

## Trichloroethylene Toxicity Information and MTCA Cleanup Levels (TCE), CAS # 79-01-6

### **Background Information**

The United States Environmental Protection Agency (EPA) recently published updated toxicity information for trichloroethylene (TCE). The new information was published in EPA's Integrated Risk Information System (IRIS) on-line database on September 28, 2011.

The Washington State Department of Ecology (Ecology) Cleanup Levels and Risk Calculation (CLARC) on-line database contains toxicity information and presents pre-calculated Method B and C formula values used to establish cleanup standards.

Ecology is updating CLARC's pre-calculated formula values to reflect the new EPA IRIS toxicity values for TCE by (1) updating Method B and C values for soil, groundwater, surface water, air, and the leaching pathway and (2) updating the narrative guidance for TCE to reflect the recent changes in IRIS.

TCE is a known human carcinogen. The new IRIS toxicity values include oral cancer potency factors (CPFo's) and inhalation unit risks for three kinds of cancer: kidney tumors, non-Hodgkin lymphoma, and liver cancer. One of these, cancer of the kidney, operates through a mutagenic mode of action and poses an increased risk to children. The calculations presented in this guidance acknowledge early life susceptibility for kidney cancer only and apply age-dependant adjustment factors (ADAFs) when calculating the associated Method B formula cleanup values for this cancer potency factor.

Making this adjustment under MTCA is complicated by the MTCA equations being a simplified version of the EPA risk equations. To overcome this difference, the formula-based cleanup level values for the three types of cancer are calculated separately and then the harmonic mean of these three values is determined to derive the final formula-based cleanup level. This approach is consistent with EPA regulatory guidance and information in IRIS.

No adjustment for early life exposure is made under Method C since these cleanup levels are based on an adult exposure scenario. Instead, the cancer potency factors for the three types of cancer are summed and the summed value used in the calculations.

TCE is also known to cause a wide range of non-cancer adverse health effects. EPA has published for the first time in IRIS an oral reference dose (RfDo) and inhalation reference dose (RfDi) for TCE. This information has also been used to calculate formula-based cleanup level values for non cancer risk using the MTCA equations.

Under MTCA, the more stringent of the cancer and non-cancer driven cleanup value becomes the cleanup level. For TCE, this is typically (but not always) the value based on protection from cancer.

Note that according to the Model Toxics Control Act (MTCA) cleanup regulation, in addition to these formula-based values, a variety of narrative standards must also be met, so the formula-based values may or may not be the final cleanup level. For example, actual cleanup standards established for a site must also comply with applicable state and federal laws, which have not changed.

Please note that the MTCA Method A cleanup levels for TCE have not changed. If a site qualifies for the use of Method A and Method A is being used to determine TCE cleanup levels, the Method A values in Tables 720-1, 740-1 and 745-1 can still be used.

### **Cancer Risk**

Updated toxicity information provided by EPA for TCE includes three CPFo's and inhalation unit risks for TCE based on three cancer end points (Tables 1 and 2). All three CPFo's are used to calculate a single MTCA cancer risk-based cleanup level. The three TCE cancer end points are:

- TCE Cancer Potency Factor based on kidney cancer. EPA has determined that TCE is carcinogenic by a mutagenic mode of action for the induction of kidney tumors. Based on EPA guidance, individuals exposed to carcinogens with a mutagenic mode of action are assumed to have increased early-life susceptibility and require application of ADAFs. To calculate MTCA cancer risk-based cleanup levels for soils, groundwater, and air, ADAFs have been applied to the CPFo or inhalation unit risk based on cancer effects to the kidney. ADAFs have **not** been applied to MTCA cancer risk-based cleanup levels for surface water because the MTCA surface water cancer cleanup equation is based on adult fish consumption. In addition, fish consumption rates are highly variable across different regions, populations, and age groups and Ecology believes insufficient information is currently available to make an adjustment based on the amount of fish consumed at by different age groups. This may change as additional fish consumption information become available.
- TCE Cancer Potency Factor based on non-Hodgkin lymphoma (NHL). EPA has determined that there is insufficient information to characterize the mode of action for TCE induced NHL and, therefore, no ADAFs are applied for this cancer endpoint.
- TCE Cancer Potency Factor based on liver cancer. EPA has determined that there is insufficient information to characterize the mode of action for TCE induced liver cancer and, therefore, no ADAFs are applied for this cancer endpoint.

### **Non Cancer Health Effects**

In addition to cancer, exposure to TCE causes a wide range of non-cancer adverse health effects. For example, IRIS notes:

“Adverse noncancer effects associated with oral TCE exposure include decreased body weight, liver and kidney effects, and neurological, immunological, reproductive, and developmental effects.”

IRIS further notes the following regarding the development of reference doses (RfDs):

“The most sensitive observed adverse effects, which were used as the primary basis for the RfD, were those affecting the immune system and the developing fetus, and were all based on oral studies.”

### **More on Early-Life Exposure Age Dependent Adjustments**

Cancer is one of many adverse health effects that may occur in children resulting from exposures to environmental contaminants. In March 2005, the EPA addressed the potential for increased susceptibility to cancer caused by exposures to environmental chemicals during an early lifestage in “Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.”<sup>1</sup> This regulatory guidance is a companion document to the revised “Guidelines for Carcinogen Risk Assessment” originally published by the EPA in 1986 and revised in 2005.<sup>2</sup> Using different methodologies to evaluate cancer potency, the EPA and the California Environmental Protection Agency (Cal-EPA) have independently concluded that risks of cancer from exposures to carcinogens occurring from conception through puberty (i.e., <16 years old) can be different than those cancer risks from exposures occurring in adulthood.

EPA and Cal-EPA have assessed and developed age groupings to help evaluate childhood exposures to environmental contaminants. Both agencies apply age related factors to adjust the cancer potencies to consider early life susceptibility for infants and children. Although the age groupings between the agencies vary slightly, the adjustment factors are the same. For EPA, the age adjustment factors are termed: Age Dependent Adjustment Factors (ADAFs)<sup>3</sup>; for Cal-EPA the age adjustment factors are termed Age Sensitivity Factors (ASFs).<sup>4</sup> These adjustment factors have been used to calculate cleanup levels under this guidance.

### **TCE Toxicity Values for Establishing Cleanup Levels Under MTCA**

Tables 1 and 2 below provide the new toxicity values for TCE published in IRIS. These toxicity values are used to establish risk-based cleanup levels under MTCA.

### **MTCA Cleanup Levels for TCE**

Tables 4 through 8 below provide MTCA Method B and C cleanup levels protective of various exposure pathways for TCE.

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<sup>1</sup> Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. U.S. Environmental Protection Agency, Risk Assessment Forum, March 2005. EPA/630/R-03/003F. (Available at [http://www.epa.gov/ttn/atw/childrens\\_supplement\\_final.pdf](http://www.epa.gov/ttn/atw/childrens_supplement_final.pdf))

<sup>2</sup> Guidelines for Carcinogen Risk Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum, 2005. EPA/630/P-03/001F.

<sup>3</sup> Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. U.S. Environmental Protection Agency, Risk Assessment Forum, March 2005. EPA/630/R-03/003F.

<sup>4</sup> Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II, Technical Support Document for Cancer Potency Factors, June 2008, Public Review Draft, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment.

Table 1: New Trichloroethylene (TCE) Oral Cancer Potency (Slope) Factors <sup>5</sup> (Used for calculating, soil, groundwater and surface water cleanup levels)					
Toxicity Value Based on Kidney Cancer With A Mutagenic Mode of Action & Potential for Early Life Exposure (ELE)		Toxicity Value Based on Non-Hodgkin Lymphoma (NHL)		Toxicity Value Based on Liver Cancer	
<b>9.33E-03 (mg/kg-day)<sup>-1</sup></b>		<b>2.16E-02 (mg/kg-day)<sup>-1</sup></b>		<b>1.55E-02 (mg/kg-day)<sup>-1</sup></b>	
<b>ELE Adjustment Factor</b> For groundwater = <b>3.26 liter-yr/kg-day (a)</b> For soil = <b>400 mg-year/kg-day (b)</b>		<b>No adjustment needed</b>		<b>No adjustment needed</b>	
IRIS also provides the sum of the three individual cancer types, resulting in <b>total oral cancer Cancer Potency Factor of 4.64E-02 per mg/kg-day</b> . This cancer potency factor is used for calculation of Method B surface water cleanup levels and all Method C cleanup levels.					
<b>(a)</b> The early life exposure (ELE) adjustment factor <u>for drinking water</u> was determined using the following equation: $\text{ELE Adj. Factor} = \frac{(\text{ADAF} * \text{ED} * \text{DWIR})_{(<2 \text{ yrs})}}{\text{BW}} + \frac{(\text{ADAF} * \text{ED} * \text{DWIR})_{(2 \text{ to } <6 \text{ yrs})}}{\text{BW}} + \frac{(\text{ADAF} * \text{ED} * \text{DWIR})_{(6 \text{ to } <16 \text{ yrs})}}{\text{BW}} + \frac{(\text{ADAF} * \text{ED} * \text{DWIR})_{(16 \text{ to } 30 \text{ yrs})}}{\text{BW}}$					
<b>(b)</b> The early life exposure (ELE) adjustment factor <u>for soil ingestion</u> was determined using the following equation <sup>6</sup> $\text{ELE Adj. Factor} = \frac{(\text{ADAF} * \text{ED} * \text{SIR})_{(<2 \text{ yrs})}}{\text{BW}} + \frac{(\text{ADAF} * \text{ED} * \text{SIR})_{(2 \text{ to } <6 \text{ yrs})}}{\text{BW}}$					
Where the assumptions used for the various age ranges in these equations were as follows:					
Early-Life Exposure Age Adjustment Assumptions					
Parameter		<2 yrs	2 to <6 yrs	6 to <16 yrs	16 to 30 yrs
<b>ADAFs</b>	Age Dependent Adjustment Factor (unitless)	10	3	3	1
<b>ED</b>	Exposure Duration (years)	2	4	10	14
<b>DWIR</b>	Drinking Water Ingestion Rate (liters/day)	1	1	2	2
<b>SIR</b>	Soil Ingestion Rate (mg/day)	200	200	50	50
<b>BW</b>	Body Weight (kg)	16	16	70	70
Source of information: U.S. EPA's Integrated Risk Information System (IRIS) <a href="http://www.epa.gov/iris/subst/0199.htm">http://www.epa.gov/iris/subst/0199.htm</a>					

<sup>5</sup> MTCA uses the term "Cancer Potency Factor", abbreviated here as CPF; EPA uses the term (cancer) "Slope Factor" in the Integrated Risk Information System (IRIS). The units are (mg/kg-day)<sup>-1</sup> or risk per mg/kg-day.

<sup>6</sup> Adjusted for only 6 years since MTCA uses a 6 year exposure scenario for soil ingestion of carcinogens.

<b>Table 2: New Trichloroethylene (TCE) Inhalation Unit Risk Factors (URF) and Inhalation Cancer Potency (Slope) Factors (CPF<sub>i</sub>)<sup>7</sup> (Used for calculating air cleanup levels)</b>					
<b>Toxicity Value Based on Kidney Cancer With A Mutagenic Mode of Action &amp; Potential for Early Life Exposure (ELE)</b>		<b>Toxicity Value Based on Non-Hodgkin Lymphoma (NHL)</b>		<b>Toxicity Value Based on Liver Cancer</b>	
URF = 10 <sup>-6</sup> (μg/m <sup>3</sup> ) <sup>-1</sup>		URF = 2E-06 (μg/m <sup>3</sup> ) <sup>-1</sup>		URF = 10 <sup>-6</sup> (μg/m <sup>3</sup> ) <sup>-1</sup>	
<b>Converted to CPF<sub>i</sub> (a)</b> <b>= 3.5E-03 (mg/kg-day)<sup>-1</sup></b>		<b>Converted to CPF<sub>i</sub> (a)</b> <b>= 7.0E-03 (mg/kg-day)<sup>-1</sup></b>		<b>Converted to CPF<sub>i</sub> (a)</b> <b>= 3.5E-03 (mg/kg-day)<sup>-1</sup></b>	
<b>ELE Adjustment Factor (b)</b> <b>32.6 ug-year/kg-day</b>		<b>No adjustment needed</b>		<b>No adjustment needed</b>	
IRIS also provides the sum of the three individual cancer types, resulting in <b>total inhalation unit risk factor of 4.1E-06 (ug/m<sup>3</sup>)<sup>-1</sup> or CPF<sub>i</sub> of 1.44E-02 (mg/kg-day)<sup>-1</sup></b> . This cancer potency factor is used for calculation of Method C air cleanup levels.					
<b>(a)</b> The following equation was used to convert the EPA cancer unit risk factor (URF) to an inhalation cancer potency (slope) factor: CPF <sub>i</sub> (kg-day/mg) = (URF [m <sup>3</sup> /μg] × 70 kg) ÷ (20 m <sup>3</sup> /day × 10 <sup>-3</sup> mg /μg)					
<b>(b)</b> The early life exposure (ELE) adjustment factor was determined using the following equation: ELE Adj. Factor = $\frac{(ADAF*ED*BR)_{(<2 \text{ yrs})}}{BW} + \frac{(ADAF*ED*BR)_{(2 \text{ to } <6 \text{ yrs})}}{BW} + \frac{(ADAF*ED*BR)_{(6 \text{ to } <16 \text{ yrs})}}{BW} + \frac{(ADAF*ED*BR)_{(16 \text{ to } 30 \text{ yrs})}}{BW}$					
Where the assumptions used for the various age ranges were as follows:					
<b>Early-Life Exposure Age Adjustment Assumptions</b>					
<b>Parameter</b>		<b>&lt;2 yrs</b>	<b>2 to &lt;6 yrs</b>	<b>6 to &lt;16 yrs</b>	<b>16 to 30 yrs</b>
<b>ADAFs</b>	Age Dependent Adjustment Factor (unitless)	10	3	3	1
<b>ED</b>	Exposure Duration (years)	2	4	10	14
<b>BR</b>	Breathing Rate (cubic meters/day)	10	10	20	20
<b>BW</b>	Body Weight (kg)	16	16	70	70
Source of information: U.S. EPA's Integrated Risk Information System (IRIS) <a href="http://www.epa.gov/iris/subst/0199.htm">http://www.epa.gov/iris/subst/0199.htm</a>					

<b>Table 3: New Trichloroethylene (TCE) Toxicity Values - Non-Cancer Toxicity Values</b>	
<b>Oral Reference Dose (RfDo)</b>	<b>Inhalation Reference Dose (RfDi)</b>
<b>5.0E-04 mg/kg-day</b>	<b>5.7E-04 mg/kg-day ( or 2.0E-03 mg/m<sup>3</sup>)</b>
The following equation was used to convert the EPA inhalation reference concentration (RfC) to an inhalation reference dose (RfDi): $RfDi = (RfC [mg/m^3] \div 70 \text{ kg}) \times 20 \text{ m}^3/\text{day}$	
Source of information: U.S. EPA's Integrated Risk Information System (IRIS) <a href="http://www.epa.gov/iris/subst/0199.htm">http://www.epa.gov/iris/subst/0199.htm</a>	

<sup>7</sup> EPA uses the term "Unit Risk Factor" in risk calculations for the air exposure pathway. The MTCA rule uses the term "Cancer Potency Factor". Until the MTCA rule is updated to incorporate this new EPA approach, the URF needs to be converted to a cancer potency factor so the current MTCA equations can be used to calculate cleanup levels.

<b>Table 4: MTCA Standard Method B and C Groundwater Cleanup Levels for Trichloroethylene (TCE) for Drinking Water (potable groundwater)</b> [see WAC 173-340-720(4) & (5)] (a)				
Toxicity Values from Table 2	MTCA Method B (µg /L)		MTCA Method C (µg /L)	
	Eqn 720-1 Non-Cancer (@ HQ=1)	Eqn 720-2 Cancer (@Risk = 10 <sup>-6</sup> )	Eqn 720-1 (mod) Non-Cancer (@ HQ=1) (c)	Eqn 720-2 Cancer (@Risk = 10 <sup>-5</sup> )
Using old CPF <sub>0</sub> of 0.089 per mg/kg-day	-----	0.5	-----	5.0
Using 3 new CPF <sub>0</sub> 's	-----	5.4E-01 (b)	-----	9.4E+00 (d)
Using old RfD <sub>0</sub> of 0.0003 mg/kg-day	2.4	-----	5.3	-----
Using new RfD <sub>0</sub> of 0.0005 mg/kg-day	4.0E+00	-----	8.8E+00	-----
Applicable State and Federal Law: State & Federal MCL = 5.0 µg/L; Federal drinking water standards located at: <a href="http://water.epa.gov/action/advisories/drinking/drinking_index.cfm">http://water.epa.gov/action/advisories/drinking/drinking_index.cfm</a>				
<b>New TCE Potable Groundwater Cleanup Levels (e)</b>				
	MTCA Method B		MTCA Method C	
	<b>4 µg/L</b>		<b>5 µg/L</b>	
(a) All cleanup levels calculated using an inhalation correction factor (INH) = 2.				
(b) Method B (cancer) groundwater CUL = 1/[1/CUL for Kidney] + (1/CUL for Lymphoma) + (1/CUL for Liver)] Where: Kidney CUL = (RISK x AT x UCF) / (CPF <sub>0</sub> x ELE Adjustment Factor x INH x DWF) <sup>8</sup> [CUL = 1.23 µg/L] Lymphoma CUL calculated using Equation 720-2 and CPF <sub>0</sub> of 0.0216 (mg/kg-day) <sup>-1</sup> [CUL = 1.64 µg/L] Liver CUL calculated using Equation 720-2 and CPF <sub>0</sub> of 0.0155 (mg/kg-day) <sup>-1</sup> [CUL = 2.28 µg/L]				
(c) Method C (non-cancer) groundwater CUL calculated using equation 720-1 modified for an adult exposure scenario by changing the body weight to 70 kg and the drinking water intake rate to 2 liters/day per WAC 173-340-720(5).				
(d) Method C (cancer) groundwater CUL calculated using Equation 720-2, a cancer risk of 10 <sup>-5</sup> and a CPF <sub>0</sub> = 4.64E-02 mg/kg-day (sum of 3 CPF <sub>0</sub> 's with no ELE adjustment).				
(e) Normally, under MTCA, Ecology would use the MCL of 5 µg/L for TCE as the Method B cleanup level. However, in this case, the new toxicity information indicates the MCL exceeds a hazard quotient of 1. Therefore, under WAC 173-340-720 (7)(b), the MCL must be adjusted downward to 4 ug/L, so that the Method B cleanup level will not exceed a hazard quotient of 1. Thus, 4 ug/L is used as the Method B groundwater cleanup level. Because the MCL does not exceed either a hazard quotient of 1 or a cancer risk of 1x10 <sup>-5</sup> , the MCL can be used as the Method C cleanup level.				
<b>NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk, PQLs and natural background per WAC 173-340-720(7). (They are already adjusted for ARARs.) Also, if contaminants in the groundwater are likely to discharge to a surface water, surface water CULs may need to be considered when determining a final CUL (see Table 5).				

<sup>8</sup> See WAC 173-340-720(4) for definitions of terms in this equation. Because the age-adjusted cancer potency factor already takes into account body weight, drinking water ingestion rate and exposure duration, these factors are left out of this equation when calculating this cleanup level.

<b>Table 5: MTCA Standard Method B and C Surface Water Cleanup Levels for Trichloroethylene (TCE) [see WAC 173-340-730(3) &amp; (4)]</b>				
<b>Toxicity Values from Table 2</b>	<b>MTCA Method B (µg /L)</b>		<b>MTCA Method C (µg /L)</b>	
	<b>Eqn 730-1 Non-Cancer (@ HQ=1)</b>	<b>Eqn 730-2 Cancer (@ Risk = 10<sup>-6</sup>)</b>	<b>Eqn 730-1 (mod) Non-Cancer (@ HQ=1) (c)</b>	<b>Eqn 730-2 (mod) Cancer (@ Risk = 10<sup>-5</sup>)</b>
Old CPF <sub>0</sub> : 0.089 per mg/kg-day	-----	6.7	-----	170
Using 3 CPF <sub>0</sub> 's with <b>no ELE Adjustment</b>	-----	<b>1.3E+01 (a)</b>	-----	<b>3.2E+02 (b)</b>
Old RfD <sub>0</sub> : 0.0003 mg/kg-day	71	-----	180	-----
New RfD <sub>0</sub> : 0.0005 mg/kg-day	<b>1.2E+02</b>	-----	<b>3.0E+02</b>	-----
<b>Applicable State &amp; Federal Law: Ambient water quality criteria (AWQC)</b>				
U.S. EPA's AWQC	Drinking Water + organism consumption = 2.5 µg/L			
	Consumption of organism only = 30.0 µg/L			
U.S. EPA's AWQC web location: <a href="http://water.epa.gov/scitech/swguidance/standards/current/index.cfm">http://water.epa.gov/scitech/swguidance/standards/current/index.cfm</a>				
<b>New MTCA Surface Water Cleanup levels (d)</b>				
	<b>MTCA Method B</b>		<b>MTCA Method C</b>	
	<b>2.5 µg/L or 30 µg/L</b>		<b>2.5 µg/L or 30 µg/L</b>	
<b>(a) Method B</b> (cancer) surface water CUL calculated using Equation 730-2, a BCF = 11 L/kg, and a CPF <sub>0</sub> of 4.64E-02 mg/kg-day (sum of 3 CPF <sub>0</sub> 's with no ELE adjustment).				
<b>(b) Method C</b> (cancer) surface water CUL calculated using Equation 730-2, cancer risk of 10 <sup>-5</sup> , BCF = 11 L/kg, FDF = 0.2, per WAC 173-340-730(4), and a CPF <sub>0</sub> of 4.64E-02 mg/kg-day (sum of 3 CPF <sub>0</sub> 's with no ELE adjustment).				
<b>(c) Method C</b> (non-cancer) surface water CULs calculated using Equation 730-1, a BCF = 11 L/kg, and FDF = 0.2, per WAC 173-340-730(4).				
<b>(d)</b> MTCA requires CULs to comply with ARARs, which in this case are the federal and state water quality criteria. This includes consideration of both the survivability of the organisms and risk to humans eating fish and shellfish. It also includes consideration of whether or not the surface water has drinking water as a designated beneficial use under state law.				
<b>The most stringent ARARs for TCE are the Federal Ambient Water Quality Criteria (AWQC), and thus these criteria govern the cleanup levels in this case. If drinking the surface water is identified as a beneficial use under WAC 173-340-201A, then use 2.5 ug/L as the cleanup level. Otherwise, use 30 ug/L.</b>				
<b>NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk, PQLs and natural background per WAC 173-340-730(5). (They are already adjusted for ARARs.)				

<b>Table 6: MTCA Standard Method B and C Soil Cleanup Levels for Trichloroethylene (TCE) Protective of the Soil Ingestion Pathway</b> [see WAC 173-340-740 (3)(b)(iii)(B) & 173-340-745(5)(b)(iii)(B)]				
Toxicity Values from Table 2	MTCA Method B (mg/kg)		MTCA Method C (mg/kg)	
	Eqn 740-1 Non-Cancer (@ HQ=1)	Eqn 740-2 Cancer (@Risk = 10 <sup>-6</sup> )	Eqn 745-1 Non-Cancer (@ HQ=1)	Eqn 745-2 Cancer (@Risk = 10 <sup>-5</sup> )
Using old CPF <sub>0</sub> of 0.089 per mg/kg-day	-----	11	-----	1,480
Using 3 new CPF <sub>0</sub> 's	-----	1.2E+01 (a)	-----	2.8E+03 (b)
Using old RfD <sub>0</sub> of 0.0003 mg/kg-day	24	-----	1,050	-----
Using new RfD <sub>0</sub> of 0.0005 mg/kg-day	4.0E+01	-----	1.8E+03	-----
<b>New TCE Soil Cleanup Levels for the Soil Ingestion Pathway (c)</b>				
	MTCA Method B		MTCA Method C	
	<b>11 mg/kg</b>		<b>1,800 mg/kg</b>	
(a) <u>Method B</u> (cancer) soil CUL = 1/[1/CUL for Kidney) + (1/CUL for Lymphoma) + (1/CUL for Liver)] Where: Kidney CUL = (RISK x AT x UCF) / (CPF <sub>0</sub> x ELE Adjustment Factor x AB1 x EF) <sup>9</sup> [CUL = 20.1 mg/kg] Lymphoma CUL calculated using Equation 740-2, and CPF <sub>0</sub> = 0.0216 (mg/kg-day) <sup>-1</sup> [CUL = 46.3 mg/kg] Liver CUL calculated using Equation 740-2, and CPF <sub>0</sub> = 0.0155 (mg/kg-day) <sup>-1</sup> [CUL = 64.5 mg/kg]				
(b) <u>Method C</u> (cancer) soil CUL calculated using equation 745-2, and a CPF <sub>0</sub> = 4.64E-02 mg/kg-day. (sum of 3 CPF <sub>0</sub> 's with no ELE adjustment)				
(c) <b>NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk, PQLs and natural background per WAC 173-340-740(5) and 745(6). (There are no known ARARs, so there is no adjustment for ARARs.) Also, this is just the soil ingestion exposure pathway. Other pathways such as leaching (see Table 7) and vapors may need to be considered when determining a final cleanup level.				

<sup>9</sup> See WAC 173-340-740(3) for definitions of terms in this equation. Because the age-adjusted cancer potency factor already takes into account body weight, soil ingestion rate and exposure duration, these factors are left out of this equation when calculating this cleanup level.

<b>Table 7: MTCA Soil Cleanup Levels for Trichloroethylene (TCE) Protective of Potable Groundwater through the Soil Leaching Pathway (see WAC 173-340-747(4))</b>				
<b>Target Groundwater Cleanup Level</b>	<b>Based on Protection of Potable Groundwater</b>		<b>Based on Protection of Surface Water</b>	
	<b>Method B Drinking H2O (see Table 4)</b>	<b>Method C Drinking H2O (See Table 4)</b>	<b>Drinking H2O and Fish Consumption (see Table 5)</b>	<b>Fish Consumption Only (see Table 5)</b>
	4.0 µg/L	5.0 µg/L	2.5 µg/L	30 µg/L
<b>New TCE Soil Cleanup Level for Leaching Pathway (a)</b>	<b>0.03 mg/kg</b>	<b>0.03 mg/kg</b>	<b>0.02 mg/kg</b>	<b>0.2 mg/kg</b>
<p>(a) Calculated using Equation 747-1 (3-phase model), default assumptions and the following TCE specific properties: Koc = 94 L/kg; Henry's Law Constant (Hcc) = 0.422 (unitless)</p> <p>These values are the same for unrestricted and industrial uses as the surface land use (zoning) does not affect the leachability of a chemical.</p> <p><b>NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk, PQLs and natural background per WAC 173-340-740(5) and 745(6). (There are no known ARARs, so there is no adjustment needed for ARARs.)</p>				

<b>Table 8: MTCA Standard Method B and C Air Cleanup Levels for Trichloroethylene (TCE) [WAC 173-340-750(3)and (4)]</b>				
<b>Toxicity Values from Table 2</b>	<b>MTCA Method B (<math>\mu\text{g}/\text{m}^3</math>)</b>		<b>MTCA Method C (<math>\mu\text{g}/\text{m}^3</math>)</b>	
	<b>Eqn 750-1 Non-Cancer (@ HQ = 1)</b>	<b>Eqn 750-2 Cancer (@ Risk = <math>10^{-6}</math>)</b>	<b>Eqn 750-1 (mod) Non-Cancer (c) (@ HQ = 1)</b>	<b>Eqn 750-2 Cancer (@ Risk = <math>10^{-5}</math>)</b>
Using old $\text{CPF}_0$ of 0.089 per mg/kg-day	-----	0.10	-----	1.0
Using new $\text{CPF}_i$ 's	-----	3.7E-01 (a)	-----	6.3E+00 (b)
Using old $\text{RfD}_i$ of 0.01 mg/kg-day	16	-----	35	-----
Using new $\text{RfD}_i$ of 5.7E-04 mg/kg-day	9.0E-01	-----	2.0E+00	-----
<b>New TCE Air Cleanup Levels (d)</b>				
	<b>MTCA Method B</b>		<b>MTCA Method C</b>	
	<b>0.37 <math>\mu\text{g}/\text{m}^3</math></b>		<b>2.0 <math>\mu\text{g}/\text{m}^3</math></b>	
<p>(a) <u>Method B</u> (cancer) Air CUL = <math>1/[(1/\text{CUL for Kidney})+(1/\text{CUL for Lymphoma})+(1/\text{CUL for Liver})]</math></p> <p>Where:</p> <p>Kidney CUL = <math>(\text{RISK} \times \text{AT} \times \text{UCF}) / (\text{CPF}_i \times \text{ELE Adjustment Factor} \times \text{ABS} \times \text{EF})^{10}</math> [CUL = 0.658 <math>\mu\text{g}/\text{m}^3</math>]</p> <p>Lymphoma CUL calculated using Equation 750-2 and <math>\text{CPF}_i = 7.00\text{E-}3</math> (mg/kg-day)<math>^{-1}</math> [CUL = 1.25 <math>\mu\text{g}/\text{m}^3</math>]</p> <p>Liver CUL calculated using Equation 750-2 and <math>\text{CPF}_i = 3.5\text{E-}3</math>(mg/kg-day)<math>^{-1}</math> [CUL = 2.50 <math>\mu\text{g}/\text{m}^3</math>]</p>				
<p>(b) <u>Method C</u> (cancer) air CUL calculated using equation 750-2, a cancer risk of <math>10^{-5}</math>, and a <math>\text{CPF}_i = 1.435\text{E-}02</math> (mg/kg-day)<math>^{-1}</math>. (sum of 3 <math>\text{CPF}_i</math>'s with no ELE adjustment)</p>				
<p>(c) <u>Method C</u> (non-cancer) air CUL calculated using equation 750-1 modified for an adult exposure scenario by changing the body weight to 70 kg and the breathing rate to 20 <math>\text{m}^3/\text{day}</math> per WAC 173-340-750(4).</p>				
<p>(d) These are not necessarily final cleanup levels. These values may need to be adjusted for ARARs, additive risk, PQLs and natural background per WAC 173-340-750(5).</p>				

<sup>10</sup> See WAC 173-340-750(3) for definitions of terms in this equation. Because the age-adjusted cancer potency factor already takes into account body weight, breathing rate and exposure duration, these factors are left out of this equation when calculating this cleanup level.

**Tetrachloroethylene Toxicity Information & MTCA Cleanup Levels  
(Perc, PCE, Perchloroethylene)  
CAS # 127-18-4**

**Background Information**

On February 10, 2012, the U.S. Environmental Protection Agency (EPA) provided new toxicity values for its Integrated Risk Information System (IRIS) for tetrachloroethylene (CAS # 127-18-4). The new IRIS toxicity information for tetrachloroethylene is summarized in the Table 1 below. No early-life exposure age adjustments are required for tetrachloroethylene because EPA has determined that there is insufficient or equivocal information to characterize the carcinogenic mode of action for tetrachloroethylene as mutagenic.

**Table 1: New IRIS Toxicity Information for Tetrachloroethylene**

	<b>Oral Cancer Potency Factor (CPFo) (a) (mg/kg-day)<sup>-1</sup></b>	<b>Inhalation Cancer Potency Factor (CPFi) (b) (mg/kg-day)<sup>-1</sup></b>	<b>Oral Reference Dose (RfDo) (mg/kg-day)</b>	<b>Inhalation Reference Dose (RfDi) (c) (mg/kg-day)</b>
Old Tox Values	0.54	0.021	0.01	Not available
New Tox Values:	<b>2.1E-03</b>	<b>9.1E-04</b>	<b>6.0E-03</b>	<b>1.14E-02</b>

(a) MTCA uses the term (oral) “Cancer Potency Factor” or CPFo; EPA uses the term (oral cancer) “Slope Factor” in the Integrated Risk Information System (IRIS). The units are the same for both terms (mg/kg-day)<sup>-1</sup>.

(b) EPA uses the term “Unit Risk Factor” (URF) in risk calculations for the air exposure pathway. The MTCA rule uses the term (inhalation) “Cancer Potency Factor” (CPFi). Until the MTCA rule is updated to incorporate this new EPA approach, the URF needs to be converted to a cancer potency factor so the current MTCA equations can be used to calculate cleanup levels.

Inhalation URF for tetrachloroethylene = 2.6E-07 per µg/ m<sup>3</sup>

To convert this URF to an inhalation CPF use the following equation:

$$\text{CPFi (kg-day/mg)} = (\text{URF [m}^3/\mu\text{g]} * 70 \text{ kg}) \div (20 \text{ m}^3/\text{day} * 10^{-3} \text{ mg}/\mu\text{g})$$

$$\text{Perc CPFi} = 9.1\text{E-}04 \text{ kg-day/mg}$$

(c) Similarly, EPA uses the term “Reference Concentration” (RfC), while MTCA uses the term (inhalation) reference dose (RfDi).

RfC for tetrachloroethylene = 4E-02 mg/m<sup>3</sup>

To convert a RfC to a RfDi using the following equation:

$$\text{RfDi} = (\text{RfC [mg/m}^3] \div 70 \text{ kg}) * 20 \text{ m}^3/\text{day};$$

$$\text{Perc RfDi} = 1.14\text{E-}02 \text{ mg/kg-day}$$

U.S. Environmental Protection Agency, Integrated Risk Information System, link:

<http://www.epa.gov/iris/index.html>

<b>Table 2: MTCA Standard Method B and C Groundwater Cleanup Levels for Tetrachloroethylene (Perc) [WAC 173-340-720(4) &amp; (5)] (a)</b>				
<b>Toxicity Values From Table 1</b>	<b>MTCA Method B (µg/L)</b>		<b>MTCA Method C (µg/L)</b>	
	<b>Eqn 720-1 Non-Cancer (@ HQ = 1)</b>	<b>Eqn 720-2 Cancer (@ Risk = 10<sup>-6</sup>)</b>	<b>Eqn 720-1 (mod) Non-Cancer (@ HQ = 1) (b)</b>	<b>Eqn 720-2 Cancer (@ Risk = 10<sup>-5</sup>)</b>
Using new CPFo of 2E-03 (mg/kg-day) <sup>-1</sup>	-----	2.1E+01	-----	2.1E+02
Using new RfDo of 6E-03 mg/kg-day	4.8E+01	-----	1.1E+02	-----
Applicable State and Federal Law: State & Federal MCL = 5.0 µg/L; Federal drinking water standards located at: <a href="http://water.epa.gov/action/advisories/drinking/drinking_index.cfm">http://water.epa.gov/action/advisories/drinking/drinking_index.cfm</a>				
<b>New Perc Groundwater Cleanup Levels (c)</b>				
	<b>MTCA Method B</b>		<b>MTCA Method C</b>	
	<b>5 µg/L</b>		<b>5 µg/L</b>	
<b>(a)</b> All cleanup levels calculated using an inhalation correction factor (INH) = 2.				
<b>(b)</b> <u>Method C</u> (non-cancer) groundwater CUL calculated using equation 720-1 modified for an adult exposure scenario by changing the body weight to 70 kg and the drinking water intake rate to 2 liters/day per WAC 173-340-720(5).				
<b>(c)</b> Because the MCL does not exceed a hazard quotient of 1 or a cancer risk of 1 x 10 <sup>-5</sup> , the MCL can be used as the Method B and Method C ground water cleanup level [WAC 173-340-720 (7) (b)]. Thus, the MTCA groundwater cleanup levels are based on the drinking water standard (MCL) for Perc of 5 µg/L.				
<b>NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk, PQLs and natural background per WAC 173-340-720(7). (They are already adjusted for ARARs.)				
Also, if contaminants in the groundwater are likely to discharge to a surface water, surface water CULs may need to be considered when determining a final CUL (see Table 3).				

<b>Table 3: MTCA Standard Method B and C Surface Water Cleanup Levels for Tetrachloroethylene (Perc) [WAC 173-340-730(3) and (4)] (a)</b>				
Toxicity Values from Table 1	MTCA Method B (µg /L)		MTCA Method C (µg /L) (b)	
	Eqn 730-1 Non-Cancer (@ HQ=1)	Eqn 730-2 Cancer (@ Risk = 10 <sup>-6</sup> )	Eqn 730-1 (mod) Non-Cancer (@ HQ=1)	Eqn 730-2 (mod) Cancer (@ Risk = 10 <sup>-5</sup> )
Using new CPFo of 2E-03 (mg/kg-day) <sup>-1</sup>	-----	1.0E+02	-----	2.5E+03
Using new RfDo of 6E-03 mg/kg-day	5.0E+02	-----	1.3E+03	-----
<b>Applicable State &amp; Federal Law: Ambient water quality criteria (AWQC)</b>				
U.S. EPA's AWQC	Drinking Water + organism consumption = 0.69 µg/L			
	Consumption of organism only = 3.3 µg/L			
U.S. EPA's AWQC web location: <a href="http://water.epa.gov/scitech/swguidance/standards/current/index.cfm">http://water.epa.gov/scitech/swguidance/standards/current/index.cfm</a>				
<b>New MTCA Surface Water Cleanup levels (c)</b>				
	<b>MTCA Method B</b>		<b>MTCA Method C</b>	
	<b>0.69 µg/L or 3.3 µg/L</b>		<b>0.69 µg/L or 3.3 µg/L</b>	
<p>(a) All cleanup levels calculated using a BCF = 31 liters/kg.</p> <p>(b) Method C cleanup levels calculated using equations 730-1 and 730-2 modified with a FDF = 0.2 and a cancer risk of 1x 10<sup>-5</sup> per WAC 173-340-730(4).</p> <p>(c) MTCA requires CULs to comply with ARARs, which in this case are the federal and state water quality criteria. This includes consideration of both the survivability of the organisms and risk to humans eating fish and shellfish. It also includes consideration of whether or not the surface water has drinking water as a designated beneficial use under state law.</p> <p><b>The most stringent ARARs for Perc are the Federal Ambient Water Quality Criteria (AWQC), and thus these criteria govern the cleanup levels in this case. If drinking the surface water is identified as a beneficial use under WAC 173-340-201A, then use 0.69 ug/L as the cleanup level. Otherwise, use 3.3 ug/L.</b></p> <p><b>NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk, PQLs and natural background per WAC 173-340-730(5). (They are already adjusted for ARARs.)</p>				

<b>Table 4: MTCA Standard Method B and C Soil Cleanup Levels for Tetrachloroethylene (Perc) Protective of the Soil Ingestion Pathway [see WAC 173-340-740 (3)(b)(iii)(B) &amp; 173-340-745(5)(b)(iii)(B)]</b>				
Toxicity Values from Table 2	MTCA Method B (mg/kg)		MTCA Method C (mg/kg)	
	Eqn 740-1 Non-Cancer (@ HQ=1)	Eqn 740-2 Cancer (@ Risk = 10 <sup>-6</sup> )	Eqn 745-1 Non-Cancer (@ HQ=1)	Eqn 745-2 Cancer (@ Risk = 10 <sup>-5</sup> )
Using new CPFO of 2E-03 (mg/kg-day) <sup>-1</sup>	-----	4.8E+02	-----	6.3E+04
Using new RfDo of 6E-03 mg/kg-day	4.8E+02	-----	2.1E+04	-----
<b>New Perc Soil Cleanup Levels for the Soil Ingestion Pathway (a)</b>				
	MTCA Method B		MTCA Method C	
	<b>480 mg/kg</b>		<b>21,000 mg/kg</b>	
<p><b>(a) NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk PQLs and natural background per WAC 173-340-740(5) and 745(6). (There are no known ARARs, so there is no adjustment for ARARs.)</p> <p>Also, this is just the soil ingestion exposure pathway. Other pathways such as leaching (see Table 5) and vapors may need to be considered when determining a final cleanup level.</p>				

<b>Table 5: MTCA Soil Cleanup Levels for Tetrachloroethylene (Perc) Protective of Potable Groundwater through the Soil Leaching Pathway (see WAC 173-340-747(4))</b>				
Target Groundwater Cleanup Level	Based on Protection of Potable Groundwater		Based on Protection of Surface Water	
	Method B Drinking H2O (see Table 2)	Method C Drinking H2O (See Table 2)	Drinking H2O and Fish Consumption (see Table 3)	Fish Consumption Only (see Table 3)
		5.0 µg/L	5.0 µg/L	0.69 µg/L
<b>New Perc Soil Cleanup Level for Leaching Pathway (a)</b>	<b>0.05 mg/kg</b>	<b>0.05 mg/kg</b>	<b>0.007 mg/kg</b>	<b>0.04 mg/kg</b>
<p><b>(a)</b> Calculated using Equation 747-1 (3-phase model), default assumptions and the following Perc specific properties: Koc = 265 L/kg; Henry's Law Constant (Hcc) = 0.754 (unitless)</p> <p>These values are the same for unrestricted and industrial uses as the surface land use (zoning) does not affect the leachability of a chemical.</p> <p><b>NOTE:</b> These are not necessarily final cleanup levels. These values may need to be adjusted for additive risk, PQLs and natural background per WAC 173-340-740(5) and 745(6). (There are no known ARARs, so there is no adjustment needed for ARARs.)</p>				

<b>Table 6: MTCA Standard Method B and C Air Cleanup Levels for Tetrachloroethylene (Perc) [WAC 173-340-750(3)and (4)]</b>				
<b>Toxicity Values from Table 1</b>	<b>MTCA Method B (<math>\mu\text{g}/\text{m}^3</math>)</b>		<b>MTCA Method C (<math>\mu\text{g}/\text{m}^3</math>)</b>	
	<b>Eqn 750-1 Non-Cancer (@ HQ = 1)</b>	<b>Eqn 750-2 Cancer (@ Risk = <math>10^{-6}</math>)</b>	<b>Eqn 750-1 (mod) Non-Cancer (a) (@ HQ = 1)</b>	<b>Eqn 750-2 Cancer (@ Risk = <math>10^{-5}</math>)</b>
Using new CPFi of $9.10\text{E-}04$ ( $\text{mg}/\text{kg}\text{-day}$ ) <sup>-1</sup>	-----	9.6E+00	-----	9.6E+01
Using new RfDi of $1.14\text{E-}02$ $\text{mg}/\text{kg}\text{-day}$	1.8E+01	-----	4.0E+01	-----
<b>New Perc Air Cleanup Levels (b)</b>				
	<b>MTCA Method B</b>		<b>MTCA Method C</b>	
	<b>9.6 <math>\mu\text{g}/\text{m}^3</math></b>		<b>40 <math>\mu\text{g}/\text{m}^3</math></b>	
<b>(a)</b> Method C (non-cancer) air CUL calculated using equation 750-1 modified for an adult exposure scenario by changing the body weight to 70 kg and the breathing rate to $20 \text{ m}^3/\text{day}$ per WAC 173-340-750(4).				
<b>(b)</b> These are not necessarily final cleanup levels. These values may need to be adjusted for ARARs, additive risk, PQLs and natural background per WAC 173-340-750(5).				