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Revision 1

Environmental Calculation of WAC 173-340-720 Method B Groundwater Cleanup Levels for Potable Groundwater

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

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Environmental Calculation Cover Page

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Project: 200-PO-1 Groundwater OU RI **Date:** 9/7/2011

Calculation Title & Description: Environmental Calculation of WAC 173-340-720 Method B Groundwater Cleanup Levels for Potable Groundwater

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1 Purpose

This environmental calculation documents the calculation of Method B groundwater cleanup levels per the requirements set forth in WAC 173-340-720. The calculated Method B groundwater cleanup levels will be used in the development of human health protection action levels for use in risk assessments of Hanford Site groundwater operable units. Example calculations are presented in this revision of the Environmental Calculation for all Contaminants of Potential Concern (COPCs) identified for the 200-PO-1 operable unit (OU) as well wide range of non-radionuclides that may be COPCs in the remaining groundwater operable units at the Hanford Site. A list of the 200-PO-1 OU nonradiological COPCs is provided in Table 1-1.

2 Methodology

The Method B groundwater cleanup levels were calculated for noncarcinogens and carcinogens using equation 720-1 and equation 720-2, respectively. Default input parameters for calculating the groundwater cleanup levels are defined within the equation. Groundwater cleanup levels are based on an acceptable cancer risk level of 1×10^{-6} for carcinogens or a hazard quotient of 1 for noncarcinogens. Reference dose and carcinogenic potency factors are obtained from Washington Department of Ecology's Cleanup Level and Risk Calculator (CLARC) web site (https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx) or EPA's "*Regional Screening Levels for Chemical Contaminants at Superfund Sites*" website available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm/. EPA's Regional Screening Levels web site was used as the source for toxicity values for those contaminants where EPA has recently updated those values. Further details on the selection of toxicity values are presented in Section 3 of this Environmental Calculation.

The specific steps taken to calculate the Method B groundwater cleanup levels for nonradionuclides are presented below:

1. Identify equation 720-1 and equation 720-2 from WAC 173-340-720 for noncarcinogenic and carcinogenic groundwater cleanup levels.
2. Identify the exposure assumptions within equation 720-1 and equation 720-2 from WAC 173-340-720 for noncarcinogenic and carcinogenic groundwater cleanup levels.
3. Determine if the constituent is a volatile organic compound.
4. Obtain toxicity values for each contamination of potential concern.
5. Calculate concentrations in groundwater that correspond to a 1×10^{-6} acceptable target risk level or calculate concentrations in groundwater that correspond to a hazard quotient of 1.
6. When a nonradiological constituent has a groundwater cleanup level calculated for both carcinogenic and noncarcinogenic effects, the lower of the two cleanup levels is protective of both effects.
7. Document exposure assumptions, chemical-specific parameters, and their primary sources in a summary table.

The following section presents the equations for analytes with carcinogenic and noncarcinogenic effects. Groundwater cleanup levels consider exposure through the drinking water ingestion pathway.

2.1 Equations for Groundwater Cleanup Levels

The following section defines the equations used to calculate groundwater cleanup levels for noncarcinogens and carcinogens.

2.1.1 Noncarcinogens

The equation below is obtained from WAC 173-340-720(4) (iii) (A) Equation 720-1.

$$Groundwater\ CUL\left(\frac{\mu g}{L}\right)=\frac{RfD\times ABW\times UCF\times HQ\times AT}{DWIR\times INH\times DWF\times ED}$$

2.1.2 Carcinogens

The equation below is obtained from WAC 173-340-720(4) (iii) (B) Equation 720-2.

$$Groundwater\ CUL\left(\frac{\mu g}{L}\right)=\frac{RISK\times ABW\times AT\times UCF}{CPF\times DWIR\times ED\times INH\times DWF}$$

3 Assumptions and Inputs

The exposure assumptions and chemical-specific parameters used to calculate the groundwater CULs are presented in Tables 3-1 and 3-2. Other key assumptions are as follows:

- Exposure assumptions used to calculate the groundwater CULs for noncarcinogens and carcinogens are in Table 3-1. The sources for each of the assumptions are also listed in Table 3-1.
- The exposure routes included in the groundwater cleanup levels are drinking water ingestion and inhalation of vapors.
- An inhalation correction factor is used for those constituents defined as a volatile organic compound. Volatile organic compoundsare identified in the Washington State Department of Ecology's "Cleanup Level and Risk Calculations Database" (CLARC) website available at: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx. All constituents identified as a volatile organic compound are listed in Table 3-2.
- Toxicity values (reference dose and carcinogenic potency factors) are listed in Table 3-2. The sources for each of the toxicity values are also listed in Table 3-2.
- The chemical-specific reference dose (RfD) used in equation 720-1 for noncarcinogens and the chemical specific carcinogen potency factor (CPF) used in equation 720-2 for carcinogens are determined using the recommended reference hierarchy as described in *Human Health Toxicity Values in Superfund Risk Assessments* (Memorandum, OSWER 9285.7-53, December 2003). The hierarchy is summarized below.
    - Tier 1 – The EPA Integrated Risk Information System (IRIS)
    - Tier 2 – The EPA Provision Peer Reviewed Toxicity Values (PPRTVs)

- Tier 3 – Other Toxicity Values

- Tier 3 toxicity values include additional EPA and non-EPA sources of toxicity information, including: the California EPA Toxicity Criteria Database, the Agency for Toxic Substances and Disease Registry (ATSDR)'s Minimal Risk Levels (RMLs) for Hazard Substances, and toxicity values in EPA Health Effects Assessment Summary Tables (HEAST) (EPA/540/R-97/036, July 1997). Each of the Tier-3 toxicity values can be found at the EPA's "Regional Screening Levels for Chemical Contaminants at Superfund Sites".

- When Tier 1, Tier 2, or Tier 3 toxicity values were not available for a chemical, the toxicity values from the National Center for Environmental Assessment (NCEA) were used. NCEA values can be found in the Oak Ridge National Laboratory Risk Assessment Information System (RAIS) available at: http://rais.ornl.gov/.

- Toxic equivalence factors (TEFs) were used to calculate toxicity values for dioxins, furans, and carcinogenic polyaromatic hydrocarbons (PAHs) as described in WAC-173-340-708(8)(D)(iii)(A)).

- A derived RfD for nitrate was calculated from the RfD reported in IRIS (1.6 mg/kg-day) for nitrate as nitrogen (NO_3^--N) using the mass fraction of nitrogen in nitrate. The mass fraction of nitrogen in nitrate = mol wt N/mol wt NO_3^- = (14 g/mol)/(62 g/mol) = 0.226. The derived RfD for nitrate = (1.6 mg NO_3^- -N/kg-day) x (1 mg NO_3^-/0.226 mg NO_3^--N) = 7.1 mg NO_3^-/kg-day.

- A derived RfD for nitrite was calculated from the RfD reported in IRIS (0.1 mg/kg-day) for nitrite as nitrogen (NO_2^--N) using the mass fraction of nitrogen in nitrite. The mass fraction of nitrogen in nitrite = mol wt N/mol wt NO_2^- = (14 g/mol)/(46 g/mol) = 0.304. The derived RfD for nitrite = (0.1 mg NO_2^--N/kg-day) x (1 mg NO_2^-/0.304 mg NO_2^--N) = 0.3 mg NO_2^-/kg-day.

- The toxicity value published in the Washington State Department of Ecology's "Cleanup Level and Risk Calculations Database" (CLARC) website was selected for final COPCs when Cook, 2003 recommended a different source of information. The differences in toxicity values for final COPCs are summarized below.

  - The oral cancer potency factor of 0.089 $(mg/kg\text{-}day)^{-1}$ published by HEAST is the value published on Ecology's CLARC web site and is used to develop the WAC 173-340-720 groundwater cleanup level. HEAST has not been updated since 1997 and therefore does not reflect the most current source of information for the the oral cancer potency factor. The source of this toxicity value is consistent with the hierarchy of toxicity values recommended in Cook, 2003. However, the oral slope factor currently implemented by EPA for trichloroethene in the Regional Screening Levels is established by the CalEPA OEHHA. The oral slope factor derived by OEHHA is 0.0059 $(mg/kg\text{-}day)^{-1}$, as presented in OEHHA, 2009, *Public Health Goal for Chemicals In Drinking Water Trichloroethylene*. If the CalEPA values were used to calculate the WAC 173-340-720 groundwater cleanup level, the groundwater concentration would increase from 0.49 µg/L to 7.4 µg/L. While the CalEPA toxicity value may be more current, the existing value published by Ecology provides a more conservative cleanup level in groundwater.

  - The oral reference dose of 0.06 mg/kg-day for fluoride is the value published on Ecology's CLARC web site and is is used to develop the WAC 173-340-720 groundwater cleanup level. The oral reference dose originally was published on IRIS but the value provided by Ecology has not been updated since 1989, and oral reference dose

does not reflect the most current source of information. The oral reference dose currently implemented by EPA for fluoride is established by the CalEPA OEHHA and documented in 2003, *Chronic Toxicity Summary: Fluorides including Hydrogen Fluoride..* The source of this toxicity value is consistent with the hierarchy of toxicity values recommended in Cook, 2003. If the CalEPA oral reference dose were used to calculate the WAC 173-340-720 groundwater cleanup level, the groundwater concentration would decrease from 480 µg/L to 320 µg/L.

- The oral reference dose of 0.003 mg/kg-day that is published by IRIS is used to develop the WAC 173-340-720 groundwater cleanup level for hexavalent chromium. An oral carcinogenic potency factor has recently been published by the New Jersey Department of Environmental Protection (NJDEP). The oral carcinogenic potency factor derived by NJDEP is 0.5 $(mg/kg\text{-}day)^{-1}$, as presented in, 2009, *Derivation of an Ingestion-Based Soil Remediation Criterion for Cr+6 Based on the NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate.* If the NJDEP value was used to calculate the WAC 173-340-720 groundwater cleanup level, the groundwater concentration would decrease from 48 µg/L to 0.18 µg/L.

- The oral reference dose of 0.2 mg/-kg-day that is published by the PPRTV is used to develop the WAC 173-340-720 groundwater cleanup level for 1,1-dichloroethane. An oral carcinogenic potency factor has recently been published by the CalEPA OEHHA. The oral carcinogenic potency factor derived by OEHHA is 0.0057 $(mg/kg\text{-}day)^{-1}$, as presented in, 2003, *Public Health Goals for Chemicals in Drinking Water: 1,1-Dichloroethane in Drinking Water.* If the value published by Cal-EPA was used to calculate the WAC 173-340-720 groundwater cleanup level, the groundwater concentration would decrease from 1600 µg/L to 7.7 µg/L.

4 Software Applications

All supporting calculations are performed on electronic spreadsheets using Microsoft Excel[1] for nonradiological PRGs. The methodology and equations are described in Section 2.0, the exposure assumptions and inputs are provided in Section 3.0, and results for groundwater CUL calculations are presented in Section 6.0.

5 Calculation

Calculate the ground water CULs using the methodology presented in Section 2. Groundwater CUL calculations are validated by comparison with hand calculations. Hand calculations are provided in Figures 5-1 and 5-2.

6 Results/Conclusions

The calculated groundwater CULs are presented in Table 6-1.

7 References

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Table 1-1. Summary of 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern

Metals	Semivolatile Organic Compounds
Aluminum	Tributyl phosphate
Antimony	**Radiological**
Arsenic	Gross alpha
Beryllium	Iodine-129
Cadmium	Strontium-90
Chromium	Technetium-99
Cobalt	Tritium
Copper	**Anions**
Hexavalent Chromium	Fluoride
Iron	Nitrate
Lead	Nitrite
Manganese	Sulfate
Mercury	
Nickel	
Selenium	
Silver	
Thallium	
Uranium	
Vanadium	
Zinc	
Volatile Organic Compounds	
Carbon tetrachloride	
Chloroform	
Methylene chloride	
Tetrachloroethene	
Trichloroethene	

Table 3-1. Summary of Exposure Assumptions Used to Calculate Groundwater Cleanup Levels

Exposure Factor	Symbol	Value	Unit	Source
Average body weight during the exposure duration	ABW	16	kg	WAC 173-340-720(4)(iii) (A) Equation 720-1
		70	kg	WAC 173-340-720(4) (iii) (B) Equation 720-2
Averaging time	AT	6 (	years	WAC 173-340-720(4)(iii) (A) Equation 720-1
		75	years	WAC 173-340-720(4) (iii) (B) Equation 720-2
Carcinogenic potency factor	CPF	Chemical Specific	kg-day/mg	See Table 3-2.
Drinking water fraction	DWF	1	unitless	WAC 173-340-720(4)(iii) (A) Equation 720-1 and WAC 173-340-720(4) (iii) (B) Equation 720-2
Drinking water ingestion rate	DWIR	1 (Equation 720-1)	liter/day	WAC 173-340-720(4)(iii) (A) Equation 720-1
		2 (Equation 720-2)	liters/day	WAC 173-340-720(4) (iii) (B) Equation 720-2
Exposure duration	ED	6 (Equation 720-1)	years	WAC 173-340-720(4)(iii) (A) Equation 720-1
		30 (Equation 720-2)	years	WAC 173-340-720(4) (iii) (B) Equation 720-2
Hazard quotient	HQ	1	unitless	WAC 173-340-720(4)(iii) (A) Equation 720-1
Inhalation correction factor	INH	Chemical Specific	unitless	See Table 3-2.
Reference dose	RfD	Chemical Specific	mg/kg-day	See Table 3-2.
Acceptable cancer risk level	RISK	1E-06	unitless	WAC 173-340-720(4) (iii) (B) Equation 720-2
Unit conversion factor	UCF	1,000	µg/mg	WAC 173-340-720(4)(iii) (A) Equation 720-1 and WAC 173-340-720(4) (iii) (B) Equation 720-2

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
179601-23-1	(m+p)-Xylene	V	2	0.2	I	--	--
630-20-6	1,1,1,2-Tetrachloroethane	V	2	0.03	I	0.026	I
71-55-6	1,1,1-Trichloroethane	V	2	2	I	--	--
79-34-5	1,1,2,2-Tetrachloroethane	V	2	0.004	P	0.2	I
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	V	2	30	I	--	--
79-00-5	1,1,2-Trichloroethane	V	2	0.004	I	0.057	I
75-34-3	1,1-Dichloroethane	V	2	0.2	P	--	--
75-35-4	1,1-Dichloroethene	V	2	0.05	I	--	--
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzodioxin	--	1	--	--	1300	WAC
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	--	1	--	--	1300	WAC
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	--	1	--	--	1300	WAC
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	--	1	--	--	13000	WAC
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	--	1	--	--	13000	WAC
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	--	1	--	--	13000	WAC
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	--	1	--	--	13000	WAC
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	--	1	--	--	13000	WAC
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	--	1	--	--	13000	WAC
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	--	1	--	--	3900	WAC

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	--	1	--	--	130000	WAC
87-61-6	1,2,3-Trichlorobenzene	--	1	0.0008	X	--	--
96-18-4	1,2,3-Trichloropropane	V	2	0.004	I	30	I
95-94-3	1,2,4,5-Tetrachlorobenzene	--	1	0.0003	I	--	--
120-82-1	1,2,4-Trichlorobenzene	V	2	0.01	I	0.029	P
96-12-8	1,2-Dibromo-3-chloropropane	V	2	0.0002	P	0.8	P
106-93-4	1,2-Dibromoethane	V	2	0.009	I	2	I
95-50-1	1,2-Dichlorobenzene	V	2	0.09	I	--	--
107-06-2	1,2-Dichloroethane	V	2	0.02	P	0.091	I
540-59-0	1,2-Dichloroethene (Total)	V	2	0.009	H	--	--
78-87-5	1,2-Dichloropropane	V	2	0.09	A	0.036	C
122-66-7	1,2-Diphenylhydrazine	--	1	--	--	0.8	I
57-55-6	1,2-Propanediol	V	2	20	P	--	--
108-67-8	1,3,5-Trimethylbenzene	V	2	0.01	X	--	--
142-28-9	1,3-Dichloropropane	--	1	0.02	P	--	--
85-44-9	1,3-Isobenzofurandione	--	1	2	I	--	--
106-46-7	1,4-Dichlorobenzene	V	2	0.07	A	0.0054	C
123-91-1	1,4-Dioxane	V	2	0.1	A	0.011	I
71-36-3	1-Butanol	V	2	0.1	I	--	--
93-65-2	2-(2-methyl-4-chlorophenoxy) propionic acid	--	1	0.001	I	--	--
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	--	1	--	--	13000	WAC
58-90-2	2,3,4,6-Tetrachlorophenol	--	1	0.03	I	--	--
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	--	1	--	--	39000	WAC

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	--	1	--	--	13000	WAC
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	--	1	0.000000001	A	130000	C
93-76-5	2,4,5-T(2,4,5-Trichlorophenoxyacetic acid)	--	1	0.01	I	--	--
93-72-1	2,4,5-TP(2-(2,4,5-Trichlorophenoxy)propionic acid)Silvex	--	1	0.008	I	--	--
95-95-4	2,4,5-Trichlorophenol	V	2	0.1	I	--	--
88-06-2	2,4,6-Trichlorophenol	V	2	0.001	P	0.011	I
94-75-7	2,4-D(2,4-Dichlorophenoxyacetic acid)	--	1	0.01	I	--	--
94-82-6	2,4-DB(4-(2,4-Dichlorophenoxy)butanoic acid)	--	1	0.008	I	--	--
120-83-2	2,4-Dichlorophenol	V	2	0.003	I	--	--
105-67-9	2,4-Dimethylphenol	V	2	0.02	I	--	--
51-28-5	2,4-Dinitrophenol	--	1	0.002	I	--	--
121-14-2	2,4-Dinitrotoluene	--	1	0.002	I	0.31	C
606-20-2	2,6-Dinitrotoluene	--	1	0.001	P	--	--
53-96-3	2-Acetylaminofluorene	--	1	--	--	3.8	C
78-93-3	2-Butanone	V	2	0.6	I	--	--
111-76-2	2-Butoxyethanol	V	2	0.5	I	--	--
91-58-7	2-Chloronaphthalene	V	2	0.08	I	--	--
95-57-8	2-Chlorophenol	V	2	0.005	I	--	--
95-49-8	2-Chlorotoluene	V	2	0.02	I	--	--
591-78-6	2-Hexanone	--	1	0.005	I	--	--

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
94-74-6	2-Methyl-4 chlorophenoxyacetic acid	--	1	0.0005	I	--	--
91-57-6	2-Methylnaphthalene	V	2	0.004	I	--	--
95-48-7	2-Methylphenol (cresol, o-)	V	2	0.05	I	--	--
91-59-8	2-Naphthylamine	--	1	--	--	1.8	C
88-74-4	2-Nitroaniline	--	1	0.01	X	--	--
108-10-1	2-Pentanone, 4-Methyl	V	2	0.08	H	--	--
91-94-1	3,3'-Dichlorobenzidine	--	1	--	--	0.45	I
119-93-7	3,3'-Dimethylbenzidine	--	1	--	--	11	P
56-49-5	3-Methylcholanthrene	--	1	--	--	22	C
108-39-4	3-Methylphenol (cresol, m-)	V	2	0.05	I	--	--
99-09-2	3-Nitroaniline	--	1	0.0003	P	0.021	P
72-54-8	4,4'-DDD (Dichlorodiphenyldichloroethane)	--	1	--	--	0.24	I
72-55-9	4,4'-DDE (Dichlorodiphenyldichloroethylene)	--	1	--	--	0.34	I
50-29-3	4,4'-DDT (Dichlorodiphenyltrichloroethane)	--	1	0.0005	I	0.34	I
534-52-1	4,6-Dinitro-2-methylphenol	--	1	0.0001	P	--	--
92-67-1	4-Aminobiphenyl	--	1	--	--	21	C
59-50-7	4-Chloro-3-methylphenol	--	1	0.1	X	--	--
106-47-8	4-Chloroaniline	V	2	0.004	I	0.2	P
106-43-4	4-Chlorotoluene	--	1	0.07	P	--	--
106-44-5	4-Methylphenol (cresol, p-)	V	2	0.005	H	--	--
100-01-6	4-Nitroaniline	--	1	0.004	P	0.02	P
100-02-7	4-Nitrophenol	--	1	0.008	NCEA	--	--

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
99-55-8	5-Nitro-o-toluidine	--	1	--	--	0.033	H
57-97-6	7,12-Dimethylbenz[a]anthracene	--	1	--	--	250	C
83-32-9	Acenaphthene	--	1	0.06	I	--	--
67-64-1	Acetone	V	2	0.9	I	--	--
98-86-2	Acetophenone	V	2	0.1	I	--	--
107-02-8	Acrolein	V	2	0.0005	I	--	--
107-13-1	Acrylonitrile	V	2	0.04	A	0.54	I
309-00-2	Aldrin	V	2	0.00003	I	17	I
107-05-1	Allyl chloride	V	2	--	--	0.021	C
319-84-6	Alpha-BHC	--	1	0.008	A	6.3	I
5103-71-9	Alpha-Chlordane	--	1	0.0005	I	0.35	I
7429-90-5	Aluminum	--	1	1	P	--	--
62-53-3	Aniline	V	2	0.007	P	0.0057	I
120-12-7	Anthracene	--	1	0.3	I	--	--
7440-36-0	Antimony	--	1	0.0004	I	--	--
140-57-8	Aramite	--	1	0.05	H	0.025	I
12674-11-2	Aroclor-1016	--	1	0.00007	I	0.07	I
11104-28-2	Aroclor-1221	--	1	--	--	2	I
11141-16-5	Aroclor-1232	--	1	--	--	2	I
53469-21-9	Aroclor-1242	--	1	--	--	2	I
12672-29-6	Aroclor-1248	--	1	--	--	2	I
11097-69-1	Aroclor-1254	--	1	0.00002	I	2	I
11096-82-5	Aroclor-1260	--	1	--	--	2	I
7440-38-2	Arsenic	--	1	0.0003	I	1.5	I
103-33-3	Azobenzene	--	1	--	--	0.11	I

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
7440-39-3	Barium	--	1	0.2	I	--	--
71-43-2	Benzene	V	2	0.004	I	0.055	I
56-55-3	Benzo(a)anthracene	--	1	--	--	0.73	WAC
50-32-8	Benzo(a)pyrene	--	1	--	--	7.3	I
205-99-2	Benzo(b)fluoranthene	--	1	--	--	0.73	WAC
207-08-9	Benzo(k)fluoranthene	--	1	--	--	0.73	WAC
65-85-0	Benzoic acid	--	1	4	I	--	--
100-51-6	Benzyl alcohol	V	2	0.1	P	--	--
7440-41-7	Beryllium	--	1	0.002	I	--	--
319-85-7	beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-BHC)	--	1	--	--	1.8	I
108-60-1	Bis(2-chloro-1-methylethyl)ether	V	2	0.04	I	0.07	H
111-91-1	Bis(2-Chloroethoxy)methane	--	1	0.003	P	--	--
111-44-4	Bis(2-chloroethyl) ether	V	2	--	--	1.1	I
117-81-7	Bis(2-ethylhexyl) phthalate	--	1	0.02	I	0.014	I
80-05-7	Bisphenol A	--	1	0.05	I	--	--
7440-42-8	Boron	--	1	0.2	I	--	--
108-86-1	Bromobenzene	--	1	0.008	I	--	--
75-27-4	Bromodichloromethane	V	2	0.02	I	0.062	I
75-25-2	Bromoform	V	2	0.02	I	0.0079	I
74-83-9	Bromomethane	V	2	0.0014	I	--	--
85-68-7	Butylbenzylphthalate	--	1	0.2	I	0.0019	P
7440-43-9	Cadmium	--	1	0.0005	I	--	--
86-74-8	Carbazole	--	1	--	--	0.02	H

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
75-15-0	Carbon disulfide	V	2	0.1	I	--	--
56-23-5	Carbon tetrachloride	V	2	0.0007	I	0.13	I
57-74-9	Chlordane	--	1	0.0005	I	0.35	I
108-90-7	Chlorobenzene	V	2	0.02	I	--	--
510-15-6	Chlorobenzilate	--	1	0.02	I	0.11	C
67-66-3	Chloroform	V	2	0.01	I	0.031	C
126-99-8	Chloroprene	V	2	0.02	H	--	--
7440-47-3	Chromium	--	1	1.5	I	--	--
218-01-9	Chrysene	--	1	--	--	0.073	WAC
156-59-2	cis-1,2-Dichloroethylene	V	2	0.01	P	--	--
10061-01-5	cis-1,3-Dichloropropene	V	2	0.03	I	0.1	I
7440-48-4	Cobalt	--	1	0.0003	P	--	--
7440-50-8	Copper	--	1	0.04	H	--	--
57-12-5	Cyanide	--	1	0.02	I	--	--
108-94-1	Cyclohexanone	V	2	5	I	--	--
75-99-0	Dalapon	V	2	0.03	I	--	--
2303-16-4	Diallate	--	1	--	--	0.061	H
53-70-3	Dibenz[a,h]anthracene	--	1	--	--	0.73	WAC
132-64-9	Dibenzofuran	--	1	0.001	X	--	--
124-48-1	Dibromochloromethane	V	2	0.02	I	0.084	I
74-95-3	Dibromomethane	V	2	0.01	H	--	--
1918-00-9	Dicamba	--	1	0.03	I	--	--
75-71-8	Dichlorodifluoromethane	V	2	0.2	I	--	--
60-57-1	Dieldrin	--	1	0.00005	I	16	I
60-29-7	Diethyl ether	V	2	0.2	I	--	--

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
84-66-2	Diethylphthalate	--	1	0.8	I	--	--
60-51-5	Dimethoate	--	1	0.0002	I	--	--
84-74-2	Di-n-butylphthalate	--	1	0.1	I	--	--
88-85-7	Dinoseb(2-secButyl-4,6-dinitrophenol)	--	1	0.001	I	--	--
122-39-4	Diphenylamine	--	1	0.025	I	--	--
298-04-4	Disulfoton	--	1	0.00004	I	--	--
959-98-8	Endosulfan I	--	1	0.006	I	--	--
33213-65-9	Endosulfan II	--	1	0.006	I	--	--
72-20-8	Endrin	--	1	0.0003	I	--	--
141-78-6	Ethyl acetate	V	2	0.9	I	--	--
97-63-2	Ethyl methacrylate	V	2	0.09	H	--	--
100-41-4	Ethylbenzene	V	2	0.1	I	0.011	C
107-21-1	Ethylene glycol	V	2	2	I	--	--
206-44-0	Fluoranthene	--	1	0.04	I	--	--
86-73-7	Fluorene	--	1	0.04	I	--	--
16984-48-8	Fluoride	V	2	0.06	I	--	--
58-89-9	Gamma-BHC (Lindane)	--	1	0.0003	I	1.1	C
76-44-8	Heptachlor	--	1	0.0005	I	4.5	I
1024-57-3	Heptachlor epoxide	V	2	0.000013	I	9.1	I
118-74-1	Hexachlorobenzene	--	1	0.0008	I	1.6	I
87-68-3	Hexachlorobutadiene	V	2	0.001	P	0.078	I
77-47-4	Hexachlorocyclopentadiene	V	2	0.006	I	--	--
67-72-1	Hexachloroethane	V	2	0.001	I	0.014	I
70-30-4	Hexachlorophene	--	1	0.0003	I	--	--

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
110-54-3	Hexane	V	2	0.06	H	--	--
18540-29-9	Hexavalent Chromium	--	1	0.003	I	--	--
302-01-2	Hydrazine	V	2	--	--	3	I
193-39-5	Indeno(1,2,3-cd)pyrene	--	1	--	--	0.73	I
7439-89-6	Iron	--	1	0.7	P	--	--
78-83-1	Isobutyl alcohol	V	2	0.3	I	--	--
78-59-1	Isophorone	V	2	0.2	I	0.00095	I
98-82-8	Isopropylbenzene	V	2	0.1	I	--	--
143-50-0	Kepone	--	1	0.0003	I	10	I
7439-93-2	Lithium	--	1	0.002	P	--	--
7439-96-5	Manganese	--	1	0.14	I	--	--
99-65-0	m-Dinitrobenzene	--	1	0.0001	I	--	--
7439-97-6	Mercury	--	1	0.0003	I	--	--
126-98-7	Methacrylonitrile	V	2	0.0001	I	--	--
67-56-1	Methanol	V	2	0.5	I	--	--
72-43-5	Methoxychlor	--	1	0.005	I	--	--
80-62-6	Methyl methacrylate	V	2	1.4	I	--	--
66-27-3	Methyl methanesulfonate	--	1	--	--	0.099	C
298-00-0	Methyl parathion	--	1	0.00025	I	--	--
1634-04-4	Methyl tert-butyl ether	V	2	--	--	0.0018	C
75-09-2	Methylene chloride	V	2	0.06	I	0.0075	I
7439-98-7	Molybdenum	--	1	0.005	I	--	--
108-38-3	m-Xylene	V	2	0.2	I	--	--
91-20-3	Naphthalene	V	2	0.02	I	--	--
7440-02-0	Nickel	--	1	0.02	I	--	--

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
14797-55-8	Nitrate	--	1	7.1	I	--	--
14797-65-0	Nitrite	--	1	0.3	I	--	--
98-95-3	Nitrobenzene	V	2	0.002	I	--	--
930-55-2	Nitrosopyrrolidine	V	2	--	--	2.1	I
55-18-5	n-Nitrosodiethylamine	V	2	--	--	150	I
62-75-9	n-Nitrosodimethylamine	V	2	0.000008	P	51	I
924-16-3	n-Nitrosodi-n-butylamine	V	2	--	--	5.4	I
621-64-7	n-Nitrosodi-n-dipropylamine	--	1	--	--	7	I
86-30-6	n-Nitrosodiphenylamine	--	1	--	--	0.0049	I
10595-95-6	n-Nitrosomethylethylamine	--	1	--	--	22	I
59-89-2	n-Nitrosomorpholine	--	1	--	--	6.7	C
100-75-4	n-Nitrosopiperidine	--	1	--	--	9.4	C
103-65-1	n-Propylbenzene	V	2	0.1	X	--	--
39001-02-0	Octachlorodibenzofuran	--	1	--	--	39	WAC
3268-87-9	Octachlorodibenzo-p-dioxin	--	1	--	--	39	WAC
95-47-6	o-Xylene	V	2	0.2	I	--	--
56-38-2	Parathion	--	1	0.006	H	--	--
60-11-7	p-Dimethylaminoazobenzene	--	1	--	--	4.6	C
608-93-5	Pentachlorobenzene	--	1	0.0008	I	--	--
76-01-7	Pentachloroethane	--	1	--	--	0.09	P
82-68-8	Pentachloronitrobenzene (PCNB)	--	1	0.003	I	0.26	H
87-86-5	Pentachlorophenol	--	1	0.03	I	0.12	I
14797-73-0	Perchlorate anion	--	1	0.0007	I	--	--
62-44-2	Phenacetin	--	1	--	--	0.0022	C
108-95-2	Phenol	V	2	0.3	I	--	--

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
298-02-2	Phorate	--	1	0.0002	H	--	--
7723-14-0	Phosphorus	V	2	0.00002	I	--	--
106-50-3	p-Phenylenediamine	--	1	0.19	H	--	--
23950-58-5	Pronamide	--	1	0.075	I	--	--
106-42-3	p-Xylene	V	2	0.2	I	--	--
129-00-0	Pyrene	--	1	0.03	I	--	--
110-86-1	Pyridine	V	2	0.001	I	--	--
94-59-7	Safrol	--	1	--	--	0.22	C
7782-49-2	Selenium	--	1	0.005	I	--	--
7440-22-4	Silver	--	1	0.005	I	--	--
7440-24-6	Strontium	--	1	0.6	I	--	--
100-42-5	Styrene	V	2	0.2	I	--	--
99-35-4	sym-Trinitrobenzene	--	1	0.03	I	--	--
127-18-4	Tetrachloroethene	V	2	0.01	I	0.54	C
3689-24-5	Tetraethyl dithiopyrophosphate (Sulfotepp)	--	1	0.0005	I	--	--
7440-31-5	Tin	--	1	0.6	H	--	--
7440-32-6	Titanium	--	1	4	NCEA	--	--
108-88-3	Toluene	V	2	0.08	I	--	--
1319-77-3	Total cresols	--	1	0.1	A	--	--
8001-35-2	Toxaphene	--	1	--	--	1.1	I
156-60-5	trans-1,2-Dichloroethylene	V	2	0.02	I	--	--
10061-02-6	trans-1,3-Dichloropropene	V	2	0.03	I	0.1	I
5103-74-2	trans-Chlordane	--	1	0.0005	I	0.35	I
126-73-8	Tributyl phosphate	--	1	0.2	P	0.0092	P

Table 3-2 Summary of Inhalation Correction Factors, Reference Doses, and Carcinogen Potency Factors Used to Calculate Groundwater Cleanup Levels

CAS #	Chemical Name	Volatile[1]	Inhalation Correction Factor	Non-Carcinogens[2]		Carcinogen[2]	
				RfD (mg/kg-day)	Reference	CPF (mg/kg-day)$^{-1}$	Reference
79-01-6	Trichloroethene	V	2	--	--	0.089	H
75-69-4	Trichloromonofluoromethane	V	2	0.3	I	--	--
115-96-8	Tris-2-chloroethyl phosphate	--	1	0.007	P	0.02	P
7440-61-1	Uranium	--	1	0.003	I	--	--
7440-62-2	Vanadium	--	1	0.005	S	--	--
108-05-4	Vinyl acetate	V	2	1	H	--	--
75-01-4	Vinyl chloride	V	2	0.003	I	0.72	I
1330-20-7	Xylenes (total)	V	2	0.2	I	--	--
7440-66-6	Zinc	--	1	0.3	I	--	--

I - EPA's Integrated Risk Information System (IRIS)
H - Health Effects Assessment Summary Tables (HEAST)
C - The California Environmental Protection Agency Office of Environmental Health Hazard Assessment's (CalEPA)
A- The Agency for Toxic Substances and Disease Registry (ATSDR)
P - Provisional Peer Reviewed Toxicity Values (PPRTV)
NCEA =National Center for Environmental Assessment

X- PPRTV Appendix
WAC- uses Toxicity Equivalence factors as provided by WAC 173-340-900 Ecology, 2007, The Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC, Publication No. 94-06, amended 1996, Washington State Department of Ecology, Olympia, Washington.

[1]-As Defined by WAC "Cleanup Levels and Risk Calculations" Web Database https://fortress.wa.gov/ecy/clarc/CLARCOverview.aspx
[2] - EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites", screening level/preliminary remediation goal website, updated December 7, 2009

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
179601-23-1	(m+p)-Xylene	--	1.60E+03	1.60E+03
630-20-6	1,1,1,2-Tetrachloroethane	1.68E+00	2.40E+02	1.68E+00
71-55-6	1,1,1-Trichloroethane	--	1.60E+04	1.60E+04
79-34-5	1,1,2,2-Tetrachloroethane	2.19E-01	3.20E+01	2.19E-01
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	--	2.40E+05	2.40E+05
79-00-5	1,1,2-Trichloroethane	7.68E-01	3.20E+01	7.68E-01
75-34-3	1,1-Dichloroethane	--	1.60E+03	1.60E+03
75-35-4	1,1-Dichloroethene	--	4.00E+02	4.00E+02
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzodioxin	6.73E-05	--	6.73E-05
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	6.73E-05	--	6.73E-05
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	6.73E-05	--	6.73E-05
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	6.73E-06	--	6.73E-06
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	6.73E-06	--	6.73E-06
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	6.73E-06	--	6.73E-06
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	6.73E-06	--	6.73E-06
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	6.73E-06	--	6.73E-06
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	6.73E-06	--	6.73E-06
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	2.24E-05	--	2.24E-05
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	6.73E-07	--	6.73E-07
95-94-3	1,2,4,5-Tetrachlorobenzene	--	4.80E+00	4.80E+00
96-12-8	1,2-Dibromo-3-chloropropane	5.47E-02	1.60E+00	5.47E-02
106-93-4	1,2-Dibromoethane	2.19E-02	7.20E+01	2.19E-02

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
95-50-1	1,2-Dichlorobenzene	--	7.20E+02	7.20E+02
107-06-2	1,2-Dichloroethane	4.81E-01	1.60E+02	4.81E-01
540-59-0	1,2-Dichloroethene (Total)	--	7.20E+01	7.20E+01
78-87-5	1,2-Dichloropropane	1.22E+00	7.20E+02	1.22E+00
122-66-7	1,2-Diphenylhydrazine	1.09E-01	--	1.09E-01
57-55-6	1,2-Propanediol	--	1.60E+05	1.60E+05
142-28-9	1,3-Dichloropropane	--	3.20E+02	3.20E+02
85-44-9	1,3-Isobenzofurandione	--	3.20E+04	3.20E+04
106-46-7	1,4-Dichlorobenzene	8.10E+00	5.60E+02	8.10E+00
123-91-1	1,4-Dioxane	3.98E+00	8.00E+02	3.98E+00
71-36-3	1-Butanol	--	8.00E+02	8.00E+02
93-65-2	2-(2-methyl-4-chlorophenoxy) propionic acid	--	1.60E+01	1.60E+01
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	6.73E-06	--	6.73E-06
58-90-2	2,3,4,6-Tetrachlorophenol	--	4.80E+02	4.80E+02
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	2.24E-06	--	2.24E-06
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	6.73E-06	--	6.73E-06
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	6.73E-07	1.60E-05	6.73E-07
93-76-5	2,4,5-T(2,4,5-Trichlorophenoxyacetic acid)	--	1.60E+02	1.60E+02
93-72-1	2,4,5-TP(2-(2,4,5-Trichlorophenoxy)propionic acid)Silvex	--	1.28E+02	1.28E+02
95-95-4	2,4,5-Trichlorophenol	--	8.00E+02	8.00E+02
88-06-2	2,4,6-Trichlorophenol	3.98E+00	8.00E+00	3.98E+00
94-75-7	2,4-D(2,4-Dichlorophenoxyacetic acid)	--	1.60E+02	1.60E+02
94-82-6	2,4-DB(4-(2,4-Dichlorophenoxy)butanoic acid)	--	1.28E+02	1.28E+02

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
120-83-2	2,4-Dichlorophenol	--	2.40E+01	2.40E+01
105-67-9	2,4-Dimethylphenol	--	1.60E+02	1.60E+02
51-28-5	2,4-Dinitrophenol	--	3.20E+01	3.20E+01
121-14-2	2,4-Dinitrotoluene	2.82E-01	3.20E+01	2.82E-01
606-20-2	2,6-Dinitrotoluene	--	1.60E+01	1.60E+01
53-96-3	2-Acetylaminofluorene	2.30E-02	--	2.30E-02
78-93-3	2-Butanone	--	4.80E+03	4.80E+03
111-76-2	2-Butoxyethanol	--	4.00E+03	4.00E+03
91-58-7	2-Chloronaphthalene	--	6.40E+02	6.40E+02
95-57-8	2-Chlorophenol	--	4.00E+01	4.00E+01
95-49-8	2-Chlorotoluene	--	1.60E+02	1.60E+02
591-78-6	2-Hexanone	--	8.00E+01	8.00E+01
94-74-6	2-Methyl-4 chlorophenoxyacetic acid	--	8.00E+00	8.00E+00
91-57-6	2-Methylnaphthalene	--	3.20E+01	3.20E+01
95-48-7	2-Methylphenol (cresol, o-)	--	4.00E+02	4.00E+02
91-59-8	2-Naphthylamine	4.86E-02	--	4.86E-02
108-10-1	2-Pentanone, 4-Methyl	--	6.40E+02	6.40E+02
91-94-1	3,3'-Dichlorobenzidine	1.94E-01	--	1.94E-01
119-93-7	3,3'-Dimethylbenzidine	7.95E-03	--	7.95E-03
56-49-5	3-Methylcholanthrene	3.98E-03	--	3.98E-03
108-39-4	3-Methylphenol (cresol, m-)	--	4.00E+02	4.00E+02
99-09-2	3-Nitroaniline	4.17E+00	4.80E+00	4.17E+00
72-54-8	4,4'-DDD (Dichlorodiphenyldichloroethane)	3.65E-01	--	3.65E-01
72-55-9	4,4'-DDE (Dichlorodiphenyldichloroethylene)	2.57E-01	--	2.57E-01

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
50-29-3	4,4'-DDT (Dichlorodiphenyltrichloroethane)	2.57E-01	8.00E+00	2.57E-01
534-52-1	4,6-Dinitro-2-methylphenol	--	1.60E+00	1.60E+00
92-67-1	4-Aminobiphenyl	4.17E-03	--	4.17E-03
59-50-7	4-Chloro-3-methylphenol	--	1.60E+03	1.60E+03
106-47-8	4-Chloroaniline	2.19E-01	3.20E+01	2.19E-01
106-43-4	4-Chlorotoluene	--	1.12E+03	1.12E+03
106-44-5	4-Methylphenol (cresol, p-)	--	4.00E+01	4.00E+01
100-01-6	4-Nitroaniline	4.38E+00	6.40E+01	4.38E+00
100-02-7	4-Nitrophenol	--	1.28E+02	1.28E+02
99-55-8	5-Nitro-o-toluidine	2.65E+00	--	2.65E+00
57-97-6	7,12-Dimethylbenz[a]anthracene	3.50E-04	--	3.50E-04
83-32-9	Acenaphthene	--	9.60E+02	9.60E+02
67-64-1	Acetone	--	7.20E+03	7.20E+03
98-86-2	Acetophenone	--	8.00E+02	8.00E+02
107-02-8	Acrolein	--	4.00E+00	4.00E+00
107-13-1	Acrylonitrile	8.10E-02	3.20E+02	8.10E-02
309-00-2	Aldrin	2.57E-03	2.40E-01	2.57E-03
107-05-1	Allyl chloride	2.08E+00	--	2.08E+00
319-84-6	Alpha-BHC	1.39E-02	1.28E+02	1.39E-02
7429-90-5	Aluminum	--	1.60E+04	1.60E+04
62-53-3	Aniline	7.68E+00	5.60E+01	7.68E+00
120-12-7	Anthracene	--	4.80E+03	4.80E+03
7440-36-0	Antimony	--	6.40E+00	6.40E+00
140-57-8	Aramite	3.50E+00	8.00E+02	3.50E+00
12674-11-2	Aroclor-1016	1.25E+00	1.12E+00	1.12E+00

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
11104-28-2	Aroclor-1221	4.38E-02	--	4.38E-02
11141-16-5	Aroclor-1232	4.38E-02	--	4.38E-02
53469-21-9	Aroclor-1242	4.38E-02	--	4.38E-02
12672-29-6	Aroclor-1248	4.38E-02	--	4.38E-02
11097-69-1	Aroclor-1254	4.38E-02	3.20E-01	4.38E-02
11096-82-5	Aroclor-1260	4.38E-02	--	4.38E-02
7440-38-2	Arsenic	5.83E-02	4.80E+00	5.83E-02
103-33-3	Azobenzene	7.95E-01	--	7.95E-01
7440-39-3	Barium	--	3.20E+03	3.20E+03
71-43-2	Benzene	7.95E-01	3.20E+01	7.95E-01
56-55-3	Benzo(a)anthracene	1.20E-01	--	1.20E-01
50-32-8	Benzo(a)pyrene	1.20E-02	--	1.20E-02
205-99-2	Benzo(b)fluoranthene	1.20E-01	--	1.20E-01
207-08-9	Benzo(k)fluoranthene	1.20E-01	--	1.20E-01
65-85-0	Benzoic acid	--	6.40E+04	6.40E+04
100-51-6	Benzyl alcohol	--	8.00E+02	8.00E+02
7440-41-7	Beryllium	--	3.20E+01	3.20E+01
319-85-7	beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-BHC)	4.86E-02	--	4.86E-02
108-60-1	Bis(2-chloro-1-methylethyl)ether	6.25E-01	3.20E+02	6.25E-01
111-91-1	Bis(2-Chloroethoxy)methane	--	4.80E+01	4.80E+01
111-44-4	Bis(2-chloroethyl) ether	3.98E-02	--	3.98E-02
117-81-7	Bis(2-ethylhexyl) phthalate	6.25E+00	3.20E+02	6.25E+00
80-05-7	Bisphenol A	--	8.00E+02	8.00E+02
7440-42-8	Boron	--	3.20E+03	3.20E+03
108-86-1	Bromobenzene	--	1.28E+02	1.28E+02

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
75-27-4	Bromodichloromethane	7.06E-01	1.60E+02	7.06E-01
75-25-2	Bromoform	5.54E+00	1.60E+02	5.54E+00
74-83-9	Bromomethane	--	1.12E+01	1.12E+01
85-68-7	Butylbenzylphthalate	4.61E+01	3.20E+03	4.61E+01
7440-43-9	Cadmium	--	8.00E+00	8.00E+00
86-74-8	Carbazole	4.38E+00	--	4.38E+00
75-15-0	Carbon disulfide	--	8.00E+02	8.00E+02
56-23-5	Carbon tetrachloride	3.37E-01	5.60E+00	3.37E-01
57-74-9	Chlordane	2.50E-01	8.00E+00	2.50E-01
108-90-7	Chlorobenzene	--	1.60E+02	1.60E+02
510-15-6	Chlorobenzilate	7.95E-01	3.20E+02	7.95E-01
67-66-3	Chloroform	1.41E+00	8.00E+01	1.41E+00
126-99-8	Chloroprene	--	1.60E+02	1.60E+02
7440-47-3	Chromium	--	2.40E+04	2.40E+04
218-01-9	Chrysene	1.20E+00	--	1.20E+00
156-59-2	cis-1,2-Dichloroethylene	--	8.00E+01	8.00E+01
10061-01-5	cis-1,3-Dichloropropene	4.38E-01	2.40E+02	4.38E-01
7440-48-4	Cobalt	--	4.80E+00	4.80E+00
7440-50-8	Copper	--	6.40E+02	6.40E+02
57-12-5	Cyanide	--	3.20E+02	3.20E+02
108-94-1	Cyclohexanone	--	4.00E+04	4.00E+04
75-99-0	Dalapon	--	2.40E+02	2.40E+02
2303-16-4	Diallate	1.43E+00	--	1.43E+00
53-70-3	Dibenz[a,h]anthracene	1.20E-01	--	1.20E-01
132-64-9	Dibenzofuran	--	1.60E+01	1.60E+01

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
124-48-1	Dibromochloromethane	5.21E-01	1.60E+02	5.21E-01
74-95-3	Dibromomethane	--	8.00E+01	8.00E+01
1918-00-9	Dicamba	--	4.80E+02	4.80E+02
75-71-8	Dichlorodifluoromethane	--	1.60E+03	1.60E+03
60-57-1	Dieldrin	5.47E-03	8.00E-01	5.47E-03
60-29-7	Diethyl ether	--	1.60E+03	1.60E+03
84-66-2	Diethylphthalate	--	1.28E+04	1.28E+04
60-51-5	Dimethoate	--	3.20E+00	3.20E+00
84-74-2	Di-n-butylphthalate	--	1.60E+03	1.60E+03
88-85-7	Dinoseb(2-secButyl-4,6-dinitrophenol)	--	1.60E+01	1.60E+01
122-39-4	Diphenylamine	--	4.00E+02	4.00E+02
298-04-4	Disulfoton	--	6.40E-01	6.40E-01
959-98-8	Endosulfan I	--	9.60E+01	9.60E+01
33213-65-9	Endosulfan II	--	9.60E+01	9.60E+01
72-20-8	Endrin	--	4.80E+00	4.80E+00
141-78-6	Ethyl acetate	--	7.20E+03	7.20E+03
97-63-2	Ethyl methacrylate	--	7.20E+02	7.20E+02
100-41-4	Ethylbenzene	3.98E+00	8.00E+02	3.98E+00
107-21-1	Ethylene glycol	--	1.60E+04	1.60E+04
206-44-0	Fluoranthene	--	6.40E+02	6.40E+02
86-73-7	Fluorene	--	6.40E+02	6.40E+02
16984-48-8	Fluoride	--	4.80E+02	4.80E+02
58-89-9	Gamma-BHC (Lindane)	7.95E-02	4.80E+00	7.95E-02
76-44-8	Heptachlor	1.94E-02	8.00E+00	1.94E-02
1024-57-3	Heptachlor epoxide	4.81E-03	1.04E-01	4.81E-03

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
118-74-1	Hexachlorobenzene	5.47E-02	1.28E+01	5.47E-02
87-68-3	Hexachlorobutadiene	5.61E-01	8.00E+00	5.61E-01
77-47-4	Hexachlorocyclopentadiene	--	4.80E+01	4.80E+01
67-72-1	Hexachloroethane	3.13E+00	8.00E+00	3.13E+00
70-30-4	Hexachlorophene	--	4.80E+00	4.80E+00
110-54-3	Hexane	--	4.80E+02	4.80E+02
18540-29-9	Hexavalent Chromium	-	4.80E+01	4.80E+01
302-01-2	Hydrazine	1.46E-02	--	1.46E-02
193-39-5	Indeno(1,2,3-cd)pyrene	1.20E-01	--	1.20E-01
7439-89-6	Iron	--	1.12E+04	1.12E+04
78-83-1	Isobutyl alcohol	--	2.40E+03	2.40E+03
78-59-1	Isophorone	4.61E+01	1.60E+03	4.61E+01
98-82-8	Isopropylbenzene	--	8.00E+02	8.00E+02
143-50-0	Kepone	8.75E-03	4.80E+00	8.75E-03
7439-93-2	Lithium	--	3.20E+01	3.20E+01
7439-96-5	Manganese	--	2.24E+03	2.24E+03
99-65-0	m-Dinitrobenzene	--	1.60E+00	1.60E+00
7439-97-6	Mercury	--	4.80E+00	4.80E+00
126-98-7	Methacrylonitrile	--	8.00E-01	8.00E-01
67-56-1	Methanol	--	4.00E+03	4.00E+03
72-43-5	Methoxychlor	--	8.00E+01	8.00E+01
80-62-6	Methyl methacrylate	--	1.12E+04	1.12E+04
66-27-3	Methyl methanesulfonate	8.84E-01	--	8.84E-01
298-00-0	Methyl parathion	--	4.00E+00	4.00E+00
1634-04-4	Methyl tert-butyl ether	2.43E+01	--	2.43E+01

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
75-09-2	Methylene chloride	5.83E+00	4.80E+02	5.83E+00
7439-98-7	Molybdenum	--	8.00E+01	8.00E+01
108-38-3	m-Xylene	--	1.60E+03	1.60E+03
91-20-3	Naphthalene	--	1.60E+02	1.60E+02
7440-02-0	Nickel	--	3.20E+02	3.20E+02
14797-55-8	Nitrate	--	1.14E+05	1.14E+05
14797-65-0	Nitrite	--	4.80E+03	4.80E+03
98-95-3	Nitrobenzene	--	1.60E+01	1.60E+01
930-55-2	Nitrosopyrrolidine	2.08E-02	--	2.08E-02
55-18-5	n-Nitrosodiethylamine	2.92E-04	--	2.92E-04
62-75-9	n-Nitrosodimethylamine	8.58E-04	6.40E-02	8.58E-04
924-16-3	n-Nitrosodi-n-butylamine	8.10E-03	--	8.10E-03
621-64-7	n-Nitrosodi-n-dipropylamine	1.25E-02	--	1.25E-02
86-30-6	n-Nitrosodiphenylamine	1.79E+01	--	1.79E+01
10595-95-6	n-Nitrosomethylethylamine	3.98E-03	--	3.98E-03
59-89-2	n-Nitrosomorpholine	1.31E-02	--	1.31E-02
100-75-4	n-Nitrosopiperidine	9.31E-03	--	9.31E-03
103-65-1	n-Propylbenzene	--	8.00E+02	8.00E+02
39001-02-0	Octachlorodibenzofuran	2.24E-03	--	2.24E-03
3268-87-9	Octachlorodibenzo-p-dioxin	2.24E-03	--	2.24E-03
95-47-6	o-Xylene	--	1.60E+03	1.60E+03
56-38-2	Parathion	--	9.60E+01	9.60E+01
60-11-7	p-Dimethylaminoazobenzene	1.90E-02	--	1.90E-02
608-93-5	Pentachlorobenzene	--	1.28E+01	1.28E+01
76-01-7	Pentachloroethane	9.72E-01	--	9.72E-01

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
82-68-8	Pentachloronitrobenzene (PCNB)	3.37E-01	4.80E+01	3.37E-01
87-86-5	Pentachlorophenol	7.29E-01	4.80E+02	7.29E-01
14797-73-0	Perchlorate anion	--	1.12E+01	1.12E+01
62-44-2	Phenacetin	3.98E+01	--	3.98E+01
108-95-2	Phenol	--	2.40E+03	2.40E+03
298-02-2	Phorate	--	3.20E+00	3.20E+00
7723-14-0	Phosphorus	--	1.60E-01	1.60E-01
106-50-3	p-Phenylenediamine	--	3.04E+03	3.04E+03
23950-58-5	Pronamide	--	1.20E+03	1.20E+03
106-42-3	p-Xylene	--	1.60E+03	1.60E+03
129-00-0	Pyrene	--	4.80E+02	4.80E+02
110-86-1	Pyridine	--	8.00E+00	8.00E+00
94-59-7	Safrol	3.98E-01	--	3.98E-01
7782-49-2	Selenium	--	8.00E+01	8.00E+01
7440-22-4	Silver	--	8.00E+01	8.00E+01
7440-24-6	Strontium	--	9.60E+03	9.60E+03
100-42-5	Styrene	--	1.60E+03	1.60E+03
99-35-4	sym-Trinitrobenzene	--	4.80E+02	4.80E+02
127-18-4	Tetrachloroethene	8.10E-02	8.00E+01	8.10E-02
3689-24-5	Tetraethyl dithiopyrophosphate (Sulfotepp)	--	8.00E+00	8.00E+00
7440-31-5	Tin	--	9.60E+03	9.60E+03
7440-32-6	Titanium	--	6.40E+04	6.40E+04
108-88-3	Toluene	--	6.40E+02	6.40E+02
1319-77-3	Total cresols	--	1.60E+03	1.60E+03
8001-35-2	Toxaphene	7.95E-02	--	7.95E-02

Table 6-1. Results of the Calculation of Method B Groundwater Cleanup Levels

CAS #	Chemical Name	Carcinogen (µg/L)	Non-Carcinogen (µg/L)	Final Groundwater CUL (µg/L)
156-60-5	trans-1,2-Dichloroethylene	--	1.60E+02	1.60E+02
10061-02-6	trans-1,3-Dichloropropene	4.38E-01	2.40E+02	4.38E-01
126-73-8	Tributyl phosphate	9.51E+00	3.20E+03	9.51E+00
79-01-6	Trichloroethene	4.92E-01	--	4.92E-01
75-69-4	Trichloromonofluoromethane	--	2.40E+03	2.40E+03
115-96-8	Tris-2-chloroethyl phosphate	4.38E+00	1.12E+02	4.38E+00
7440-61-1	Uranium	--	4.80E+01	4.80E+01
7440-62-2	Vanadium	--	8.00E+01	8.00E+01
108-05-4	Vinyl acetate	--	8.00E+03	8.00E+03
75-01-4	Vinyl chloride	6.08E-02	2.40E+01	6.08E-02
1330-20-7	Xylenes (total)	--	1.60E+03	1.60E+03
7440-66-6	Zinc	--	4.80E+03	4.80E+03

Figure 5-1. Equation 720-1 Hand Calculations

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Equation 720-1 Hand Calculation

$$\frac{mg/kg\text{-}day \cdot 16\ kg \cdot 1000\ \mu g/mg \cdot 1 \cdot 6\ years}{1\ L/day \cdot [INH\ (unitless)] \cdot 1 \cdot 6\ years}$$ unit check

$= \mu g/L$ ✓

Noncarcinogen - Volatile

Benzene (CAS 71-43-2)

$$\text{Groundwater Cleanup } (\mu g/L) = \frac{RFD \times ABW \times UCF \times HQ \times AT}{DWIR \times INH \times DWF \times ED}$$

$$= \frac{0.004\ mg/kg\text{-}day * 1 * 16\ kg * 1000\ \mu g/kg\text{-}6\ years}{1\ L/day * 2 * 1 * 6\ years}$$

$= 32\ \mu g/L$ ✓

Noncarcinogen - NonVolatile

3-Nitroaniline (CAS 99-09-2)

$$\text{Groundwater Cleanup} = \frac{3E\text{-}04\ mg/kg\text{-}day * 1 * 16\ kg * 1000\ \mu g/mg * 6\ years}{1\ L/day * 1 * 1 * 6\ years}$$

$= 4.8\ \mu g/L$ ✓

Figure 5-2. Equation 720-2 Hand Calculations

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Equation 720-2 Hand Calculation

$$\frac{(10^{-6}) \cdot 70\,Kg \cdot 75\,years \cdot 1000\,\mu g/mg}{kg\text{-}day/mg \cdot 2\,L/day \cdot 30\,years \cdot [INH\ (unitless)] \cdot AWT\ (unitless)}$$

$= \mu g/L$ ✓

Carcinogen (volatile)

Benzene (CAS 71-43-2)

$$\text{Groundwater Cleanup} = \frac{10^{-6} * 70\,Kg * 75\,years * 1000\,\mu g/mg}{0.055\,Kg\text{-}day/mg * 2\,L/day \cdot 2 * 1 * 30\,years}$$

$= 0.795\,\mu g/L$ ✓

Carcinogen (nonvolatile)

3-Nitroaniline (CAS 99-09-2)

$$\text{Groundwater Cleanup} = \frac{10^{-6} * 70\,Kg * 75\,years * 1000\,\mu g/mg}{0.021\,kg\text{-}day/mg * 2\,L/day * 1 * 1 * 30\,years}$$

$= 4.167\,\mu g/L$ ✓