are calculated for a pH of 6.8. As pH deviates from 6.8, K_d/soil-water partition coefficient (L/kg) varies and must be adjusted according to Part 5 of EPA's Soil Screening Levels Guidance in Reference 1 for a site specific soil cleanup value.

$$\text{Soil cleanup level}\ (mg/kg) = C_w\ \{ K_d + ((\theta_w + \theta_a H')/ \rho_b) \}$$

Parameter/Definition (units)	**Default**
C_w/target soil leachate concentration (mg/L)	Groundwater Cleanup Level x DAF; DAF is the dilution attenuation factor, **DAF** = DF x **AF**.
K_d/soil-water partition coefficient (L/kg)	Chemical-specific (See Table 2)
ρ_b/dry soil bulk density (kg/L)	1.5
ρ_s/soil particle density (kg/L)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or (1 - ρ_b/ρ_s)
θ_w/water-filled soil porosity	0.3 (30%) or wρ_b
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.13 or n - wρ_b
H'/Henry's law constant (unitless)	Chemical specific (assume to be zero for inorganic contaminants except mercury) (See Table 2)
w/average soil moisture content $kg_{water}/kg_{soil\text{-}dry}$	0.2 (20%)

The standard default attenuation factor (AF) is AF = 4. The AF may be modified on a chemical-specific basis. The standard default dilution attenuation factor (DAF) used to determine the cleanup standards is DAF (DF x AF) = 13.2.

Equation 12. Table B1: Organic Contaminants-- Soil-Water Partitioning Equation for Migration to Groundwater

Note: For ionizing organics, the cleanup standards are pH dependant. As site pH deviates from 6.8, K_{oc} should be modified according to Part 5 of EPA's Soil Screening Levels Guidance in referenced in footnote 1, below, and the soil cleanup values must be recalculated for the site.

Soil cleanup level (mg/kg) = $C_w \{(K_{oc} f_{oc}) + ((\theta_w + \theta_a H')/ \rho_b)\}$

Parameter/Definition (units)	**Default**
C_w/target soil leachate concentration (mg/L)	Groundwater Cleanup Level x DAF; DAF is the dilution attenuation factor, **DAF** = DF x **AF.**
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	Chemical-specific and pH dependant (See Table 2)
f_{oc}/fraction organic carbon in soil (g/g)	0.001 (0.1%)
ρ_b/dry soil bulk density (kg/L)	1.5
ρ_s/soil particle density (kg/L)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or (1 - ρ_b/ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.3 (30%) or $w\rho_b$
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.13 or n -$w\rho_b$
w/average soil moisture content $kg_{water}/kg_{soil\text{-}dry}$	0.2 (20%)
H'/Henry's law constant (unitless)	Chemical Specific (See Table 2)

The standard default attenuation factor (AF) used to determine the cleanup standards is: AF = 4. The AF may be modified on a chemical-specific basis. The standard default dilution attenuation factor (DAF) used to determine the cleanup standards is: DAF (DF x AF) = 13.2.

Equation 13. Table B1: Derivation of Dilution Factor

$$DF = 1 + (Kid /IL)$$

Parameter/Definition (units)	**Default**
DF/dilution factor (unitless)	---
K/aquifer hydraulic conductivity (m/yr)	876 m/yr
i/hydraulic gradient (m/m)	0.002 m/m
d/mixing zone depth (m)	5.5 m (See Equation 14 below)
I/infiltration rate (m/yr)	0.13 m/yr
L/source length parallel to groundwater flow (m)	32 m

The standard default dilution factor used to determine the cleanup standards is DF = 3.3

Equation 14. **Table B1: Estimation of Mixing Zone Depth**

$$d = (0.0112L^2)^{0.5} + d_a \{1 - \exp[(-LI)/(Kid_a)]\}$$

Parameter/Definition (units)	**Default**
d/mixing zone depth (m)	---
L/source length parallel to groundwater flow (m)	32 m
I/infiltration rate (m/yr**)**	0.13 m/yr
K/aquifer hydraulic conductivity (m/yr)	876 m/yr
i/hydraulic gradient (m/m)	0.002
d_a/aquifer thickness (m)	10 m

The standard default mixing zone depth used to determine the cleanup standards is: d = 5.5 m. This is a fixed value and cannot be modified site-specifically.

Table 1 - Commercial/Industrial Exposure Parameters		
Parameters[1]	**Definition (units)**	**Value**
AT	averaging time for carcinogens (years)	70 (unchanged from residential)
AT	averaging time for non-carcinogens (years)	25
BW	body weight (kg)	70
ED	exposure duration (years)	25
EF	exposure frequency (days/years)	250
IR_{soil}	soil ingestion rate (mg/day)	50
SA	Surface Area	3300 cm^2
AF	Adherence Factors	0.2 mg/cm^2

[1] These parameters may be modified under 18 AAC 75.340(e)(3) using the equations in this guidance document.

For additional guidance on the equations for and calculation of commercial/industrial cleanup levels, reference the EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (OSWER 9355.4-24, December 2002)

Table 2 - Chemical Specific Parameters – Carcinogenic and Non-Carcinogenic

CAS Number	HAZARDOUS SUBSTANCE (Carcinogenics in Bold Type)	Oral SFo $(mg/kg\text{-}d)^{-1}$	Oral RfDo (mg/kg-d)	Oral URF $(mg/L)^{-1}$	Inhalation SFi $(mg/Kg\text{-}d)^{-1}$	Inhalation RfDi (mg/kg-d)	Inhalation RfC (mg/m^3)	Inhalation URF $(mg/m^3)^{-1}$	ABS Factor (Unitless)	Dermal Slope Factor $(mg/Kg\text{-}d)^{-1}$	Dermal RfD (mg/kg-d)	K_{oc} (L/kg)	Di, air (cm^2/s)	Di, water (cm^2/s)	Solubility (mg/L)	H' unitless
355-72-782	2-Amino-4,6-dinitrotoluene		2.00E-04						0.006		1.00E-04	100.5			1223	6.62E-09
194-06-510	4-Amino-2,6-dinitrotoluene		2.00E-04						0.009		1.00E-04	100.5			1223	6.61E-09
83-32-9	Acenaphthene		6.00E-02						0.130		1.86E-02	6123	0.0421	7.69E-06	3.9	0.00744
208-96-8	Acenaphthylene		6.00E-02						0.130		1.86E-02	6123	0.0438669	7.53E-06	16.1	0.00511
67-64-1	Acetone		9.00E-01				3.15E+00		0.000		7.47E-01	1.981	0.124	1.14E-05	1000000	0.00162
309-00-2	**Aldrin**	1.70E+01	3.00E-05	4.90E-01	1.72E+01			4.90E+00	0.100	3.40E+01	1.50E-05	106000	0.0132	4.86E-06	0.017	0.0018
120-12-7	Anthracene		3.00E-01						0.130		2.28E-01	20400	0.0324	7.74E-06	0.0434	0.00227
71-43-2	**Benzene**	5.50E-02	4.00E-03	1.60E-03	2.73E-02	8.57E-03	3.00E-02	7.80E-03	0.000	5.67E-02	3.88E-03	165.5	0.088	9.80E-06	1790	0.227
56-55-3	**Benzo(a)anthracene**	7.30E-01			3.08E-01			8.80E-02	0.130	2.35E+00		231000	0.051	9.00E-06	0.0094	0.000491
205-99-2	**Benzo(b)fluoranthene**	7.30E-01			3.08E-01			8.80E-02	0.130	2.35E+00		803000	0.0226	5.56E-06	0.0015	0.0000269
207-08-9	**Benzo(k)fluoranthene**	7.30E-02			3.08E-02			8.80E-03	0.130	2.35E-01		787000	0.0226	5.56E-06	0.0008	0.0000239
65-85-0	Benzoic acid*		4.00E+00						0.100		4.00E+00	14.49	0.0536	7.97E-06	3400	0.00000156
191-24-2	Benzo(g,h,i)perylene		3.00E-02						0.130		9.30E-03	2680000	0.0272	7.24E-06	0.00026	0.0000135
50-32-8	**Benzo(a)pyrene**	7.30E+00		2.10E-01	3.08E+00			8.80E-01	0.130	2.35E+01		787000	0.043	9.00E-06	0.00162	0.0000187
111-44-4	**Bis(2-chloroethyl)ether**	1.10E+00		3.30E-02	1.16E+00			3.30E-01	0.000	2.20E+00		14.95	0.0692	7.53E-06	17200	0.000695
117-81-7	**Bis(2-ethylhexyl)phthalate**	1.40E-02	2.00E-02	4.00E-04					0.100	7.37E-02	3.80E-03	165000	0.0351	3.66E-06	0.27	0.000011
75-27-4	**Bromodichloromethane**	6.20E-02	2.00E-02	1.80E-03				1.77E-02	0.000	6.33E-02	1.96E-02	35.04	0.0298	1.06E-05	3030	0.0867
75-25-2	**Bromoform**	7.90E-03	2.00E-02	2.30E-04	3.85E-03			1.10E-03	0.000	1.32E-02	1.20E-02	35.04	0.0149	1.03E-05	3100	0.0219
71-36-3	Butanol		1.00E-01						0.100		5.00E-02	2.443	0.08	9.30E-06	63200	0.00036
104-51-8	n-Butylbenzene		1.00E-02				3.50E-02		0.000			2830	0.075	7.80E-06	13.8	0.5371
135-98-8	sec-Butylbenzene		1.00E-02				3.50E-02		0.000			2150	0.075	7.80E-06	17	0.7667
98-06-6	tert-Butylbenzene		1.00E-02				3.50E-02		0.000			2150	0.075	7.80E-06	30	0.5166
85-68-7	**Butyl benzyl phthalate**	1.90E-03	2.00E-01						0.100	3.11E-03	1.22E-01	9359	0.0174	4.83E-06	2.69	0.0000515
86-74-8	**Carbazole**	2.00E-02		5.70E-04					0.100	2.86E-02		11300	0.039	7.03E-06	1.8	0.0000209
75-15-0	Carbon disulfide		1.00E-01			2.00E-01	7.00E-01		0.250		6.30E-02	1	0.104	1.00E-05	1180	0.589
56-23-5	**Carbon tetrachloride**	1.30E-01	7.00E-04	3.70E-03	5.25E-02			1.50E-02	0.000	2.00E-01	4.55E-04	48.64	0.078	8.80E-06	793	1.13
57-74-9	**Chlordane**	3.50E-01	5.00E-04	1.00E-02	3.50E-01	2.00E-04	7.00E-04	1.00E-01	0.040	7.00E-01	2.50E-04	86700	0.0118	4.37E-06	0.056	0.00199
106-47-8	**p-Chloroaniline**	5.40E-02	4.00E-03						0.100	1.08E-01	2.00E-03	72.53	0.0483	1.01E-05	3900	0.0000474

CAS Number	HAZARDOUS SUBSTANCE (Carcinogenics in Bold Type)	Oral SFo $(mg/kg\text{-}d)^{-1}$	Oral RfDo (mg/kg-d)	Oral URF $(mg/L)^{-1}$	Inhalation SFi $(mg/Kg\text{-}d)^{-1}$	Inhalation RfDi (mg/kg-d)	Inhalation RfC (mg/m^3)	Inhalation URF $(mg/m^3)^{-1}$	ABS Factor (Unitless)	Dermal Slope Factor $(mg/Kg\text{-}d)^{-1}$	Dermal RfD (mg/kg-d)	K_{oc} (L/kg)	Di, air (cm^2/s)	Di, water (cm^2/s)	Solubility (mg/L)	H' unitless
108-90-7	Chlorobenzene		2.00E-02			1.43E-02	5.00E-02		0.000		6.20E-03	268	0.073	8.70E-06	498	0.127
124-48-1	**Chlorodibromomethane (Dibromochloromethane)**	8.40E-02	2.00E-02	2.40E-03				2.40E-02	0.000	1.40E-01	1.20E-02	35.04	0.0196	1.05E-05	2700	0.032
75-00-3	**Chloroethane**	2.90E-03	4.00E-01			2.86E+00	1.00E+01	8.29E-04	0.000	3.63E-03	3.20E-01	23.74	0.271	1.15E-05	6710	0.454
67-66-3	**Chloroform**	6.10E-03	1.00E-02	1.70E-04	8.05E-02			2.30E-02	0.000	3.05E-02	2.00E-03	35.04	0.104	1.00E-05	7950	0.15
91-58-7	2-Chloronaphthalene		8.00E-02						0.130		4.00E-02	2976	0.0347	8.79E-06	11.7	0.0131
95-57-8	2-Chlorophenol*		5.00E-03				1.75E-02		0.000		2.50E-03	443.1	0.0501	9.46E-06	28500	0.000458
218-01-9	**Chrysene**	7.30E-03			3.08E-03			8.80E-04	0.130	2.35E-02		236000	0.0248	6.21E-06	0.002	0.000214
72-54-8	**DDD**	2.40E-01	2.00E-03	6.90E-03					0.030	3.43E-01	1.40E-03	153000	0.0169	4.76E-06	0.09	0.00027
72-55-9	**DDE**	3.40E-01		9.70E-03					0.030	4.86E-01		153000	0.0144	5.87E-06	0.04	0.0017
50-29-3	**DDT**	3.40E-01	5.00E-04	9.70E-03	3.40E-01			9.70E-02	0.030	4.86E-01	3.50E-04	220000	0.0137	4.95E-06	0.0055	0.00034
53-70-3	**Dibenzo(a,h)anthracene**	7.30E+00			3.08E+00			8.80E-01	0.130	2.35E+01		2620000	0.0202	5.18E-06	0.00103	0.00000503
132-64-9	Dibenzofuran		2.00E-03						0.000		1.60E-03	11300	6.00E-02	1.00E-05	3.1	0.00871
84-74-2	Di-n-butyl phthalate		1.00E-01						0.100		1.00E-01	1460	0.0438	7.86E-06	11.2	0.000074
117-84-0	Di-n-octyl phthalate		4.00E-02						0.100		3.60E-02	196000	0.0151	3.58E-06	0.02	0.000105
94-75-7	2,4-Dichlorophenoxyacetic acid (2,4-D)		1.00E-02						0.050		8.00E-03	29.41	0.0231	7.31E-06	677	0.00000145
95-50-1	1,2-Dichlorobenzene		9.00E-02			5.71E-02	2.00E-01		0.000		7.20E-02	443.1	0.069	7.90E-06	80	0.0785
541-73-1	1,3-Dichlorobenzene		9.00E-02			5.71E-02	2.00E-01		0.000		7.20E-02	434	0.069	7.90E-06	125	0.108
106-46-7	**1,4-Dichlorobenzene**	2.40E-02		6.80E-04		2.29E-01	8.00E-01	6.86E-03	0.000	2.67E-02		434	0.069	7.90E-06	81.3	0.0985
91-94-1	**3,3-Dichlorobenzidine**	4.50E-01		1.30E-02					0.100	9.00E-01		7489	0.0194	6.74E-06	3.1	2.09E-09
75-71-8	Dichlorodifluoromethane		2.00E-01			5.71E-02	2.00E-01		0.000		4.60E-02	48.64	0.052	1.05E-05	280	14
75-34-3	1,1-Dichloroethane		2.00E-01			1.43E-01	5.00E-01		0.000		2.00E-01	35.04	0.0742	1.05E-05	5040	0.23
107-06-2	**1,2-Dichloroethane**	9.10E-02	2.00E-02	2.60E-03	9.10E-02			2.60E-02	0.000	9.10E-02	2.00E-02	43.79	0.104	9.90E-06	5100	0.0482
75-35-4	**1,1-Dichloroethylene**	6.00E-01	5.00E-02	1.70E-02	1.75E-01	5.71E-02	2.00E-01	5.00E-02	0.000	6.00E-01	5.00E-02	35.04	0.09	1.04E-05	2420	1.07
156-59-2	cis-1,2-Dichloroethylene		1.00E-02				3.50E-02		0.000		1.00E-02	43.79	0.0736	1.13E-05	3500	0.167
156-60-5	trans-1,2-Dichloroethylene		2.00E-02			1.71E-02	6.00E-02		0.000		2.00E-02	43.79	0.0707	1.19E-05	3500	0.383
120-83-2	2,4-Dichlorophenol*		3.00E-03						0.100		2.46E-03	717.6	0.0346	8.77E-06	4500	0.0000895
78-87-5	**1,2-Dichloropropane**	6.80E-02		1.90E-03		1.14E-03	4.00E-03	1.94E-02	0.000	9.19E-02		67.7	0.0782	8.73E-06	2800	0.115
542-75-6	**1,3-Dichloropropene**	1.00E-01	3.00E-02	3.00E-03	1.40E-02	5.71E-03	2.00E-02	4.00E-03	0.000	1.82E-01	1.65E-02	80.77	0.0626	1.00E-05	2800	0.145
60-57-1	**Dieldrin**	1.60E+01	5.00E-05	4.60E-01	1.61E+01			4.60E+00	0.100	3.20E+01	2.50E-05	10600	0.0125	4.74E-06	0.25	0.000409
84-66-2	Diethyl phthalate		8.00E-01						0.100		7.20E-01	126.2	0.0256	6.35E-06	1080	0.0000249
105-67-9	2,4-Dimethylphenol		2.00E-02						0.100		1.00E-02	717.6	0.0584	8.69E-06	7870	0.0000389

CAS Number	HAZARDOUS SUBSTANCE (Carcinogenics in Bold Type)	Oral SFo $(mg/kg\text{-}d)^{-1}$	Oral RfDo (mg/kg-d)	Oral URF $(mg/L)^{-1}$	Inhalation SFi $(mg/Kg\text{-}d)^{-1}$	Inhalation RfDi (mg/kg-d)	Inhalation RfC (mg/m^3)	Inhalation URF $(mg/m^3)^{-1}$	ABS Factor (Unitless)	Dermal Slope Factor $(mg/Kg\text{-}d)^{-1}$	Dermal RfD (mg/kg-d)	K_{oc} (L/kg)	Di, air (cm^2/s)	Di, water (cm^2/s)	Solubility (mg/L)	H' unitless
131-11-3	Dimethyl phthalate		1.00E+01						0.100		9.00E+00	37.09	0.0568	6.29E-06	4000	0.00000429
528-29-0	1,2-Dinitrobenzene		1.00E-04						0.100		9.30E-05	224.6			500	0.0000151
99-65-0	1,3-Dinitrobenzene		1.00E-04						0.100		6.50E-05	220.1	0.279	7.64E-06	533	2.00E-06
100-25-4	1,4-Dinitrobenzene		1.00E-04						0.100		5.00E-05	220.1			69	0.0000151
51-28-5	2,4-Dinitrophenol*		2.00E-03						0.100		2.00E-03	363.8	0.0273	9.06E-06	2790	3.52E-06
121-14-2	**2,4-Dinitrotoluene**	6.80E-01	2.00E-03	1.90E-02					0.102	8.00E-01	1.70E-03	363.8	0.203	7.06E-06	270	0.00000221
606-20-2	**2,6-Dinitrotoluene**	6.80E-01	1.00E-03	1.90E-02					0.099	8.00E-01	8.50E-04	371.4	0.0327	7.26E-06	352.4	0.0000305
123-91-1	**1,4-Dioxane**	1.10E-02		3.10E-04					0.100	1.38E-02		1	0.229	1.02E-05	1000000	0.000196
1746-01-6	**2,3,7,8-TCDD (Dioxin)**	1.50E+05		4.50E+03	1.16E+05			3.30E+04	0.030	3.00E+05		146000	0.0142708	5.83E-06	0.0002	0.00204
122-39-4	Diphenylamine		2.50E-02						0.100		1.25E-02	1887			53	0.000139
115-29-7	Endosulfan		6.00E-03						0.000		3.00E-03	22000	0.0115	4.55E-06	0.45	0.00266
72-20-8	Endrin		3.00E-04						0.100		6.00E-06	10600	0.0125	4.74E-06	0.25	0.00026
100-41-4	**Ethylbenzene**		1.00E-01		3.85E-03	2.86E-01	1.00E+00	1.10E-03	0.000		9.70E-02	517.8	0.075	7.80E-06	169	0.322
106-93-4	**Ethylene dibromide (1,2-Dibromomethane)**	2.00E+00	9.00E-03	6.00E-02	2.10E+00	2.57E-03	9.00E-03	6.00E-01	0.000	2.50E+00	7.20E-03	43.79	0.0217	1.19E-05	3910	0.0273
107-21-1	Ethylene glycol		2.00E+00						0.100		1.00E+00	1	0.108	1.22E-05	1000000	0.00000245
206-44-0	Fluoranthene		4.00E-02						0.130		1.24E-02	70900	0.0302	6.35E-06	0.26	0.000362
86-73-7	Fluorene		4.00E-02						0.130		2.00E-02	11300	0.0363	7.88E-06	1.89	0.00393
76-44-8	**Heptachlor**	4.50E+00	5.00E-04	1.30E-01	4.55E+00			1.30E+00	0.100	6.25E+00	3.60E-04	52400	0.0112	5.69E-06	0.18	0.012
1024-57-3	**Heptachlor epoxide**	9.10E+00	1.30E-05	2.60E-01	9.10E+00			2.60E+00	0.100	1.26E+01	9.36E-06	5260	0.0132	4.23E-06	0.2	0.000859
118-74-1	**Hexachlorobenzene**	1.60E+00	8.00E-04	4.60E-02	1.61E+00			4.60E-01	0.100	3.20E+00	4.00E-04	3380	0.0542	5.91E-06	0.0062	0.0695
87-68-3	**Hexachloro-1,3-butadiene**	7.80E-02	2.00E-04	2.20E-03	7.70E-02			2.20E-02	0.100	1.56E-01	1.00E-04	993.5	0.0561	6.16E-06	3.2	0.421
319-84-6	**alpha-Hexachlorocyclohexane**	6.30E+00		1.80E-01	6.30E+00			1.80E+00	0.040	6.49E+00		3380	0.0142	7.34E-06	8	0.000499
319-85-7	**beta-Hexachlorocyclohexane**	1.80E+00		5.30E-02	1.86E+00			5.30E-01	0.040	1.98E+00		3380	0.0142	7.34E-06	8	0.000018
58-89-9	**gamma-Hexachlorocyclohexane**	1.30E+00	3.00E-04	3.70E-02					0.040	1.34E+00	2.91E-04	3380	0.0142	7.34E-06	8	0.00021
77-47-4	Hexachlorocyclopentadiene		6.00E-03			5.71E-05	2.00E-04		0.100		3.00E-03	1667	0.0161	7.21E-06	1.8	1.1
67-72-1	**Hexachloroethane**	1.40E-02	1.00E-03	4.00E-04	1.40E-02			4.00E-03	0.100	2.80E-02	5.00E-04	224.7	0.0025	6.80E-06	50	0.159
121-82-4	**Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)**	1.10E-01	3.00E-03	3.10E-03					0.015	1.10E-01	3.00E-03	195.4			59.7	2.58E-06
302-01-2	**Hydrazine**	3.00E+00		8.50E-02	1.72E+01			4.90E+00	0.100	6.00E+00		14.3	0.4163853	1.90E-05	1000000	5.89E-07
193-39-5	**Indeno(1,2,3-c,d)pyrene**	7.30E-01			3.08E-01			8.80E-02	0.130	2.35E+00		2680000	0.019	5.66E-06	0.00019	0.0000142
78-59-1	**Isophorone**	9.50E-04	2.00E-01	2.70E-05					0.100	1.90E-03	1.00E-01	58.32	0.0623	6.76E-06	12000	0.000271
98-82-8	Isopropylbenzene (Cumene)		1.00E-01			1.14E-01	4.00E-01		0.000		8.00E-02	817.2	0.065	7.10E-06	61.3	0.47

CAS Number	HAZARDOUS SUBSTANCE (Carcinogenics in Bold Type)	Oral SFo $(mg/kg\text{-}d)^{-1}$	Oral RfDo (mg/kg-d)	Oral URF $(mg/L)^{-1}$	Inhalation SFi $(mg/Kg\text{-}d)^{-1}$	Inhalation RfDi (mg/kg-d)	Inhalation RfC (mg/m^3)	Inhalation URF $(mg/m^3)^{-1}$	ABS Factor (Unitless)	Dermal Slope Factor $(mg/Kg\text{-}d)^{-1}$	Dermal RfD (mg/kg-d)	K_{oc} (L/kg)	Di, air (cm^2/s)	Di, water (cm^2/s)	Solubility (mg/L)	H' unitless
72-43-5	Methoxychlor		5.00E-03						0.100		2.50E-03	42600	0.0156	4.46E-06	0.1	0.0000083
74-83-9	Methyl bromide (Bromomethane)		1.40E-03			1.43E-03	5.00E-03		0.000		1.12E-03	14.3	0.0728	1.21E-05	15200	0.255
74-87-3	**Methyl chloride (Chloromethane)**	1.30E-02		3.70E-04	6.30E-03	2.57E-02	9.00E-02	1.80E-03	0.000	1.63E-02		14.3	0.126	6.50E-06	5320	0.361
78-93-3	Methyl ethyl ketone (MEK)		6.00E-01			1.43E+00	5.00E+00		0.000		4.80E-01	3.827	0.0808	9.80E-06	223000	0.00233
108-10-1	Methyl isobutyl ketone (MIBK)		8.00E-02			8.57E-01	3.00E+00		0.000		6.40E-02	10.91	0.075	7.80E-06	19000	0.00564
74-95-3	Methylene bromide		1.00E-02				3.50E-02		0.000		8.00E-03	23.74	0.0318	8.44E-06	11900	0.0336
75-09-2	**Methylene chloride**	7.50E-03	6.00E-02	2.10E-04	1.65E-03	8.57E-01	3.00E+00	4.70E-04	0.000	7.89E-03	5.70E-02	23.74	0.101	1.17E-05	13000	0.133
22967-92-6	Mercury (Methyl)		1.00E-04						0.100		9.00E-05	14.3			0	2.95E-01
90-12-0	1-Methylnaphthalene		4.00E-03				1.40E-02		0.130		3.20E-03	3038	0.048	7.84E-06	25	0.021
91-57-6	2-Methylnaphthalene		4.00E-03				1.40E-02		0.130		3.20E-03	2976	0.048	7.84E-06	24.6	0.0212
95-48-7	2-Methylphenol (o-cresol)		5.00E-02						0.100		2.50E-02	443.1	0.074	8.30E-06	25900	0.0000491
108-39-4	3-Methylphenol (m-cresol)		5.00E-02						0.100		2.50E-02	434	0.074	1.00E-05	22700	0.000035
106-44-5	4-Methylphenol (p-cresol)		5.00E-03						0.100		3.25E-03	434	0.074	1.00E-05	21500	0.0000409
1634-04-4	**Methyl tert-butyl ether (MTBE)**	1.80E-03			9.10E-04	8.57E-01	3.00E+00	5.14E-04	0.000	2.25E-03		5.258	0.1024	1.05E-05	51000	0.024
91-20-3	Naphthalene		2.00E-02		1.20E-01	8.57E-04	3.00E-03	3.40E-02	0.130		1.60E-02	1837	0.059	7.50E-06	31	0.018
98-95-3	Nitrobenzene		5.00E-04			5.71E-04	2.00E-03		0.000		4.85E-04	190.8	0.076	8.60E-06	2090	0.000981
55-63-0	**Nitroglycerin**	1.70E-02							0.100	3.40E-02		130.8			1380	1.04E-07
556-88-7	Nitroguanidine		1.00E-01						0.100		5.00E-02	25.44			4400	1.84E-10
62-75-9	**n-Nitrosodimethylamine**	5.10E+01	8.00E-06	1.40E+00	4.90E+01			1.40E+01	0.000	1.02E+02	4.00E-06	38.21	0.1126315	1.24E-05	1000000	7.44E-05
86-30-6	**n-Nitrosodiphenylamine**	4.90E-03	2.00E-02	1.40E-04					0.100	1.96E-02	5.00E-03	6154	0.0312	6.35E-06	35	0.0000495
621-64-7	**n-Nitroso-di-n-propylamine**	7.00E+00		2.00E-01					0.100	2.80E+01		485.3	0.0545	8.17E-06	13000	0.00022
88-72-2	**2-Nitrotoluene**	2.30E-01	1.00E-02						0.100	2.88E-01	8.00E-03	315.5	0.0475	8.67E-06	650	0.000511
99-08-1	3-Nitrotoluene		2.00E-02						0.100		1.60E-02	309	0.0495	8.22E-06	500	0.00038
99-99-0	**4-Nitrotoluene**	1.70E-02	1.00E-02						0.100	2.13E-02	8.00E-03	309	0.0478	8.61E-06	442	0.00023
103-65-1	n-Propylbenzene		1.00E-02				3.50E-02		0.000			2830	0.075	7.80E-06	13.8	0.5371
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)		5.00E-02						0.006		7.50E-03	1853			2556	3.54E-08
87-86-5	**Pentachlorophenol***	1.20E-01	3.00E-02	3.00E-03					0.250	1.20E-01	3.00E-02	3380	0.056	6.10E-06	14	0.000001
85-01-8	Phenanthrene		3.00E-01						0.130		2.28E-01	20800	0.0324	7.74E-06	1.15	0.00173
108-95-2	Phenol		3.00E-01						0.100		2.70E-01	268	0.082	9.10E-06	82800	0.0000136
133-63-63	**Polychlorinated biphenyls (PCB)**	2.00E+00			2.00E+00			5.70E-01	0.140	2.22E+00		44800	0.0175	8.00E-06	0.277	0.014
129-00-0	Pyrene		3.00E-02						0.130		9.30E-03	69400	0.0272	7.24E-06	0.135	0.000487

CAS Number	HAZARDOUS SUBSTANCE (Carcinogenics in Bold Type)	Oral SFo $(mg/kg\text{-}d)^{-1}$	Oral RfDo (mg/kg-d)	Oral URF $(mg/L)^{-1}$	Inhalation SFi $(mg/Kg\text{-}d)^{-1}$	Inhalation RfDi (mg/kg-d)	Inhalation RfC (mg/m^3)	Inhalation URF $(mg/m^3)^{-1}$	ABS Factor (Unitless)	Dermal Slope Factor $(mg/Kg\text{-}d)^{-1}$	Dermal RfD (mg/kg-d)	K_{oc} (L/kg)	Di, air (cm^2/s)	Di, water (cm^2/s)	Solubility (mg/L)	H' unitless
100-42-5	Styrene		2.00E-01			2.86E-01	1.00E+00		0.000		1.60E-01	517.8	0.071	8.00E-06	310	0.112
79-34-5	**1,1,2,2-Tetrachloroethane**	2.00E-01	6.00E-02	5.80E-03	2.03E-01			5.80E-02	0.000	2.86E-01	4.20E-02	106.8	0.071	7.90E-06	2870	0.015
127-18-4	**Tetrachloroethylene (PCE)**	5.40E-01	1.00E-02		2.07E-02	1.71E-01	6.00E-01	5.90E-03	0.000	5.40E-01	1.00E-02	106.8	0.072	8.20E-06	206	0.724
108-88-3	Toluene		8.00E-02			1.43E+00	5.00E+00		0.000		6.40E-02	268	0.087	8.60E-06	526	0.271
8001-35-2	**Toxaphene**	1.10E+00		3.20E-02	1.12E+00			3.20E-01	0.000	2.20E+00		99300	0.0116	4.34E-06	0.55	2.45E-04
688-73-3	Tributyltin (as Tributyltin Oxide)		3.00E-04						0.100		1.50E-04	37500000			100	3.86E+03
120-82-1	1,2,4-Trichlorobenzene		1.00E-02			1.14E-03	4.00E-03		0.000		9.70E-03	717.6	0.03	8.23E-06	49	0.0581
71-55-6	1,1,1-Trichloroethane		2.00E-01			6.29E-01	2.20E+00		0.000		1.80E-01	48.64	0.078	8.80E-06	1290	0.703
79-00-5	**1,1,2-Trichloroethane**	5.70E-02	4.00E-03	1.60E-03	5.60E-02			1.60E-02	0.000	7.04E-02	3.24E-03	67.7	0.078	8.80E-06	1100	0.0337
79-01-6	**Trichloroethylene (TCE)**	4.00E-01	3.00E-04		4.00E-01	1.14E-02	4.00E-02	1.10E-01	0.000	2.67E+00	4.50E-05	67.7	0.079	9.10E-06	1280	0.403
95-95-4	2,4,5-Trichlorophenol*		1.00E-01						0.100		5.00E-02	1186	0.0291	7.03E-06	1200	0.0000662
88-06-2	**2,4,6-Trichlorophenol***	1.10E-02		3.10E-04	1.09E-02			3.10E-03	0.100	2.20E-02		1186	0.0318	6.25E-06	800	0.000106
93-72-1	2-(2,4,5-Trichlorpheynoxy) propionic acid (2,4,5-TP)		8.00E-03						0.100		4.00E-03	80.4	0.0194	5.83E-06	200	0.00000037
96-18-4	**1,2,3-Trichloropropane**	7.00E+00	6.00E-03	2.00E-01				2.00E+00	0.000	8.75E+00	4.80E-03	130.8	0.071	7.90E-06	1750	0.014
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)		3.00E+01			8.57E+00	3.00E+01		0.000		2.40E+01	224.7	0.0288	8.07E-06	170	21.5
75-69-4	Trchlorofluoromethane (Freon-11)		3.00E-01			2.00E-01	7.00E-01		0.000		6.90E-02	48.64	0.087	9.70E-06	1100	3.97
95-63-6	1,2,4-Trimethylbenzene		5.00E-02			1.71E-03	7.00E-03		0.000		4.00E-02	717.6	0.0644	7.92E-06	57	0.252
108-67-8	1,3,5-Trimethylbenzene		5.00E-02			1.71E-03	7.00E-03		0.000		4.00E-02	703	0.0602	8.67E-06	48.2	0.359
99-35-4	1,3,5-Trinitrobenzene		3.00E-02						0.019		1.95E-02	1087			278	1.26E-07
479-45-8	Tetryl (2,4,6-Trinitrophenylmethylnitramine)		4.00E-03						0.00065		2.00E-03	2141			74	1.11E-07
118-96-7	**2,4,6-Trinitrotoluene (TNT)**	3.00E-02	5.00E-04	9.00E-04					0.032	5.00E-02	3.00E-04	1834	0.0245	6.36E-06	130	0.0000187
108-05-4	Vinyl acetate		1.00E+00			5.71E-02	2.00E-01		0.000		6.50E-01	6.131	0.085	9.20E-06	20000	0.0209
75-01-4	**Vinyl chloride (Chloroethene)**	1.50E+00	3.00E-03	4.20E-02	3.08E-02	2.86E-02	1.00E-01	8.80E-03	0.000	1.50E+00	3.00E-03	23.74	0.106	1.23E-06	8800	1.14
1330-20-7	Xylenes (total)		2.00E-01			2.86E-02	1.00E-01		0.000		1.84E-01	443.1	0.0714	9.34E-06	106	0.271

*Denotes ionizing organics, for which K_{oc} changes over the pH range of the subsurface environment. The same is true of all organics.
Thus, for these compounds, as site pH deviates from 6.8 site specific cleanup standards must be calculated based on changes in K_{oc} or K_d.

Inorganics

CAS Number	HAZARDOUS SUBSTANCE (Carcinogenics in Bold Type)	Oral SFo $(mg/kg\text{-}d)^{-1}$	Oral RfDo (mg/kg-d)	Oral URF $(mg/L)^{-1}$	Inhalation SFi $(mg/Kg\text{-}d)^{-1}$	Inhalation RfDi (mg/kg-d)	Inhalation RfC (mg/m^3)	Inhalation URF $(mg/m^3)^{-1}$	ABS Factor (Unitless)	Dermal Slope Factor $(mg/Kg\text{-}d)^{-1}$	Dermal RfD (mg/kg-d)	K_d[1] (L/kg)	Di, air (cm^2/s)	Di, water (cm^2/s)	Solubility (mg/L)	H' unitless
7440-36-0	Antimony		4.00E-04						0.000		8.00E-06	45			0	0
7440-38-2	**Arsenic**	1.50E+00	3.00E-04	5.00E-02	1.51E+01			4.30E+00	0.030	3.66E+00	1.23E-04	29			0	0
7440-39-3	Barium		2.00E-01			1.43E-04	5.00E-04		0.000		1.40E-02	41			0	0
7440-41-7	**Beryllium**	4.30E+00	2.00E-03	1.20E-01	8.40E+00	5.71E-06	2.00E-05	2.40E+00	0.000	4.30E+02	2.00E-05	790			0	0
7440-43-9	**Cadmium**		1.00E-03		6.30E+00			1.80E+00	0.001		1.00E-05	75			0	0
7440-47-3	Chromium (Total)		3.00E-03		4.20E+01	2.86E-05	1.00E-04	1.20E+01	0.000		6.00E-05	19			1690000	0
16065-83-1	Chromium +3		1.50E+00						0.000		7.50E-03	1800000			0	0
18540-29-9	Chromium +6		3.00E-03		4.20E+01	2.86E-05	1.00E-04	1.20E+01	0.000		6.00E-05	19			1690000	0
7440-50-8	Copper		4.00E-02						0.000		1.20E-02	35			0	0
57-12-5	Cyanide		2.00E-02						0.000		3.40E-03	9.9			0	0
7439-92-1	**Lead**								0.000			900			0	
7439-97-6	Mercury		3.00E-04			8.57E-05	3.00E-04		0.000		2.10E-05	52	0.0307	6.30E-06	0.06	4.62E-01
7440-02-0	Nickel		2.00E-02		8.40E-01			2.40E-01	0.000		5.40E-03	65			0	0
7790-98-9	Perchlorate		7.00E-04						0.000		1.40E-04	0			245000	0
7782-49-2	Selenium		5.00E-03						0.000		2.20E-03	5			0	0
7440-22-4	Silver		5.00E-03						0.000		9.00E-04	8.3			0	0
7440-28-0	Thallium		8.00E-05						0.000		1.60E-05	71			0	0
7440-62-2	Vanadium		7.00E-03						0.000		7.00E-05	1000			0	0
7723-14-0	White phosphorus		2.00E-05						0.000		4.00E-06	3.5			0	0
7440-66-6	Zinc		3.00E-01						0.000		6.00E-02	62			0	0

[1] K_d changes over the pH range of the subsurface environment. For inorganics (metals), as site pH deviates from 6.8, site specific cleanup standards must be calculated based on changes in K_d.

Selection of Compounds for Dermal Absorption

The direct contact pathway accounts for ingestion of soil and for dermal contact with soil. For those contaminants that are unlikely to undergo significant dermal absorption, the direct contact level reflects only the soil ingestion pathway.

Dermal absorption of contaminants in soil was calculated based on *EPA RAGS Part E: Supplemental Guidance for Dermal Risk Assessment, 2000*. All chemicals and families of chemicals for which specific absorption factors exist were included as specified in *EPA RAGS Part E: Supplemental Guidance for Dermal Risk Assessment, 2000* and *"Supplemental Guidance for Dermal Risk Assessment," Part E: Risk Assessment Guidance for Superfund Human Health Evaluation Manual (Volume 1), August 16, 2004*. If specific absorption factors were not available, chemicals with Henry's constant below 1E-5 atm-m^3/mol at 25 ^{o} C, and molecular weight below 400 g/mol were evaluated as Semivolatile Organic Compounds (SVOCs), with an absorption fraction of 0.10. The atm-m^3/mole units are obtained by multiplying the unitless value by 0.02446 (which comes from multiplying the gas constant (0.0000802 atm-m3/mole-K) by the temperature (298.16 K)). It is generally thought volatile compounds evaporate from skin before significant absorption occurs and are addressed through the inhalation exposure pathway. Compounds with a molecular weight greater than 400 g/mol are considered too large to be absorbed through the skin. (*EPA, Dermal Exposure Principles and Applications, January 1992.)*

Unless listed in the table below, dermal absorption of metals was not included in direct contact cleanup levels, due to lack of information.

Table 3: Chemical Specific Exposure Parameters for the Dermal Route

Chemical	Absorption Factor (ABS)
Arsenic	0.03
Cadmium	0.001
Chlordane	0.04
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.05
DDT/DDE/DDD	0.03
2,3,7,8-TCDD and other dioxins -if soil organic content is >10%	0.03 0.001
Lindane, α-HCH, β-HGH	0.04
Benzo(a)pyrene and other PAHs	0.13
Polychlorinated Biphenyls (PCBs)	0.14
Pentachlorophenol	0.25
Semivolatile Organic Compounds (SVOCs)	0.1
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.015
Trinitrobenzene	0.019
2,4-Dinitrotoluene (2,4-DNT)	0.102
2,6-Dinitrotoluene (2,6-DNT)	0.099
2-Amino-4,6-dinitrotoluene (2A, 4,6-DNT)	0.006
4-Amino-2,6-dinitrotoluene (4A, 2,6-DNT)	0.009
Trinitrotoluene (TNT)	0.032
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.006
Tetryl (N-methyl-N,2,4,6-tetranitrobenzamine)	0.00065

Petroleum Fractions Equations

Equation 15. Table C: Groundwater Cleanup Level Equation for Non-Carcinogenic Contaminants

$$\text{Cleanup Level (mg/L)} = \frac{THQ \times RfD_o \times BW \times AT \times 365\ d/yr}{IR \times EF \times ED \times A}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	70
AT/averaging time (yr)	30
RfD_o/oral reference dose (mg/kg-d)	Chemical-specific (See Table 4)
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
IR/ ingestion rate (L/d)	2
A/absorption factor	1
For non-carcinogens, averaging time is equal to exposure duration.	

Equation 16. Table B2: Soil Cleanup Level Equation for Ingestion of Non-Carcinogenic Contaminants in Residential Soil

$$\text{Cleanup Level (mg/kg)} = \frac{THQ \times BW \times AT \times 365\ d/yr}{1/RfD_o \times 10^{-6}\ kg/mg \times EF \times ED \times IR}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	15
AT/averaging time (yr)	6[a]
RfD_o/oral reference dose (mg/kg-d)	Chemical-specific (See Table 4)
EF/exposure frequency (d/yr)	Arctic Zone = 200 d/yr Under 40 Inch Zone = 270 d/yr Over 40 Inch Zone = 330 d/yr
ED/exposure duration (yr)	6
IR/soil ingestion rate (mg/d)	200

[a] For non-carcinogens, averaging time is equal to exposure duration. Cleanup levels are calculated for 6-year childhood exposure.

Equation 17. **Table B2: Soil Cleanup Level Equation for Direct Inhalation of Non-Carcinogenic Contaminants in Soil**

$$\text{Cleanup Level (mg/kg)} = \frac{\text{THQ x AT x 365 d/yr}}{\text{EF x ED x [(1/RfC) x (1/VF)]}}$$

Parameter/Definition (units)	**Default**
THQ/target hazard quotient (unitless)	1
AT/averaging time (yr)	30
EF/exposure frequency (d/yr)	Arctic Zone = 200 d/yr Under 40 Inch Zone = 270 d/yr Over 40 Inch Zone = 330 d/yr
ED/exposure duration (yr)	30
RfC/inhalation reference concentration (mg/m^3)	Chemical-specific (See Table 4)
VF/soil-to-air volatilization factor (m^3/kg)	Chemical-specific (See Equation 18)

Equation 18. **Table B2: Derivation of the Volatilization Factor**

$$\text{VF } (m^3/kg) = \frac{Q/C \times (3.14 \times D_A \times T)^{1/2} \times 10^{-4} m^2/cm^2}{(2 \times \rho_b \times D_A)}$$

where

$$D_A = \frac{[(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter/Definition (units)	**Default**
VF/volatilization factor (m^3/kg)	---
Q/C/inverse of the mean conc. at the center of a 0.5 acre square source (g/m^2-s per kg/m^3)	Arctic Zone =100.13 Under 40 Inch Zone =90.80 Over 40 Inch Zone =82.72
T/exposure interval (s)	9.5×10^8 s
ρ_b/dry soil bulk density (g/cm^3)	1.5
ρ_s/soil particle density (g/cm^3)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or 1 - (ρ_b/ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.15 or $w\rho_b$
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.284 or n - $w\rho_b$
D_i/diffusivity in air (cm^2/s)	Chemical-specific (See Table 4)
H'/ dimensionless Henry's law constant	Chemical-specific (See Table 4)
w/average soil moisture content $kg_{water}/kg_{soil\text{-}dry}$	0.1 (10%)
D_w/diffusivity in water (cm^2/s)	Chemical-specific (See Table 4)
K_d/soil-water partition coefficient (cm^3/g)	K_{oc} x f_{oc} (organics)
K_{oc}/organic carbon partition coefficient (cm^3/g)	Chemical-specific (See Table 4)
f_{oc}/organic carbon content of soil (g/g)	0.001 (0.1%)

Equation 19. **Table B2: Derivation of the Soil Saturation Limit**

Note = The Soil Saturation Limit will be used as an upper limit for volatiles for the Inhalation Pathway Calculations.

$$C_{sat}\ (mg/kg) = \frac{S}{\rho_b}\ (K_d\ \rho_b + \theta_w + H'\theta_a)$$

Parameter/Definition (units)	**Default**
C_{sat}/soil saturation concentration (mg/kg)	---
S/solubility in water (mg/L-water)	Chemical-specific (See Table 4)
ρ_b/dry soil bulk density (kg/L)	1.5
ρ_s/soil particle density (kg/L)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or 1 - (ρ_b / ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.15 or wρ_b
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.284 or n - wρ_b
K_d/soil-water partition coefficient (L/kg)	K_{oc} x f_{oc}
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	Chemical-specific (See Table 4)
f_{oc}/fraction organic carbon of soil (g/g)	0.001 (0.1%)
w/average soil moisture content $kg_{water}/kg_{soil\text{-}dry}$	0.1 (10%)
H'/Henry's law constant (unitless)	Chemical-specific (See Table 4)

Equation 20. **Table B2: Organic Contaminants-- Soil-Water Partitioning Equation for Migration to Groundwater**

Soil cleanup level (mg/kg) = $C_w\ \{(K_{oc}\ f_{oc})\ + (\ (\theta_w + \theta_a H')/\ \rho_b\ )\}$

Parameter/Definition (units)	**Default**
C_w/target soil leachate concentration (mg/L)	Groundwater Cleanup Level x (10 + DF), 10 is attenuation factor
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	Chemical-specific (See Table 4)
f_{oc}/fraction organic carbon in soil (g/g)	0.001 (0.1%)
ρ_b/dry soil bulk density (kg/L)	1.5
ρ_s/soil particle density (kg/L)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or (1 - ρ_b/ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.3 (30%) or wρ_b
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.13 or n -wρ_b
w/average soil moisture content $kg_{water}/kg_{soil\text{-}dry}$	0.2 (20%)
H'/Henry's law constant (unitless)	Chemical Specific (See Table 4)

Equation 21. **Table B2: Derivation of Dilution Factor**

$DF = 1 + (Kid / IL)$	
Parameter/Definition (units)	**Default**
DF/dilution factor (unitless)	---
K/aquifer hydraulic conductivity (m/yr)	876 m/yr
i/hydraulic gradient (m/m)	0.002 m/m
d/mixing zone depth (m)	(See Equation 22 below)
I/infiltration rate (m/yr)	Over 40 Inch Zone =0.6 m/yr
(calculated as 1/5 * (mean plus one standard deviation of yearly rainfall))	Under 40 Inch Zone =0.13 m/yr
L/source length parallel to groundwater flow (m)	32 m
The standard default dilution factors used to determine the cleanup standards are DF = 1.9 for the Over 40 Inch Zone; and DF = 3.3 for the Under 40 Inch Zone.	

Equation 22. **Table B2: Estimation of Mixing Zone Depth**

$d = (0.0112L^2)^{0.5} + d_a \{1 - \exp[(-LI)/(Kid_a)]\}$	
Parameter/Definition (units)	**Default**
d/mixing zone depth (m)	---
L/source length parallel to groundwater flow (m)	32 m
I/infiltration rate (m/yr)	Over 40 Inch Zone =0.6 m/yr
(calculated as 1/5 * (mean plus one standard deviation of yearly rainfall))	Under 40 Inch Zone =0.13 m/yr
K/aquifer hydraulic conductivity (m/yr)	876 m/yr
i/hydraulic gradient (m/m)	0.002
d_a/aquifer thickness (m)	10 m
The standard default mixing zone depths used to determine the cleanup standards are: d = 10.0 for the Over 40 Inch Zone; and d = 5.5 for the Under 40 Inch Zone.	

Total GRO, DRO, RRO versus Aromatic/Aliphatic fractions

Table B2 soil cleanup levels for petroleum hydrocarbons (GRO, DRO, and RRO) are based on Methods AK 101, 102, and 103. The Table B2 GRO, DRO, and RRO levels were derived based on assumed default percentages of aromatic and aliphatic fractions within each carbon range. The Table B2 aliphatic/aromatic fractional cleanup levels were transformed into the GRO, DRO, and RRO levels by dividing the aromatic or aliphatic cleanup level by a corresponding aromatic or aliphatic default percentage.

DEC selected the default compositions of GRO, DRO, and RRO shown in the following table.

Petroleum Hydrocarbon Default Compositions

CARBON RANGE	PERCENT ALIPHATIC*	PERCENT AROMATIC*
GRO - C_6 - C_{10}	70	50
DRO - C_{10} - C_{25}	80	40
RRO - C_{25} - C_{36}	90	30

*Note - Because fuel constituents vary considerably, the default composition of the percent aliphatic and percent aromatics was set at 120% of the total.

For example, the C10-C25 DRO cleanup levels in Table B2 were calculated by dividing the corresponding C10-C25 aliphatic level by 0.80 and also dividing the corresponding C10-C25 aromatic level by 0.40. The lowest result of these two calculations became the method two C10-C25 DRO cleanup level.

Table 4 - Chemical Specific Parameters for Petroleum Hydrocarbon Fractions

HENRY'S LAW CONSTANT, H' (unitless)

aromatics $\log_{10} H = [-0.23][EC] + 1.7$

aliphatics $\log_{10} H = [0.02][EC] + 1.6$

ORGANIC CARBON PARTITION COEFFICIENT, Koc (ml/g)

aromatics $\log_{10} Koc = [0.10][EC] + 2.3$

aliphatics $\log_{10} Koc = [0.45][EC] + 0.43$

Hydrocarbon Range	Equivalent Carbon Number (EC)	Oral Reference Dose (mg/kg/day)	Reference Concentration (mg/m^3)	H' (unitless)	Koc	Diffusivity in Air	Diffusivity in Water
C_6-C_{10} Aliphatics	8	5	18.4	5.75 E+1	1.07 E+4	1 E-1	1 E-5
C_6-C_{10} Aromatics	8	0.2	0.4	7.24 E-1	1.26 E+3	1 E-1	1 E-5
C_{10}-C_{25} Aliphatics	14	0.1	1	7.59 E+1	5.37 E+6	1 E-1	1 E-5
C_{10}-C_{25} Aromatics	14	0.04	0.2	3.02 E-2	5.01 E+3	1 E-1	1 E-5
C_{25}-C_{36} Aliphatics	30.5	2	n/a				
C_{25}-C_{36} Aromatics	30.5	0.03	n/a	4.86 E-6	2.24 E+5	1 E-1	1 E-5

*Note that no values are recommended for the C_{25}-C_{36} aliphatic fraction, as these compounds are essentially immobile in the environment