RATIONALE FOR THE DEVELOPMENT OF SOIL AND GROUND WATER STANDARDS FOR USE AT CONTAMINATED SITES IN ONTARIO

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Abbreviations, Acronyms, Definitions & Initialisms

ADDCR	Average Daily Dermal Contact Rate
ADSIE	Average Daily Soil Inhalation Exposure
ADSIR	Average Daily Soil Intake Rate
APV	Aquatic Protection Value
AWQC	Ambient Water Quality Criterion
BAF	Bioattenuation Factor
BGL	Below Ground Level
Comm/Ind	Commercial and Industrial
CICIAP	Cancer industrial/commercial indoor air prorating (factor)
CRIAP	Cancer residential indoor air prorating (factor)
CRL	Cancer risk level
DNAPL	Dense, non-aqueous liquid
CICIAP	Cancer Industrial/Commercial Indoor Air Prorating (factor)
CRIAP	Cancer Residential Indoor Air Prorating (factor)
CRL	Cancer Risk Level
DNAPL	Dense, Non-Aqueous Phase Liquid
ETD	Ecological Toxicity Database
foc	fraction organic carbon
GW	Groundwater
GW1	Exposure pathway due to ingestion of potable groundwater
GW2	Exposure pathway due to inhalation of indoor air containing soil vapour from groundwater at water table
GW3	Exposure pathway to aquatic biota via groundwater discharge to surface water
HHCV	Human Health Component Value
HQ	Hazard Quotient
IAC	Indoor Air Concentration
I/C/C	Industrial/Commercial/Community
J&E	Johnson & Ettinger model for movement of vapour from soil or groundwater into a building
LADDCR	Lifetime Average Daily Dermal Contact Rate
LADSIE	Lifetime Average Daily Soil Inhalation Exposure
LADSIR	Lifetime Average Daily Soil Intake Rate
LOAEC	Lowest Observed Adverse Effect Concentration
M/F	Medium and Fine-grained soil
NAPL	Non-Aqueous Phase Liquid
NCICIAP	Non- Cancer Industrial/Commercial Indoor Air Prorating (factor)
NCRIAP	Non- Cancer Residential Indoor Air Prorating (factor)
NOEC	No Observed Effect Concentration
NOAEC	No Observed Adverse Effect Concentration
ODWQS	Ontario Drinking Water Quality Standard
PHCs	Petroleum Hydrocarbons
QP	Qualified Person as prescribed by Ontario Regulation 153/04
R/P/I	Residential/Parkland/Institutional

RAF	Relative Absorption Factor
RAIS	Oak Ridges National Laboratory's Risk Assessment Information System
RfC	Reference Concentration
RfD	Reference Dose
RL	Reporting Limit
S-1	Component for direct exposure to soil via soil ingestion and dermal contact appropriate for a residential scenario
S-2	Component for direct exposure to soil via soil ingestion and dermal contact appropriate for a commercial/industrial scenario
S-3	Component for direct exposure to soil via soil ingestion and dermal contact appripriate for the subsurface soil in a commercial/industrial scenario
S-IA	Exposure pathway due to inhalation of indoor air containing soil vapour
S-GW1	Exposure pathway due to movement of a substance from the soil to groundwater then to a human receptor via drinking water.
S-GW3	Exposure pathway due to movement of a substance from soil to groundwater then to aquatic receptors in a surface water body.
S-O	Exposure pathway due to odour from surface soil
S-OA	Exposure pathway due to inhalation of soil vapour in outdoor air
SAF	Source Allocation Factor
SCS	Site Condition Standard
SD	Source Depletion
SDB	Standards Development Branch of the Ontario Ministry of the Environment
SDM	Source Depletion Multiplier
TDI	Tolerable Daily Intake
Tier 2	Modified Generic Risk Assessment – a process where generic SCSs are modified by site parameters using the same models as used for the generic standards
TRV	Toxicological Reference Value
USSCS	United States Soil Conservation Service
WBD	Well Bore Dilution

1 INTRODUCTION

This document describes the process for developing the revised generic, soil and groundwater Site Condition Standards (SCSs) that are in Tables 1 through 9 of Ontario Regulation 153/04 made under *the Environmental Protection Act*. The revised SCSs are contained in Tables 1-9 of the "Soil Ground Water and Sediment Standards for use Under Part XV.1 of the *Environmental Protection Act*". This document does not deal with sediment standards as they have not been changed from the sediment standards in the 2004 tables, and which are still the Lowest Effect Levels from the "Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (1993)". The sediment standards in the tables are not meant to replace the 1993 guidelines, but are used here for the purposes of Reg 153/04.

This document also introduces an overview of the principles of Tier 2, that is, the Modified Generic process, designed to enable revision of the Generic SCSs by using site-specific values, which better capture the site's protective features, as inputs to the same algorithms used by MOE to derive the Generic SCSs. Such revised SCSs are called Tier 2, Property-Specific Standards (PSSs), or more simply, Tier 2 standards. A user guide to the Tier 2 (Modified Generic Risk Assessment) model can be found on the Ministry of the Environment's website.

1.1 Background

The development of effects-based numeric values for use at contaminated sites in Ontario essentially began in the early 1980s with the need for clean-up of the Shell and Texaco refinery lands in Oakville and Port Credit. Information made available from that process and the criteria that were developed for these sites formed the basis of the numeric values that were used in the 1989 "*Guideline for the Decommissioning and Clean-up of Sites in Ontario*". A supporting document titled "*Soil Clean-up Guidelines for Decommissioning of Industrial Lands: Background and Rationale for Development*" was published in 1991. However, the process of development was often viewed as not having been transparent, and it is difficult from that document to determine how particular numbers were arrived at. In 1993, the Ministry of the Environment (MOE) in consultation with the Petroleum industry developed "*Interim Guidelines for the Assessment and Management of Petroleum Contaminated Sites in Ontario*". This document relied heavily on Alberta derived criteria and professional judgement to develop criteria, and, as such, the procedures for development are not completely clear and the derived numbers were not always effects-based, transparent or precisely reproducible.

In 1993, the MOE embarked on a process of developing new criteria for a wider variety of contaminants for use at contaminated sites. The approach that was being used by Massachusetts Department of Environmental Protection (MADEP) (referred to as the Massachusetts Contingency Plan or MCP) was adopted with a number of Ontario-specific modifications, including the addition of ecological and soil-gas migration to indoor air components; the use of existing Ontario or Canadian health-based numbers (namely, for dioxins/furans, PCBs, lead, arsenic, total petroleum hydrocarbons), background values and analytical capabilities, where

appropriate. These numeric criteria were implemented and published in 1996 under the title "*Guideline for Use at Contaminated Sites in Ontario*" and a full rationale document, "*Rationale for the Development and Application of Generic Soil, Groundwater and Sediment Criteria for Use at Contaminated Sites in Ontario*".

In May of 2001, Ontario signed on to the Canada Wide Standards (CWS) agreement, which included a commitment to either adopt the CWS for Petroleum Hydrocarbons (PHCs) in soils or use methods that provide at least the same degree of protection. With the passing of amendments to the EPA through the *Brownfields Statute Law Amendment Act 2001*, and the subsequent passing of Regulation 153/04 in 2004, the 1996 numeric soil and groundwater criteria (excluding the PHC values) and the PHC CWS generic values became the Generic Site Condition standards in Ontario.

Thus, most of the Generic Site Condition Standards used at contaminated sites in Ontario under the 2004 O.Reg 153/04 dated back to between 1985 and 1996. As a result of advances in knowledge, including improvements in procedures for developing criteria, such as the CCME protocols, and due to feedback from external stakeholders and Ministry staff over the last ten years, there was a need to review the standards and update them with current science.

External stakeholders and Ministry staff had identified issues with the 1996 criteria and 2004 standards related to:

- the need for additional standards;
- the use of outdated toxicity data and lack of transparency;
- the need to address additional exposure pathways;
- the lack of consideration of certain receptors for some contaminants (terrestrial);
- impractical/unrealistic settings for commercial/industrial land use (inclusion of basement for industrial use and residential human receptors assumptions);
- cross-media transfer of metals (leaching to groundwater) not adequately considered;
- degradation to vinyl chloride over time not adequately considered;
- models and settings for contaminant transport which do not represent best practice and are not transparent;
- the need for an approach that is amenable to a "Tier 2" modified generic approach;
- models for human health exposure which are not consistent with practices in other jurisdictions; and
- background standards which may be inequitable for some land uses.

As a result, significant modifications were made to the standards development proces, and as part of a regulatory amendment package, a new set of standards was passed into law in December of 2009, to take effect on July 1, 2011. Minor modifications were made to adjust for issues found after posting the new standards. This document reflects those changes.

1.2 Guiding Principles

The guiding principles for the development of effects-based criteria were described in the 1996 document "*Rationale for the Development and Application of Generic Soil, Groundwater and Sediment Criteria for Use at Contaminated Sites in Ontario*". These principles were the foundation for the current review, and are re-stated below.

The development of effects-based criteria for the Guideline was based on the following major guiding principles:

1. Remediation of contaminated sites will take place to levels which will protect against potential adverse effects or the likelihood of adverse effects to human health, ecosystem health and the natural environment resulting from contamination due to human activities, and which will result in the removal of free product and waste materials. Therefore, should such materials remain on-site, the use of these Generic Site Condition Standards may not be appropriate and risk management measures or risk assessment may be required.

2. The protection of human/ecological health and the natural environment will be predicated on effects-based criteria for soil, water and sediment quality. Development of the criteria will be based on:

    a) protection of relevant receptors in three land and two groundwater use classes, for both coarse-textured and medium/fine-textured soil situations;

    b) consideration of exposure frequency and intensity via relevant pathways; and

    c) the physical and chemical characteristics that affect contaminant transport and fate in the environment.

3. The Generic Site Condition Standards represent levels of contaminants at which no further remedial response actions would be required based upon the potential risk of harm posed by these contaminants.

4. The Generic Site Condition Standards represent one of three assessment/remediation options, the other two being to apply site-specific criteria derived through the Tier 2 and Tier 3 risk assessment approaches.

A number of major underlying principles and assumptions have also been made:

i) Due to the very lengthy timeframes needed for the creation of soil, soil is regarded as a non-renewable natural resource that is essential for the current and future health and well being of the residents of Ontario; once contaminated, it is very difficult and expensive to restore.

ii) Soil criteria will be based on the most sensitive of four main components:

a) human health - direct contact, ingestion and odour;

b) leaching from soil to groundwater;

c) vapour migration from soil to indoor air; and

d) terrestrial ecological protection.

iii) Groundwater is a shared, natural resource that is essential for the current and future health and well being of the residents of Ontario; once contaminated it is very difficult and expensive to restore.

iv) The protection of groundwater will take into consideration possible future uses of that resource and can not be based solely on the current presence or absence of a drinking water well.

v) In order to ensure the future quality of the groundwater in Ontario, the remediation of contaminated soil will take into consideration the leaching of contaminants to the underlying groundwater.

vi) Groundwater quality will be based not only on its suitability for use as a source of drinking water, but also on its potential to transport contaminants to:

a) surface water bodies, as a result of groundwater discharge, where contaminants could affect aquatic life; and

b) the indoor air of structures, as a result of vapour migration sourced from groundwater, where contaminants could affect human health.

vii) The generic SCS approach is intended to protect "typical" receptors potentially exposed at contaminated sites rather than the most sensitive of all possible receptors. However, the generic SCS may not provide adequate protection for sites that are considered 'Potentially Sensitive'. As such, additional work may have to be undertaken to ensure adequate protection based on site-specific conditions.

1.3 Overview of Development Process for Generic Site-Condition Standards

1.3.1 Background

The use of the Tables of Site Condition Standards fits into a broader framework for the assessment and remediation of contaminated sites. In most circumstances site assessments are

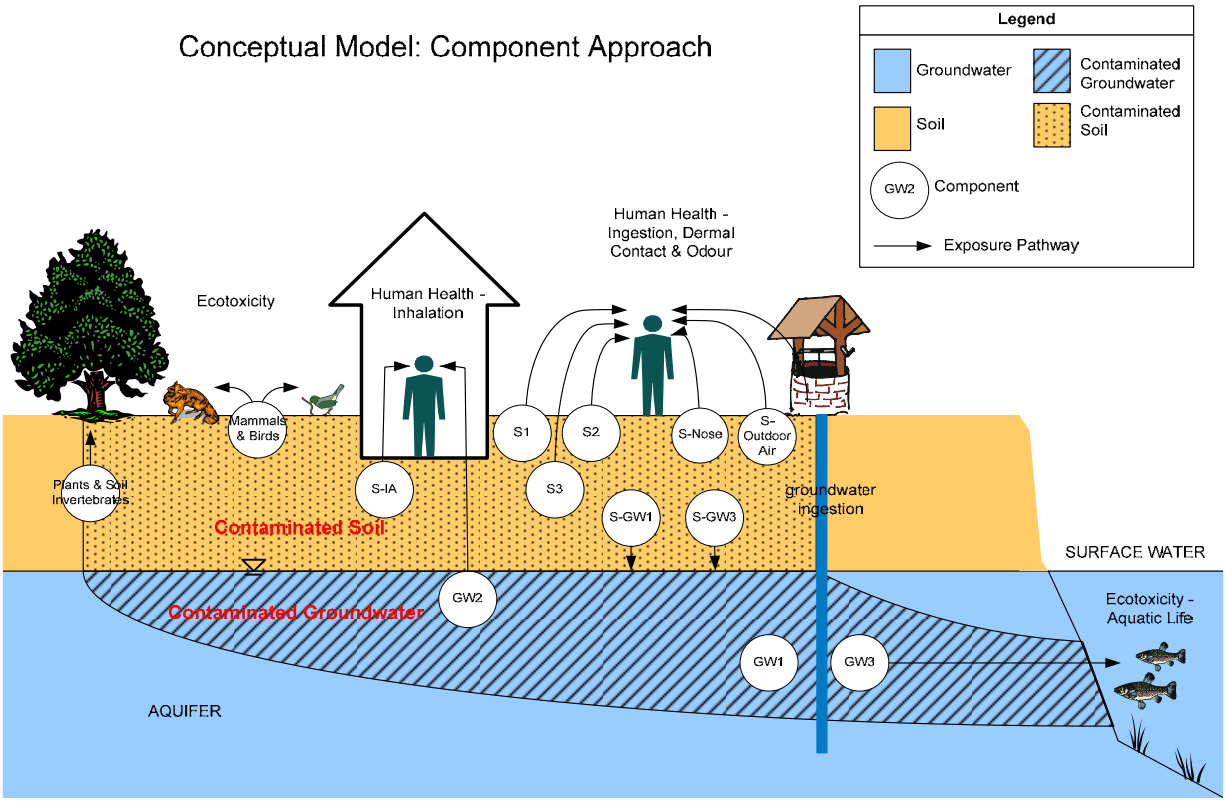
conducted and the test results compared to the generic "Tables of Site Condition Standards". Many jurisdictions refer to this as "Tier 1". Should some contaminant concentrations exceed the generic (Tier 1) standards, the option exists for the proponent to modify the Generic Site Condition Standards according to physical (or sometimes chemical) properties that are specific to the site, while retaining the same models, toxicity and exposure parameters and degree of protection. This is referred to by most jurisdictions as "Tier 2". If the "Tier 1" models are reasonably simple, include the ability to alter the important physical properties, and are readily available, then Tier 2 can be a reasonably simple process. Should Tier 2 not be feasible, then the proponent has the option to either remediate the site or proceed to a full scale risk assessment in which the models and more of the assumptions can be varied. This is often referred to as a "Tier 3" risk assessment. This document deals with the procedures and assumptions for use at the Tier 1 (generic) and Tier 2 level.

Standards Development Branch (SDB) has been receiving comments and suggestions for improvement of the process for developing generic, site-condition standards for use at contaminated sites since the inception of the "Guideline for Use at Contaminated Sites in Ontario" in 1996. Over the last few years a concerted effort has been made to assess and incorporate comments and suggestions made from staff and from stakeholders into the process, and to update the toxicity and physical chemical data upon which the process is based. The remainder of this document describes the procedures that SDB is utilizing for derivation of new Tables of Site Condition Standards, and gives the rationale behind those suggestions. The priocedures arise from a review of the process used to develop existing standards, which incorporated the 1996 numeric guidelines. The review considered information provided from stakeholder comments, from reports by consulting companies and from internal MOE discussions and consultations. The remainder of this introduction focuses on the revised process, with some comparisons to the 1996 process.

1.3.2 The Component Process for Development of Generic Site Condition Standards

The Tables of Site Condition Standards are developed through the use of a number of component values. A component value is developed to provide a receptor or group of receptors protection from a contaminant via a specific pathway. The lowest value from all the components that are relevant to a specific land use/potability/depth class is then used to develop a given standard. For example, a soil standard could be driven by the component value that protects the aquatic environment from chemicals that leach through the soil to the groundwater and then migrate into surface water. A generalized conceptual model showing the pathways and receptors that are covered by the proposed revised method of developing Tables of Site Condition Standards is presented in Figure 1.1. Detailed descriptions of the components and pathways are included in later sections of this document.

Figure 1.1 Generalized Conceptual Model of Generic Pathways (see text for details)



The following is a list and description of all the components that are used in the development of the SCSs described in this document.

<u>Groundwater Site Condition Standards</u>

The groundwater SCSs are developed from three components; the drinking water component (GW1), the protection of indoor air from vapours originating from groundwater component (GW2) and the protection of the aquatic environment component (GW3).

GW1 - Where an Ontario Drinking Water Quality Standard (ODWQS) exists, it is used for this component value. Failing this, drinking water values from other credible jurisdictions are used in the following priority sequence; Canadian Drinking Water Guidelines (CDWG), United States Environmental Protection Agency (US EPA) Maximum Contaminant Level (MCL), California EPA (CalEPA), European Union (EU), and World Health Organization (WHO). When there are no drinking water values from any of the above jurisdictions, a value is calculated using a drinking water exposure model and human health toxicity reference values (Tolerable Daily Intakes (TDIs) and oral Cancer Slope Factors (CSF_O)). In addition, where data are available and where no ODWQSs or CDWGs are available, odour thresholds are applied. There is only one GW1 value for both soil textures.

GW2 - A partitioning model coupled with the Johnson-Ettinger model for movement into structures is used to back-calculate a groundwater value from the water table based on acceptable indoor air concentrations for health and odour. Source depletion is not considered (see Section 7.1 for rationale). The GW2 component can be different for the two soil textures.

GW3 - An aquatic protection value is used to back-calculate a groundwater concentration 30 metres back from the surface water body. The Dominico-Schwarz, 2-D, continuous, finite-source transport model for groundwater is used to do this. Ten times dilution by the surface water body is assumed. The GW3 values are the same for the two soil textures, since groundwater movement is assumed in both cases to occur in a coarse textured layer. These value are also assumed to provide a sufficient degree of protection to plants, soil organisms, mammals and birds such that separate calculations for these receptors for ingestion or exposure to shallow groundwater or groundwater seeps is not needed.

Potable Groundwater Standard - This is the lowest of the above three values, but is not allowed to be below the reporting limits (RL) or the background concentration, or above ½ of solubility limits. There can be different values for the two soil textures.

Non-Potable Groundwater Standard - This is the lowest of the GW2 and GW3 values, but is not allowed to be below the Reporting Limit (RL) or the background concentration, or above ½ of solubility limits. There can be different values for the two soil textures.

<u>Soil Site Condition Standards</u>

The soil SCSs are developed from the following 10 components:

S1 - This is a high-frequency, high-intensity, human health exposure scenario equivalent to that of a surface soil at a residential/parkland/institutional or agricultural/other site (children and pregnant women are present). The soil value is calculated using toxicity reference values (TRVs) and a soil ingestion and dermal exposure model.

S2 - This is a lower-frequency and lower-intensity, human health exposure scenario without children present and is used at commercial/ and industrial/community sites or at depth at residential/parkland/institutional or agricultural/other sites. The soil value is calculated using TRVs and a soil ingestion and dermal exposure model.

S3 - This is a low-frequency, high-intensity, human health exposure scenario without children present that is protective of a worker digging in the soil. It is used for sub-surface soils at commercial/industrial/community sites. The soil value is calculated using TRVs and a soil ingestion, dermal exposure and particulate inhalation exposure model.

S-IA (Soil to Indoor Air) - A partitioning model coupled with the Johnson-Ettinger model (in 1996 the O'Connor model was used) for vapour intrusion into buildings is used to back-calculate a soil concentration that will be protective of indoor air toxicity reference values and odour. Source depletion is considered (see Section 7.0 for rationale). The S-IA value will vary with soil texture.

S- OA (Soil to Outdoor Air) – A volatilization model combined with an atmospheric mixing cell were used to back-calculate soil concentrations which are protective of outdoor air.

S-Odour - A partitioning model combined with an inhalation dilution factor is used to calculate soil concentrations that will not result in unacceptable odours from direct sniffing of the soil. It will vary with soil texture. Source depletion is considered.

S-GW1 (Soil to Potable Groundwater) - A partitioning model combined with a well-bore dilution factor is used to calculate soil values that are protective of the GW1 values. S-GW1 varies with soil texture. Source depletion is considered. With the exception of for mercury and methyl mercury, S-GW1 is not calculated for metals.

S-GW3 (Soil to Groundwater to Surface Water) - A partitioning model and vertical migration model is coupled with the GW3 value to produce soil values that are protective of aquatic life. It varies with soil texture. With the exception of for mercury and methyl mercury, S-GW3 is not calculated for metals.

Direct Terrestrial Ecological – Information from peer-reviewed journal articles is used to derive soil values that are protective of plants and soil-dwelling organisms. The 1996 CCME protocols are used (with some modification). This value varies with soil texture.

Mammals and birds - Toxicity reference values are determined and used in exposure models that back-calculate soil concentrations to be protective of some representative mammalian and avian species (American woodcock, meadow vole, sheep, red-winged blackbird, red fox, short-tailed shrew). This value does not vary with soil texture since soil-to-plant uptake factors that are required are not available for different soil textures,

The lowest of the appropriate (i.e. according to land use, potability and soil depth) components above are used to determine the soil Generic Site Condition Standards for each parameter. The standards are not permitted to be below RLs or background values, or above free phase product formation thresholds. Note that the S-GW2 value is not used, as this value can never drive a soil value to below a S-IA value. (see section 7.3.3) The following figures outline the process for developing the standards for groundwater (Figure 1.2) and soils (Figure 1.3) from the component values. In addition it is noted that if no effect-based numbers can be derived, then the standard defaults to the background standard in Table 1.

Figure 1.2: Overview of the Groundwater SCS Development Process

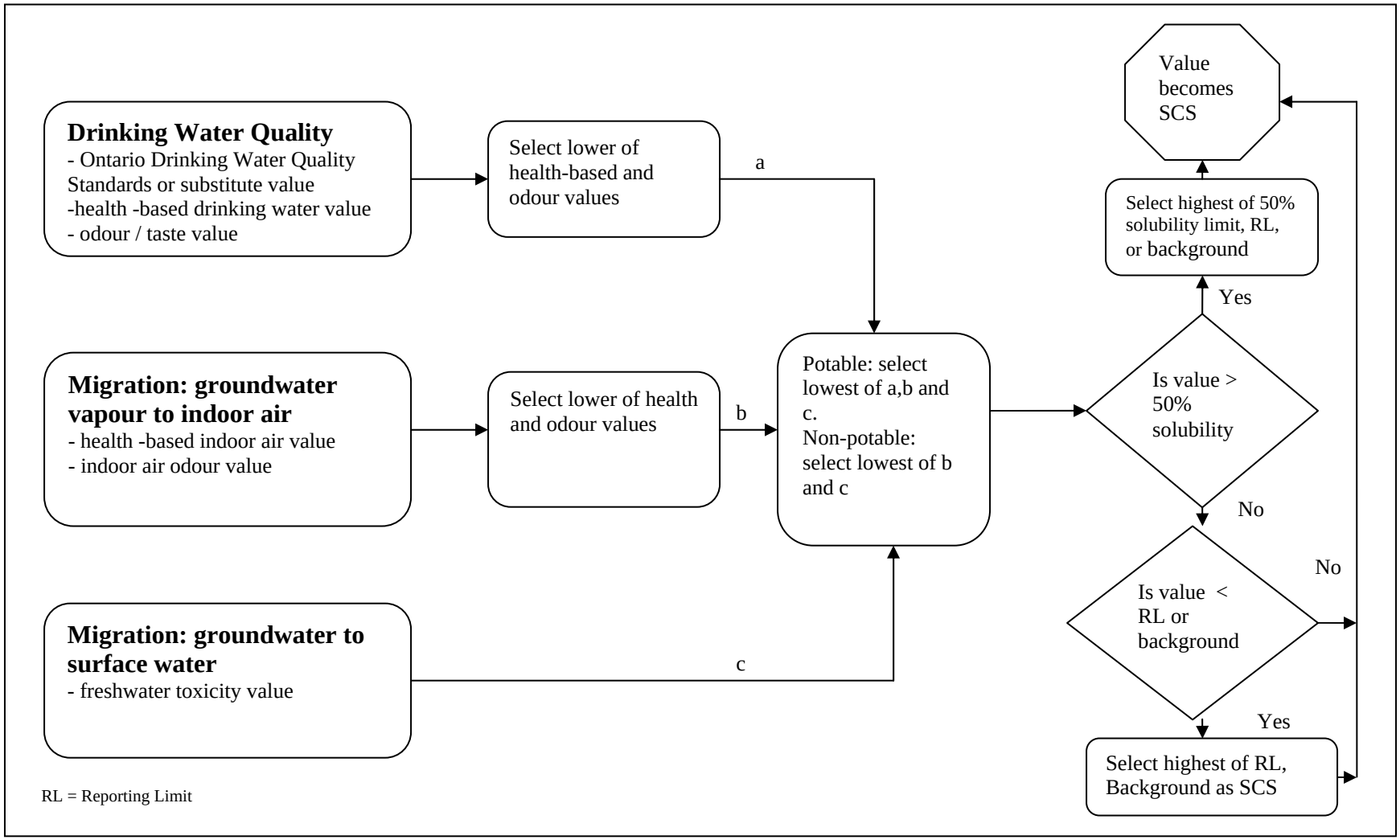
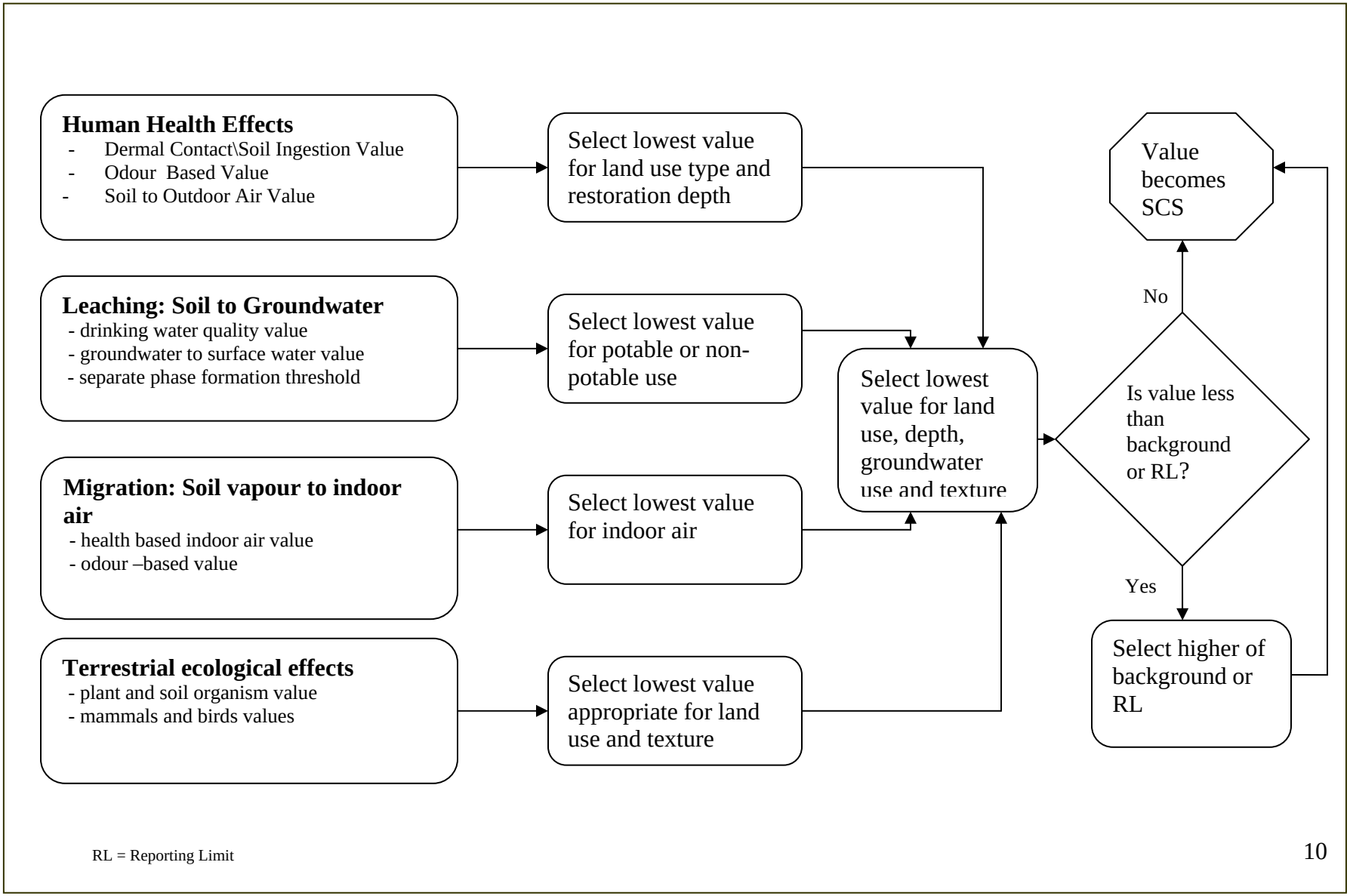


Figure 1.3: Overview of Soil SCS Development Process



Risk Management and Other Considerations

Odour values (see above) and ½ of published solubility limits are determined and used to set maximum concentrations which SCSs cannot exceed.

The minimum SCS values derived from the component process (above) are compared to background and RL s and if the SCS is lower than either of these checks, the higher of the RL and background value is selected.

Values for non-potable scenarios are derived by eliminating the potable pathways (i.e., GW1 and S-GW1). Subsurface soil values are derived by using reduced exposure scenarios for the land use category in question, and by removing the terrestrial ecological components.

It must be noted by users of these SCSs that, since source depletion is incorporated into the development process**, the SCSs should not be used in situations where there is a continuous source of the contaminant.** This is no different than for the previous standards, where a factor was used to account for degradation and depletion in the S-IA pathway. A continuous source is unlikely to be a problem at sites being remediated where sources are removed or properly risk managed; however, it should be seriously considered should anyone wish to utilize these SCSs for other purposes.

1.3.3 Application of the Component Process to Tables of Site Condition Standards

The Tables of Site Condition Standards that are developed using procedures described in this document are as follows;

Table 1: Full Depth Background Site Condition Standards

Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition.

Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition.

Table 4: Stratified Site Condition Standards in a Potable Ground Water Condition.

Table 5: Stratified Site Condition Standards in a Non-Potable Ground Water Condition.

Table 6: Generic Site Condition Standards for Shallow Soils in a Potable Ground Water Condition

Table 7: Generic Site Condition Standards for Shallow Soils in a Non-Potable Ground Water Condition

Table 8 Generic Site Condition Standards for Use within 30 m of a Water Body in a Potable Groundwater Condition

Table 9 Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition

Figure 1.1 gives a generalized version of all the components that can be used in the development of a standard. However, for a particular land use or site condition, some of these

components may be used and others may not. Table 1.1 shows a listing of which components are used in each of the land uses for each of Tables 2 – 5 of the Site Condition Standards.

When the component process is placed in context of the overall regulation of contaminated sites, it can be seen that the process can be used to assist and simplify risk assessments. Under O.Reg. 153/04, the overall process for cleaning-up a contaminated site involves a comparison of the concentrations of contaminants found on a site to those in the appropriate table of site condition standards. Should the maximum concentration of a contaminant exceed the applicable standard, then the proponent has the option of remediating the site or conducting a risk assessment. Should the risk assessment process be chosen, Table 1.1, combined with knowledge of the conceptual site model for the given property and the component that drives the standard being exceeded, can be used to direct and limit the work required within a risk assessment by allowing the risk assessment to focus on the component of concern. In addition, since the models used in the development of the proposed new standards are generic, and are coded into spreadsheets, they can be used to produce site condition standards that are modifications to the Tables of Site Condition Standards and that fall under Section 7 of Part II of Appendix C of O.Reg 153/04 as a limited scope risk assessment.

Table 1.1 Matrix of Components Used for Tables of Site Condition Standards

Pathway	Table 2			Table 3		Table 4		Table 5	
	Agr./ Other	**R/P/I**	**I/C/C**	**R/P/I**	**I/C/C**	**R/P/I**	**I/C/C**	**R/P/I**	**I/C/C**
Soil	Full Depth			Full Depth		Subsurface*		Subsurface**	
Human Health (ingestion, dermal and odour)									
S1	Y	Y	N	Y	N	N	N	N	N
S2	N	N	Y	N	Y	Y	N	Y	N
S3	N	N	Y	N	Y	Y	Y	Y	Y
Ecotoxicity – Plants and Soil Invertebrates	Y	Y	Y	Y	Y	N	N	N	N
Ecotoxicity – Mammals and Birds									
Meadow Vole	**Y**	**Y**	**Y**	**Y**	**Y**	N	N	N	N
Shrew	**Y**	**Y**	**N**	**Y**	**N**	N	N	N	N
Red Fox	**Y**	**Y**	**Y**	**Y**	**Y**	N	N	N	N
Sheep	Y	*N*	N	*N*	N	N	N	N	N
Red-winged Black Bird	**Y**	**Y**	**Y**	**Y**	**Y**	N	N	N	N
American Woodcock	**Y**	**Y**	**Y**	**Y**	**Y**	N	N	N	N
Soil Vapour to Indoor Air (S-IA)	Y	Y	Y	Y	Y	**Y**	**Y**	**Y**	**Y**
Leaching from Soil to Groundwater for Drinking (S-GW1)	Y	Y	Y	N	N	Y	Y	N	N
Leaching from Soil to Groundwater then to Indoor Air (S-GW2)	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
Leaching from Soil to Groundwater then to Surface Water (S-GW3)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Off-Gassing from Soil to Ambient Air (Model Check)	Y	Y	Y	Y	Y	N	N	N	N
Groundwater									
Potable	Lowest of GW1, GW2, GW3					Lowest of GW1, GW2, GW3			
Non-Potable				Lower of GW2, GW3				Lower of GW2, GW3	

* surface soil is the same as table 2. ** surface soil is the same as table 3

Y – Component is new (in bold font)

N – Component has been dropped in this review. (in italic font)

R/P/I - Residential/ parkland/Institutional land use

I/C/C – Industrial/Commercial/Community land use

Tables 6 and 7 are the applicable soil and groundwater site condition standards for shallow soil properties, potable and non-potable respectively. The models used in Tables 2 – 5 for groundwater assume that movement is within porous media. For bedrock the assumptions of porous media may not be valid and, as a result, the groundwater numbers for protection of the aquatic environment for this table were derived by using the aquatic protection value (APV) times ten (for dilution by the receiving water body), without any dilution in the groundwater itself. In addition, since for shallow soils there may not be sufficient space for biodegradation to occur within porous media between the bedrock (assumed to be groundwater surface) and a building above, the biodegradation component of the GW2 number was turned off, and the attenuation coefficient was set at 0.02 for residential and 0.004 for commercial/industrial in accordance with the assumption that no soil might be present between the bedrock and the basement. The GW2 number used for this table therefore represents a number that is protective of groundwater to indoor air movement in a situation where biodegradation cannot be assured and where the soil may not be present to provide attenuation. The soil numbers are the same as those for Tables 2 and 3, as these values were derived for situations where the soil is directly above the water table and are considered sufficiently protective. In the shallow soil situation, the error in the S-GW3 calculation resulting from using these numbers where there is the possibility of no dilution in the groundwater (the dilution at 30 m is around 15%) is not viewed as being significant considering sampling error, the error in the partitioning assumptions, and that the groundwater value itself must be met. Thus the soil portion of the matrix for Tables 2 and 3 above are appropriate for Tables 6 and 7. For shallow soils in Tier 2 (MGRA), since one cannot assume that dilution occurs in the bedrock aquifer (it is not in porous media), the generic value for S-GW3 should remain for all separation distances, and therefore separation distance should not be adjusted from the generic value of 36.5 m for the GW-3 pathway.

Tables 8 and 9 are the applicable site condition standards for properties within 30 m of a surface water body, potable and non-potable respectively. These tables account for concerns regarding both movement of groundwater and sediment (from site soils) to a nearby surface water body. Groundwater numbers are the lowest of the GW1, GW2 and APV times a dilution factor of ten in place of the GW3. There is therefore no dilution considered within the aquifer, as the contamination could be up to the edge of the surface water body. The soil numbers are derived by utilizing the lowest of the soil standards from Table 2 (for Table 8) or Table 3 (for Table 9) and the sediment quality guidelines. If there is no sediment quality number, the value defaults to the background Table 1 numbers. If there is neither a sediment quality number nor a background number, a “NV” is placed in the cell. If the sediment quality number is below the Table 1 background number, the value is bumped up to the Table 1 number. Thus the matrix for soil for Tables 2 and 3 above are again relevant to tables 8 and 9 respectively, with the addition that a sediment protection component has been built in.

1.3.4. Summary of Differences between 2009 Process and 1996 Process

As a result of the review process, the following changes have been made to the procedures for developing the Site Condition Standards:

1) Protection for mammals and birds has been added to the ecological component.

2) The plant and soil invertebrate component is now calculated based on a defined procedure (CCME) that uses data from published journal articles to calculate component values.
3) The S-IA component has been added to subsurface soil scenarios.
4) The S-GW2 pathway has been removed, as it cannot drive a standard below the S-IA component value.
5) Calculations for both the S-IA and the GW2 components are now based on the same model (Johnson and Ettinger).
6) Leaching and groundwater movement calculations now use the same models as the CCME protocols use.
7) The S3 category for direct contact for human health now includes inhalation of soil particles.
8) Odour based components are now calculated based on odour threshold values found in the scientific literature as opposed to ceiling limits.
9) Source depletion is calculated for each contaminant by depleting the source through the pathway of concern, rather than by using a fixed factor of 31 to account for both depletion and degradation. Source depletion is now applied to the S-GW1 and S-O pathways, as well as to the S-IA pathway. Degradation of the contaminant within the soil is now applied to the soil to indoor air pathway as a 10 fold factor for specific compounds known to degrade, and only where there is a metre or more distance from the contamination to the structure whereas it was formerly applied to the S-IA pathway within the 31 factor.
10) Formation of vinyl chloride is now accounted for by assuming that vinyl chloride concentration could reach 10% of the initial chlorinated ethylene concentration as a result of degradation, and therefore the individual chlorinated ethylene criteria is not allowed to to exceed ten times the vinyl chloride criteria.
11) Soil concentrations are now limited upward by separate phase formation thresholds.
12) Tables 6 and 7 are now Tables of Site Condition Standards that can be used directly at sites that have shallow soils, without having to go through a leachate analysis.
13) Tables 8 and 9 are now Tables of Site Condition Standards that can be used at sites within 30 m of a water body without having to use risk assessment.
14) A 2x factor is used to account for observed inaccuaracies in vapour concentrations with respect to partitioning model predictions.
15) A soil to outdoor air model that is consistent with the other spreadsheet models has been added.

These changes are described in greater detail in the appropriate sections of this document.

1.4 Notes on Application of Site Condition Standards at Individual Sites

1) Conditions can exist at a site for which the assumptions used to develop the generic SCSs may not be valid. The QP must ascertain that the site conditions are appropriate for use of the generic SCSs such that he/she can be comfortable with signing the certifications on

the RSC. To assist the QP in recognizing the types of conditions that may be important in this respect the following examples are given:

a) if the contaminated zone has a volume larger than 340 m^3 or a source length or width greater than 13 metres then all pathways which employ source depletion or groundwater transport (Soil Odour, S-GW1, S-IA, S-GW3, GW2 and GW3 components of the standards) may be affected.

b) if a high permeability zone is present in the vadose zone which provides a direct preferential pathway to the building then the soil properties assumed in the generic J&E modelling to determine the S-IA and GW2 components of the standard may change.

c) if the annual average of the capillary fringe of the water table is < 0.8 metres from the outer edge of the gravel crush of the building foundation, then the 10 x biodegradation factor assumed in the GW2 pathway may be non-conservative.

d) if the average organic carbon content (foc) of soil above the water table is < 0.002 then more contaminant may be in the water and gas phases than assumed in the Generic Site Condition StandardsGeneric Site Condition Standards.

f) if there is a continuous source of the contaminant then the pathways which assume a depleting source (i.e., S-IA, S-GW1, and Soil Odour) might be non-conservative.

The existence of any of the above conditions does not necessarily indicate that the Generic Site Condition Standards are not valid for a given site. There are many interrelated parameters and factors that were used in the development of the Generic Site Condition Standards, and in many cases one factor, such as any of those above, can be outweighed by differences in other factors in a manner that, overall, there is sufficient natural protection provided by the site. In addition, it must also be considered that the component that drives the standard may not be affected by the particular limiting condition described above (e.g. a terrestrial ecological driver, but there are high permeable zones in the vadose zone). The QP should consider these types of factors in assessing appropriateness of the use of the Generic Site Condition Standards.

1.5 References

MOE 1989. Guideline for the Decommissioning and Clean-up of Sites in Ontario. Ontario Ministry of the Environment. Waste Management Branch, Ontrio Ministry of the Environment, February, 1989. ISBN 0-7729-5278-7

MOE, 1991. Soil Clean-up Guidelines for Decommissioning of Industrial Lands: Background and Rationale for Development. Air Resources Branch, Ontario Ministry of the Environment. March, 1991. PIBS 1448, ISBN 0-7729-8109-4

MOE, 1993. Interim Guidelines for the Assessment and Management of Petroleum Contaminated Sites in Ontario

MOE 1996. Rationale for the Development and Application of Generic Soil, Groundwater and Sediment Criteria for Use at Contaminated Sites in Ontario. Ontario Ministry of Environment and Energy, December, 1996. PIBS 3250E01, ISBN 0-7778-5906-8.

2 DEVELOPMENT OF HUMAN HEALTH COMPONENT VALUES (HHCVs) FOR SOIL AND GROUNDWATER

This Section describes the process and calculations used to determine the updated Human Health-Based Component Values (HHCVs), which are, as described in Section 1, part of the array of component values used to determine the updated Site Condition Standards (SCS).

Each HHCV is a chemical-specific soil or groundwater (GW) concentration corresponding to either one or two pathways of exposure and one receptor. The following pathways of exposure are quantified in different HHCVs for soil and GW: incidental soil ingestion, dermal contact with soil, ingestion of GW, inhalation of indoor air (only for those chemicals which may contaminate indoor air as a result of subsurface vapour intrusion), and/or inhalation of soil particles. HHCVs are named S1, S2, S3, S-IA-1, S-IA-2, and S-GW1 for soil, and GW1, GW2-1, and GW2-2 for GW[1]. Table 2.1 shows the specific receptors and pathways addressed by each Component Value (CV), as well as the relevant land use categories for each HHCV. Tables 2.2 and 2.3 show which HHCVs were considered in setting SCS for Tables 2 through 6. The basis of each HHCV is described in detail in the following sections.

2.1 Approach to Derivation of HHCVs

Some HHCVs were derived specifically for the update of *O. Reg.* 153, whilst others were established by adopting soil or groundwater limits from sources such as the Ontario Drinking Water Quality Standards. A majority of the HHCVs derived for the update are risk-based, i.e., they correspond to a specific target level of potential health risk. The approach for deriving risk-based HHCVs is largely unchanged from that used previously to derive the generic criteria (see *Rationale for the Development and Application of Generic Soil, Groundwater and Sediment Criteria for Use at Contaminated Sites in Ontario* (MOE 1996)) and is described in detail in this section. Figure 2.1 illustrates the basic process used for deriving risk-based HHCVs (applicable to S1, S2, S3, GW2-1, GW2-2 and to some GW1 and S-GW1 CVs). The calculation of a risk-based HHCV is based on three main variables:

- potential toxicity of the chemical
- potential exposure to the chemical for a given exposure scenario
- a hazard quotient (HQ) of 0.2 per component value based on non-cancer effects, *and*, a target Cancer Risk Level (CRL) of 1×10^{-6} per component value based on cancer effects (with some exceptions as described in Section 2.7)

[1] The GW3 component is not discussed in this Section since it considers the protection of aquatic organisms and not human health. See sections 3 and 7 for discussion of the GW3 component.

Thus, most risk-based HHCVs denote concentrations at which the dose a receptor would receive as a result of the relevant pathway(s) of exposure would not exceed one-fifth the TDI (or one-fifth the dose-equivalent of the TC) or an incremental cancer risk of 10^{-6}. Risk-based HHCVs are intentionally developed without consideration of risk management measures or technological or economic feasibility.

In further detail, the process of derivation consisted of several key steps:

- Exposure scenarios, including receptor characteristics and pathways of exposure, were delineated for each land use category.
- Media exposure rates (rates of exposure to soil or groundwater (GW) via various exposure pathways) were then calculated for the different exposure scenarios. Each media exposure rate is based on a different combination of input values for the different exposure factors, (e.g., body weight, exposure duration).
- The media exposure rates were then used in conjunction with a Toxicological Reference Value (TRV), Relative Absorption Factor (RAF), transport modelling, and the targets for potential health risk to calculate the HHCV.

Figure 2.1: Elements Used in the Derivation of Risk-Based Human Health Component Values (HHCVs)

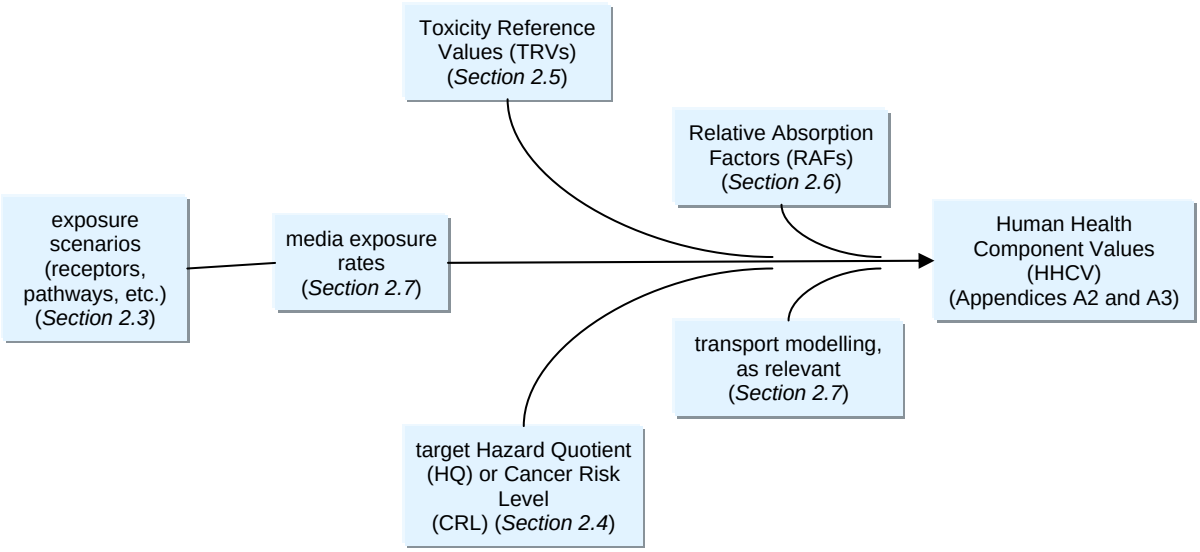


Table 2.1: Description of the Human Health Component Values (HHCVs)

Component Values for Soil	Elements of the Exposure Scenario			Notes	Land Use Category
	Soil Depth*	Receptors** and Duration of Exposure	Pathways		
S1	surface soil	Toddler resident (non-cancer). Composite resident (cancer).	Soil ingestion & dermal contact	Toddlers are considered the most highly exposed receptors with respect to direct contact with soil.	R/P/I†
S2	surface soil	Adult outdoor worker (long-term), working outdoors for at least part of every work day	Soil ingestion & dermal contact	.	I/C/C‡ *(also subsurface soil, R/P/I)*
S3	subsurface soil	Adult worker (short-term) exposed to subsurface soil, e.g., during excavations, etc.	Soil ingestion, dermal absorption following dermal contact, & inhalation of soil particles		I/C/C, R/P/I *(also surface soil,* I/C/C*)*
S-IA-1 (Soil to Indoor Air)	surface & subsurface soil	Toddler resident (non-cancer). Composite resident (cancer)	Inhalation of indoor air contaminated by subsurface vapour intrusion	Soil concentration is calculated based on the Source Depletion Multiplier (see further in Section 2.3.3.4).	R/P/I
S-IA-2 (Soil to Indoor Air)	surface & subsurface soil	Adult indoor worker (long-term)	Inhalation of indoor air contaminated by subsurface vapour intrusion		I/C/C
S-GW1 (Soil to GW)	surface and subsurface soil	Toddler resident (non-cancer). Composite resident (cancer)	Ingestion of GW as drinking water source.	Soil concentration is calculated based on acceptable GW concentration (considers migration of chemicals from soil to potable GW).	R/P/I

Component Values for Groundwater	Exposure Scenario		Notes	Land Use Category
	Receptors	**Pathways**		
GW1	Toddler resident (non-cancer). Composite resident (cancer)	Ingestion of GW as a drinking water source (potable GW).	Some GW1 values are based on existing drinking water standards.	R/P/I
GW2-1 (GW to Indoor Air)	Toddler resident (non-cancer). Composite resident (cancer)	Inhalation of indoor air contaminated by subsurface vapour intrusion	GW concentration is calculated based on chronic inhalation TRV (considers vapour intrusion from GW to indoor air).	R/P/I
GW2-2 (GW to Indoor Air)	Adult indoor worker (long-term)	Inhalation of indoor air contaminated by subsurface vapour intrusion		I/C/C

* Surface soil is to a depth of 1.5 m. Subsurface soil is below 1.5 m.
** Further details on receptors are provided in Table 2.4.
† R/P/I is Residential/Parkland/Institutional
‡ I/C/C is Industrial/Commercial/Community

Table 2.2: Human Health Component Values (HHCVs) Considered in Setting Site Condition Standards (SCS) for Soil

Table	Soil Depth	Land Use	HHCV*					
			S1	S2	S3	S-IA-1	S-IA-2	S-GW1
Table 2 - Full Depth Generic Site Condition Standards in a Potable Groundwater Condition	full depth	Residential/Parkland/ Institutional	X			X		X
		Industrial/Commercial/ Community		X	X		X	
Table 3 - Full Depth Generic Site Condition Standards in a Non-Potable Groundwater Condition	full depth	Residential/Parkland/ Institutional	X		**	X		
		Industrial/Commercial/ Community		X	X		X	
Table 4 - Stratified Site Condition Standards in a Potable Groundwater Condition	surface	Residential/Parkland/ Institutional	X			X		X
	subsurface			X	X	X		X
	surface	Industrial/Commercial/ Community		X	X		X	
	subsurface				X		X	
Table 5 - Stratified Site Condition Standards in a Non-Potable Groundwater Condition	surface	Residential/Parkland/ Institutional	X			X		
	subsurface			X	X	X		
	surface	Industrial/Commercial/ Community		X	X		X	
	subsurface				X		X	

* HHCVs are further described in Table 2.1.

** In some instances, S3 would be used to establish a SCS for the RPI land use category. See further in Section 2.2 below.

Table 2.3: Human Health Component Values (HHCVs) Considered in Setting Site Condition Standards (SCS) for Groundwater

Tables	Land Use Category	HHCV*		
		GW1	GW 2-1	GW 2-2
Table 2 - Full Depth Generic Site Condition Standards in a Potable Groundwater Condition *and* **Table 4** - Stratified Site Condition Standards in a Potable Groundwater Condition	Residential/Parkland/ Institutional	X	X	
	Industrial/Commercial/ Community			X
Table 3 - Full Depth Generic Site Condition Standards in a Non-Potable Groundwater Condition *and* **Table 5** - Stratified Site Condition Standards in a Non-Potable Groundwater Condition	Residential/Parkland/ Institutional		X	
	Industrial/Commercial/ Community			X

* Component values are further described in Table 2.1.

2.2 Background

The Ontario 1996 approach for derivation of human health risk-based HHCVs was adopted, with some modification, from the Massachusetts Contingency Plan (MCP) of the Massachusetts Department of Environmental Protection (MassDEP 1994) (see further in *Rationale for the Development and Application of Generic Soil, Groundwater and Sediment Criteria for Use at Contaminated Sites in Ontario* (MOEE 1996)). MOE considered the MCP human exposure models, pathways, and equations to be appropriate for setting soil and groundwater (GW) guidelines in Ontario.

In 2002, MOE initiated a review of the approach used to establish the 1996 criteria, including an interjurisdictional comparison. The review indicated that the MCP approach used in 1996 was still appropriate, but that some modifications were in order. Modifications included:

- Incorporation of two additional exposure pathways (inhalation of airborne soil particles for industrial/commercial subsurface soil and soil-indoor air for all subsurface soils).
- Reduction of the number of age categories from 20 to 5 to remove unnecessary complexity in the calculations and to be consistent with general risk assessment practice in Ontario and in Canada.
- Update of exposure values, Toxicological Reference Values (TRVs), and Relative Absorption Factors (RAFs) to reflect current science and current risk assessment practice, and to ensure greater defensibility of the calculated soil and GW standards.

2.3 Exposure Scenarios and Selection of Exposure Values

Exposure scenarios and pathways of exposure are two related concepts that are fundamental to the derivation of human health-based HHCVs. An exposure scenario is the set of facts, assumptions and inferences about how exposure may occur which is used in estimating potential exposure (US EPA 1992a). A pathway of exposure is the physical course that a substance takes from its source, or from a medium of concern, to the receptor (US EPA 1992a), and is part of an exposure scenario. A route of exposure is the means by which a substance gains access to an organism (e.g., ingestion, inhalation, etc.) and may be part of the description of a pathway of exposure[2]. However, the two concepts (route and pathway) are distinct.

This section and Table 2.1 document the exposure scenarios for each HHCV, including description of the different receptors and pathways of exposure. Tables 2.2 and 2.3 show which HHCVs are considered in setting SCS for Tables 1 to 6.

Note that the exposure scenarios for workers (adult outdoor workers, adult indoor workers, and subsurface workers) are for exposures of environmental origin (soil and/or GW) rather than occupational exposures. This is because HHCVs are intended to be protective of exposures from the soil and/or GW where the job is located, but not exposures resulting from chemical emissions from on-going work operations themselves.

In some instances, HHCVs derived for one land use category or exposure scenario are applied to another as well:

- The S2 component value is derived for surface soil based on long-term exposure of an adult outdoor worker via the pathways of incidental ingestion and dermal contact. The S3 component value is derived for subsurface soil based on short-term exposure of an adult worker via incidental ingestion or dermal contact. However, if the S3 component value is numerically lower than S2, then S3 will be designated as the HHCV for the surface soil as well (unless, of course, S-IA-2 is more stringent than either S2 or S3). The substitution of S3 for S2 is to avoid deriving stratified site condition standards where the sub-surface soil has a more stringent limit than the surface soil.
- Either the S2 or the S3 component values were applied in determining the SCS for subsurface soil for the R/P/I land use category.

2.3.1 Pathways Which Were Quantified for Derivation of HHCVs

Receptors can be exposed to substances in soil or GW through various activities that put them in contact with these media. In order to estimate the amount of substance to

[2] Note also that Toxicological Reference Values (TRVs) are differentiated by route of exposure, but not by pathways of exposure. See further in Section 2.5.

which a receptor may be exposed in soil or GW, it is necessary to identify and then quantify the different relevant exposure pathways.

Ingestion of Soil

Unintentional or incidental soil ingestion occurs via hand-to-mouth behaviour during activities such as gardening or play. People may also ingest outdoor soil that has been transported into buildings (e.g., tracked in on shoes or by pets) and incorporated into indoor dust. Quantifying this pathway requires information on rates of soil and dust ingestion, body weight, and frequency and duration of exposure.

Dermal Contact with Soil

Direct contact with soil can result in dermal absorption of chemicals. Dermal absorption can occur outdoors during activities such as gardening or play. People may also be exposed via direct contact with outdoor soil that has been transported into buildings and incorporated into indoor dust. Quantifying the dermal absorption pathway requires information on the amount of skin surface area in contact with the soil, the amount of soil that adheres to the skin (i.e., soil adherence), the amount of chemical that is absorbed into the body from the soil on the skin, body weight, and frequency and duration of exposure.

Ingestion of Groundwater as Drinking Water

People may ingest chemicals in groundwater (GW) which is used as a source of drinking water. Quantifying this pathway requires information on drinking water intake rates, body weights, and frequency and duration of exposure.

Inhalation of Airborne Soil Particles

People may be exposed to chemicals in soil by inhalation of airborne soil particles. Inhalation exposure may occur if particle-bound chemicals in surface soil are entrained in air (e.g. by wind). Note that this pathway is quantified for the subsurface worker, but not the long-term outdoor worker or residential receptors (see Table 2.4 for further description of these receptors). Quantifying this pathway requires information on air concentrations of particles, rates of inhalation, body weight, and frequency and duration of exposure.

Inhalation of Volatile Substances: Soil-to-Indoor-Air and Groundwater-to-Indoor-Air Pathways

People may inhale volatile substances that move from soil or GW into the indoor air of buildings. The movement, or transport, of chemicals from soil or GW is referred to as subsurface vapour intrusion. Quantifying this pathway requires vapour intrusion modelling and information on frequency and duration of exposure.

2.3.2 Pathways not Quantified for Derivation of HHCVs

During the review of the development process for the revised soil and groundwater standards, additional human health exposure pathways were considered but not incorporated into the derivation of HHCVs. However, in site-specific risk assessments, inclusion of some of these pathways in an exposure assessment may be necessary based on the conceptual site model for a specific property.

Consumption of Foods Cultivated at a Contaminated Site

Plants or animals can take up or accumulate chemicals present in soil or water. Although ingestion of foods made from these plants or animals may be a significant pathway of exposure to some chemicals in some circumstances, this pathway is not included in the calculation of HHCVs at this time as there is a high degree of uncertainty with respect to numerous assumptions required, such as uptake factors, amounts of garden produce consumed from a site, size of contaminated area, food preparation methods etc.

Inhalation or Dermal Exposure from Showering

Inhalation exposure to volatile substances in groundwater through showering was also considered. An examination of the degree of uncertainty present in the calculations indicated that these equations had not undergone significant validation studies, and that uncertainty was very high. Furthermore, this pathway is currently considered in the development of Ontario Drinking Water Standards and Guidelines for Canadian Drinking Water Quality, which are used (if available) as the GW1 component. As such, exposure via showering was not included in the development of the revised standards.

Exposure via Inhalation of Airborne Soil, Ciliary Clearance, and Subsequent Ingestion

On construction and excavation sites, amounts of airborne soil could be significant enough to contribute to human exposures. In the S3 pathway, inhalation of these particles is included in the calculations of the S3 components. However, exposure to chemicals in soil via inhalation of airborne soil which is subsequently cleared by the cilia and then swallowed was considered but not incorporated. The contribution of this pathway was evaluated for all substances in the revised set of standards and was found to be negligible compared to incidental ingestion of soil. As such, it was excluded in the development of the revised standards.

Incidental Ingestion of GW

Incidental ingestion of GW may occur from splashing or hand-to-mouth activity during activities such as excavation below the water table. Although this pathway was not incorporated into the derivation of HHCVs, Ontario Drinking Water Standards or risk-

based GW1 component values could potentially be used to screen this pathway as needed on a site-specific basis. This would be a conservative approach in most instances, as the water ingestion rates assumed in GW1 would exceed incidental ingestion rates of GW.

Inhalation in a Trench

Concentrations of volatile organic compounds may be higher in a trench than in outdoor air at the surface due to reduced mixing with ambient air. As a check on this pathway for Tier 2 (modified generic) purposes, a trench model was developed and run. The results are highly sensitive to the air exchange rate, which in turn is highly dependent upon the wind speed and trench depth. As such there may be conditions of low windspeeds and deep trenches for which the generic SCSs may pose a higher risk for workers in trenches for some VOCs than that for other receptors in other scenarios. Augmentation of air exchange rates through the use of fans etc.would be a recommended practice.

Exposures Specific to Agricultural and Other Land Use

The component values for agricultural land use are replicates of the component values for the residential scenario modelled for the R/P/I land use category. Because an agricultural exposure scenario was not delineated in detail, the precise level of protection achieved by the agricultural values is unknown. Potential exposure at agricultural sites, may be greater than the exposure estimated for the R/P/I land use category due to the generation of suspended dusts during agricultural activity, potentially higher rates of direct contact with soil, etc. The residential exposure scenario has been used for the agricultural land use because such exposures may be of short duration (e.g. only a few days or weeks/year for an operations like discing and cultivating) and would require the contaminated area to be significantly greater than that given in the conceptual site model for the generic standards for them to be of consequence, and there is a high degree of uncertainty associated with estimating such exposures.

2.3.3 Description of Receptors

The receptors for each exposure scenario are described in Table 2.4**.**

Receptors for Residential/Parkland/Institutional (R/P/I) Land Use

For land use categories where people of all ages are expected to have access (i.e., R/P/I), the toddler (0.5 – 4 years) was considered the more highly exposed receptor and was thus chosen as the basis for calculating the HHCVs for non-cancer effects. Toddlers are considered to be the more highly exposed receptors because they eat, drink, and breathe more in proportion to body size, and exhibit behaviours (e.g., hand-to-mouth activity) that increased exposure to media such as soil.

Component values based on cancer effects are derived on the basis of a lifetime average daily dose. As a result, a composite receptor (exposed from infancy through to and including adulthood) is used as the basis of HHCVs for cancer effects.

A noteworthy change from the MOEE 1996 *Rationale* is a reduction in the number of residential age categories from 20 to 5 (see Table 2.4 below). This considerably reduces the complexity of the calculations while not significantly reducing the accuracy of the final results.

Age Group of Receptors for Industrial/Community/Commercial (I/C/C) Land Use

The adult (20 or more years) was the receptor used to calculate component values for both cancer and non-cancer effects.

Table 2.4: Receptors Used in Derivation of HHCVs

Receptor	Description
infant resident	age 0 to 5 months
toddler resident	age 6 months to 4 years
child resident	age 5 to 11 years
teen resident	age 12 to 19 years
adult resident	age 20 or more years
composite resident	Resident is on-site from birth, through life stages of infant, toddler, child, teen, and adult. The composite receptor is on that uses their yard, but is not consuming backyard vegetables.
indoor worker	An adult who typically works indoors in one work location every work day. This worker is fixed at one site. Occupations include office workers and retail workers.
outdoor worker (long-term)	An adult who typically works outdoors for at least part of every work day, and whose activities bring them into contact with soil. This worker is fixed at one site and works there for a long-term duration. Occupations include gardeners and groundskeepers (e.g. on grounds outside museums, theatres, performing arts centres, universities, hotels, indoor recreation facilities, hospitals, pharmaceutical industries, etc.), workers in yards for storage, maintenance, and repair of heavy machinery or of transportation vehicles (e.g. rail yards, municipal yards, bus company yards, etc.), and workers in salvage yards and automobile wrecking yards.
subsurface worker (short-term)	This category addresses receptors who have contact with subsurface soils. The construction worker has been selected as the receptor who has the most contact with subsurface soils. The construction worker is considered to be on a former brownfield site from when the new construction is started on-site until the construction is completed.

2.3.4 Selection of Exposure Values

Numerous variables, or exposure factors (e.g., ingestion rates, inhalation rates, body weight, exposure duration) are included in the estimation of exposure. An array of different exposure values was assigned to these factors in the derivation of HHCVs. These exposure values are provided in this section, accompanied by brief rationale for their selection. Note that the term **exposure value** refers to the sample estimate or parameter assigned to characterize an exposure factor, while **exposure estimate** or **media exposure rate** refers to the result of an exposure calculation, e.g., an Average Daily Soil Ingestion Rate.

Figure 2.2 below summarizes the hierarchical considerations that should guide the selection of an exposure value for an exposure calculation.

The phrase 'level of conservatism' in Figure 2.2 refers to the proportion of receptors which are meant to be accounted for in the derivation. Each HHCV was intended to be protective not just for average exposures, but also for exposures that are moderately greater than average. Exposure values were selected based on this objective.

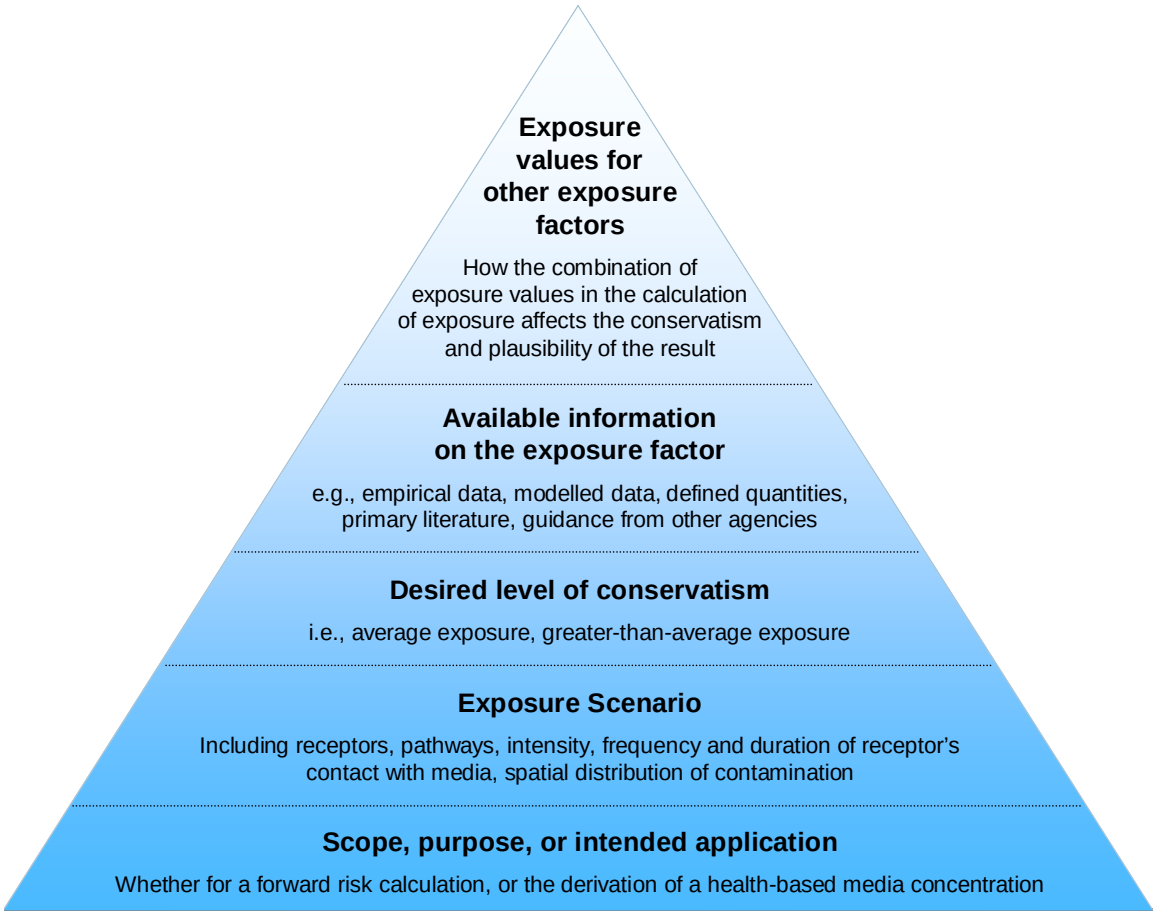
Note that the level of conservatism assigned to a particular exposure value depends on the intended purpose for the final HHCV. For example, if the purpose of the HHCV is to limit the potential health risk contributed by use of any one site, then the value selected for duration of exposure would be based on the length of time a resident or worker might use a single site. If the purpose of the HHCV is to limit the potential health risk contributed by use of multiple sites over the course of a career or a lifetime, then the value selected for duration of exposure might be based on life expectancy.

Tables 2.5 to 2.20 provide rationale for the selection of the exposure values used in the derivation of the HHCVs. The symbols in the last column of the following tables indicate the level of conservatism associated with each value. The symbols are as follows:

- CT = central tendency
- sli = slightly more than average
- C = conservative
- C* = conservative value, but does not numerically affect overall calculation
- n/a = not applicable

Note that the methods used to determine Exposure Frequency (EF; months/year) and Skin Surface Area exposed (SSA; cm^2) are shown in Tables 2.5 and 2.6, respectively.

Figure 2.2: Considerations Made in Selection of an Exposure Value



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2.3.5 Exposure Values Used in Calculation of Media Exposure Rates and Prorating Factors

Table 2.5 Rates of Soil Ingestion (SIR), mg_{soil}/day

Receptor	Value	Rationale	Level of Conservatism
Infant resident	30	van Wijnen et al. (1990) reports that the estimated geometric soil intakes of children <1 yr old in day care centres ranged up to 30 mg/day.	C*
Toddler resident	200	As noted by US EPA (2008), since young children may spend significant time indoors, it may not be appropriate to assume that all the soil ingested came from outdoor exposure (because some portion of housedust comes from outdoor soil); their recommended soil ingestion values are thus based on estimated ingestion of both soil & dust. US EPA (1997) analyzed data from several studies & recommended SIRs: mean 100 mg/d, conservative estimate of the mean 200 mg/d, & upper percentile 400 mg/d. US EPA (2008) reanalyzed SIR and provided 100 mg/d as a central tendency estimate of soil ingestion and 1000 mg/d as an estimate of soil-pica exposure. The SIR of 200 mg/day is a value higher than the central tendency but lower than the soil-pica estimate of soil ingestion (US EPA 2008).	C
Child resident	50	There are few empirical data on ingestion of soil by adults. Based on a review of three available studies, USEPA (1997) considered Calabrese et al. (1990) to be the most reliable. According to Calabrese et al. (1990), 50 mg/day seems to be a central tendency estimate, whereas according to Stanek et al. (1997), 50 mg/day seems slightly conservative. 50 mg per day is chosen as the SIR for adults. Based on an assumption that children and teens are more similar to adults than to toddlers with respect to the behaviours resulting in exposure to soil (specifically, hand-to-mouth activity), 50 mg per day is also selected as the SIR for school-aged children and teens.	CT or sli
Teen resident	50		CT or sli
Adult resident	50		CT or sli
Outdoor fixed worker	100	According to Stanek et al. (1997) data, 100 mg/day is between the 75th and 90th percentiles for average adults. For outdoor workers considered in the exposure scenarios here, 100 mg/day would correspond to a lower percentile range.	CT or C
Subsurface worker	100		CT or C

Table 2.6 Body Weight (BW), kg_{BW}

Receptor	Value	Rationale	Level of Conservatism
infant resident	8.2	Richardson (1997). Mean.	CT
toddler resident	16.5	Richardson (1997). Mean.	CT
child resident	32.9	Richardson (1997). Mean.	CT
teen resident	59.7	Richardson (1997). Mean.	CT
adult resident	70.7	Richardson (1997). Mean for adult men and women combined, age 20+ years.	CT
indoor worker	70.7	Richardson (1997). Mean for adult men and women combined, age 20-59 years.	CT
outdoor worker (long-term)	70.7		CT
construction worker	70.7		CT
adult female	63.1	Richardson (1997). Mean for adult women, age 20-59 yrs.	CT

Table 2.7 Skin Surface Area Exposed (SSA), cm^2

Receptor	Value	Rationale	Level of Conservatism
infant resident	1105	USEPA (2004a) recommends exposed skin surface area (SSA) for child resident is limited to head, hands, forearms, lower legs, & feet, & for adult resident is limited to head, hands, forearms, & lower legs. USEPA recommendations were used for 3 summer months, but during 3 spring & 3 fall months exposed SSA is assumed to be limited to head, hands, & forearms. Resultant SSAs are weighted means for the 9-month period. (Survey data from Richardson, 1997). The methodology used to determine these SSAs is shown in Table 2.20 below.	sli
toddler resident	1745		sli
child resident	2822		sli
teen resident	3858		sli
adult resident	4343		sli
adult female resident	3988		sli
outdoor worker (long-term)	3400	USEPA (2004a) recommends exposed skin surface area for adult industrial-commercial worker limited to head, hands, & forearms. Data from Richardson (1997). (Assume head = 1 arm, forearms = ½ of arms.) The methodology used to determine these SSAs is shown in Table 2.20 below.	sli
subsurface worker	3400		sli
adult female outdoor worker	3090		sli
adult female subsurface worker	3090		sli

Table 2.8 Soil Adherence Factor (SA), mg/cm^2/day

receptor	value	rationale	level of conservatism
infant resident	0.07	For child resident (<1 to <6y), USEPA (2004a) recommends 0.2 mg/cm^2 based on 95th percentile weighted AF for children playing at a daycare centre (central tendency soil contact activity) or 50th percentile for children playing in wet soil (high-end soil contact activity). The child is given the same factor as the toddler because they are both likely to have the distinguishing behaviour of getting dirty when they play. For adult resident, USEPA (2004a) recommends 0.07 mg/cm^2 based on 50th percentile weighted AF for gardeners (activity determined to represent a reasonable, high-end activity). Since the adult resident who uses their yard also uses it for other less contact-intensive activities, this factor can be considered more than average. The adult factor is used for the teen and infant because these age categories are not likely to have the distinguishing play behaviour of toddlers.	C
toddler resident	0.2		C
child resident	0.2		C
teen resident	0.07		C
adult resident	0.07		C
outdoor worker (long-term)	0.2	USEPA (2004a) recommends 0.2 mg/cm^2 for commercial-industrial adult worker based on 50th percentile weighted AF for utility workers. (See Exhibit 3-3 for appropriateness of 0.2 mg/cm^2 for use in our exposure scenarios.)	C
subsurface worker	0.2		C

Table 2.9 Drinking Water Intake Rate (DWIR), L/day

receptor	value	rationale	level of conservatism
infant resident	0.6	Richardson (1997) means are 0.3, 0.6, 0.8, 1, & 1.5, where Ershow & Cantor (1989) is the source of all but the adult rate. USEPA (1997a; Table 3-6) shows percentiles for Ershow & Cantor (1989): 90th percentiles are 0.64 (<0.5yrs), 1.162 (1-3y), 1.338 (7-10y), 1.621 (11-14y), 1.763 (15-19y), 2.121 (20-44y), 2.451 (45-64y), 2.333 (65-74y). [time-weighted average for adult 20-74y = 2.280]	C
toddler resident	1.2		C
child resident	1.3		C
teen resident	1.7		C
adult resident	2.3		C
adult female	2.1		C

Table 2.10 Duration of Exposure (ED), years

receptor	value	rationale	level of conservatism
infant resident	0.5	duration of age category	n/a
toddler resident	4.5	duration of age category	n/a
child resident	7	duration of age category	n/a
teen resident	8	duration of age category	n/a
adult resident	56	USEPA (1991a) recommends 30 yrs as the 90th percentile for time spent at one residence. US EPA (1997a) recommends 30 yrs as the 95th percentile for population mobility. However, the exposure duration of the adult resident was set equal to the averaging period (56 yrs) for this receptor to reflect the MOE's long-term goal of harmonization, i.e., establishing SCS that would be protective for use of more than one site and would potentially be more widely applicable as general soil screening criteria.	C
indoor worker	56	US EPA (1991a) recommends 25 yrs for commercial / industrial workers (95th percentile for yrs working at the same location, from US census data). US EPA (2002) uses 25 yrs and states it is supported by more recent labour statistical data showing that the 95th percentile for job tenure for men in the manufacturing sector was 25 yrs. Chart B in Heisz (1996) shows that approximately 5-7% of completed jobs in Canada lasted >20 yrs (using survey data 1981-85 and 1991-94). However, the exposure duration of the indoor worker and outdoor worker was set equal to the averaging period (56 yrs) for this receptor to reflect the MOE's long-term goal of establishing SCS that would potentially be applicable to both a Brownfields and a non-Brownfields type of RA.	CT
outdoor worker (long-term)	56		CT
subsurface worker	1.5	For construction projects in the UK completed between 1998 and 2004 (n=2554), 90th & 95th percentiles for project duration were in the range of approx. 1.4 - 1.7 yrs (Martin et al. 2006). The upper percentile value of 1.5 yrs was selected. The exposure duration for this receptor is set at an upper percentile of a single construction project because the purpose of the calculation is not to determine soil concentrations to which the worker could be exposed for a career without adverse effect. Rather, the purpose of the calculation is to determine soil concentrations to limit the contribution of any one former brownfield site to the receptors' exposure.	C
adult female resident	56	Duration of adulthood.	n/a

Table 2.11 Averaging Period (AP) for Non-Cancer, years

receptor	value	rationale	level of conservatism
toddler resident	4.5	Averaging period for non-cancer is equivalent to exposure duration for each receptor.	n/a
indoor worker	56		n/a
outdoor worker (long-term)	56		n/a
subsurface worker	1.5		n/a
adult female resident	56		n/a

Table 2.12 Averaging Period (AP) for Cancer, years

receptor	value	rationale	level of conservatism
composite resident (for carcinogens)	76	HC (2004) recommends using average life expectancy of 75 years for amortization of carcinogen exposures if cancer risks are estimated on the basis of lifetime average daily intake. AP of 76 yrs considers ages 0 to 75 yrs, inclusive.	CT
indoor worker	56	HC (2004) recommends using 56 years for amortization of carcinogen exposures if cancer risks are estimated for adults only. The 56-year duration of adulthood considers ages 20 to 75 years, inclusive, and is based on average life expectancy.	CT*
outdoor worker (long-term)	56		CT*
subsurface worker	56		CT*

Table 2.13 Frequency of Exposure (EF) for Outdoors, weeks/year

receptor	value	rationale	level of conservatism
infant resident	39	Using Canadian Climate Normals 1971-2000 data (Environment Canada, 2004) from Ottawa, Toronto, and Windsor (representing the region of Ontario where most Ontarians live), the average number of months with daily temperatures ≤0°C is 3 months, and the average number of months with at least 7 days of snow depth ≥5 cm is 3 months. It's assumed that exposure to soil is limited for 3 months/yr. (9 months/yr = 39 weeks/year). The derivation of this exposure frequency is shown in Table 2.19 below. US EPA (2006 draft) acknowledges (page 5-22) that soil exposure during winter months when ground is frozen or snow-covered would not be zero because some portion of the house dust comes from outdoor soil.	CT
toddler resident	39		CT
child resident	39		CT
teen resident	39		CT
adult resident	39		CT
composite resident (for carcinogens)	39		CT
outdoor worker (long-term)	39		CT
subsurface worker	39		CT
adult female	52	Prorating is not used for pregnant adult (as per US EPA 1992b).	n/a

Table 2.14 Frequency of Exposure (EF) for Indoors and for Ingestion of Groundwater as Drinking Water, weeks/year

receptor	value	rationale	level of conservatism
infant resident	50	HC (2004) recommends 7 days/week and 52 weeks/yr for the resident, 5 days/week and 52 weeks/yr for commercial land, and 5 days/week and 48 weeks/yr for industrial land. US EPA 2002 soil screening guidance uses 350 days/yr (= 7d/w x 50 w/y) for residents and 250 days/yr for indoor workers (= 5 d/w x 50 w/y). US EPA (1991a) states that for the common assumption that workers take 2 weeks/year vacation can be used to support a value of 15 days/yr spent away from the home.	CT
toddler resident	50		CT
child resident	50		CT
teen resident	50		CT
adult resident	50		CT
composite resident (for carcinogens)	50		CT
indoor worker	50		CT
adult female	52	Prorating is not used for pregnant adult (as per US EPA 1991b).	n/a

Table 2.15 Frequency of Exposure (EF) for Indoors and Outdoors, days/week

receptor	value	rationale	level of conservatism
infant resident	7	It's assumed that the resident is present 7 days/week, as per HC (2004) guidance. If resident were absent 15 days/yr, then EF = 350 days/yr (used by USEPA 1991a & US EPA 2002 soil screening levels), which would be 6.73 days/week. N.B. This factor is used with EF (weeks/yr) shown above.	C*
toddler resident	7		C*
child resident	7		C*
teen resident	7		C*
adult resident	7		C*
composite resident (for carcinogens)	7		C*
indoor worker	5	Typical work week is 5 d/w. HC (2004) recommends 5 d/w for commercial, industrial, and construction workers. USEPA (2002) uses 225 days/yr for outdoor workers, which is an average from U.S. census stats.	CT
outdoor worker (long-term)	5		CT
subsurface worker	5		CT
adult female	7	Prorating is not used for pregnant adult (as per US EPA 1991b).	n/a

Table 2.16 Frequency of Exposure (EF), hours/day

receptor	value	rationale	level of conservatism
infant resident	24	USEPA (1997a, Table 15-131, pg 15-147): Time spent at residence indoors. For children 1-4 yrs in all of US, 50th percentile = 1260 min/day, 90th = 1440. Note that the data distributions are similar for the N.E. census region and for all of the U.S. [Assume infant rate is same as toddler.]	C*
toddler resident	24		C*
child resident	22.23	USEPA (1997a) 5-11y. 50th=975, 90th=1334 min/day	C*
teen resident	21.83	USEPA (1997a) for 12-17y. 50th=950, 90th=1310 min/day	C*
adult resident	22.50	USEPA (1997a) for 18-64 yrs. 50th=900, 90th=1350	C*
indoor worker	9.8	In the 25-54 yr age category of all workers in Canada (full- & part-time), 12.1% (in 1997) & 9.8% (in 2006) work 49 hrs/week or more (Usalcas, 2008). Thus 49 hrs/week represents the 88th or 90th percentile. Among full-time workers (i.e., those working ≥30 hrs/week), 49 hrs/week represents the 86th (1997) or 89th (2006) percentile. [49 h/w = 9.8 h/d x 5 d/w]	C*
subsurface worker	9.8		C*
adult female	24	Prorating is not used for pregnant adult (as per US EPA 1991b).	n/a

Table 2.17 Concentration of PM_{10} in Air ([PM_{10}]), $\mu g_{soil}/m^3$

receptor	value	rationale	level of conservatism
subsurface worker	100	MDEP (2007) describes a study where mean PM_{10} ranged from 30-77 $\mu g/m^3$. Since samples were collected 30-300 feet outside construction fence lines, these concentrations might be < those on the sites themselves. HC (2004) states that a reasonable dust level created by vehicle traffic on unpaved roads is 250 $\mu g/m^3$, based on average PM_{10} from 11 downwind measurements in Claiborn et al (1995). The average of the 11 downwind & 11 upwind PM_{10} measurements reported in Claiborn et al (1995) is 173 $\mu g/m^3$. Based on these two studies, 100 $\mu g/m^3$ is selected to represent PM_{10} concentrations on construction sites. It is also assumed that 100% of the PM_{10} is soil-derived.	CT

Table 2.18 Exposure Factors Relating to Inhalation of Air Borne Soil by Workers

Exposure Factor	Receptor	Value	Rationale	Level of Conservatism
FPM_{inh}: Fraction of PM_{10} which is deposited (unitless)	subsurface worker	0.6	US EPA 2004b (For particulate matter 0.001 – 10 µm, the deposition fraction in alveolar region ranges up to 0.6)	C
IR_w: Inhalation rate of worker during exposure period (m^3/hour)	subsurface worker	1.5	For outdoor workers, USEPA (1997a; Table 5-23, pg. 5-24) recommends 1.5 m^3/hour as a mean for moderate activities.	CT
$BW_{assumed}$: Body weight assumed in development of inhalation TRVs (kg_{BW})	-	70	Correction factor. Assumed default.	n/a
$IR_{assumed}$: Inhalation rate assumed in development of inhalation TRVs (m^3/day)	-	20	Correction factor. Assumed default.	n/a

Table 2.19: Average Daily Temperature and Monthly Snow Cover for Selected Cities in Ontario

Environment Canada Station	Month	Months with average daily temperature ≤0°C	Months with at least 7 days having snow depth ≥5 cm
Windsor A	Jan	√	√
	Feb	√	√
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
	Dec	√	
	SUM for Windsor A	**3**	**2**
Toronto	Jan	√	√
	Feb	√	√
	Mar		√
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
	Dec	√	√
	SUM for Toronto	**3**	**4**
Ottawa CDA	Jan	√	√
	Feb	√	√
	Mar	√	√
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
	Dec	√	√
	SUM for Ottawa CDA	**4**	**4**
Mean of 3 city stations		3.3	3.3

Data obtained from Canadian Climate Normals 1971-2000, Environment Canada. www.climate.weatheroffice.ec.gc.ca (Last accessed March 6, 2008).

Table 2.20: Determination of Exposed Skin Surface Area (cm^2) for Receptors

		infant (0 – 5 mo.)	toddler (6 mo. – 4 y)	child (5-11 y)	teen (12-19y)	adult resident (20+ y)	female adult resident (20+ y)	outdoor or subsurface worker (20-59 y)	female outdoor or subsurface worker (20-59 y)
data as reported in Richardson (1997)	arms	550	890	1480	2230	2500	2270	2510	2270
	hands	320	430	590	800	890	820	890	820
	legs	910	1690	3070	4970	5720	5390	5740	5390
	feet	250	430	720	1080	1190	1130	1200	1130
Assumption-based Skin Surface Areas[a]	head	275	445	740	1115	1250	1135	1255	1135
	forearms	275	445	740	1115	1250	1135	1255	1135
	lower legs	455	845	1535	2485	2860	2695	2870	2695
Sums of Skin Surface Areas[b]	head + hands + forearms + lower legs + feet	1575	2595	4325	n/ap[d]	n/ap	n/ap	n/ap	n/ap
	Head + hands + forearms + lower legs + feet	n/ap	n/ap	n/ap	5515	6250	5785	n/ap	n/ap
	head + hands + forearms	870	1320	2070	3030	3390	3090	**3400**	**3090**
Season-Specific Sums[b]	summer	1575	2595	4325	5515	6250	5785	n/ap	n/ap
	spring and fall	870	1320	2070	3030	3390	3090	n/ap	n/ap
Time-Weighted Averages[c]		**1105**	**1745**	**2822**	**3858**	**4343**	**3988**	n/ap	n/ap

a) Based on the Rule of Nines, the skin surface area of the head is assumed to equal that of one arm. Based on professional judgement, the forearms are assumed to be approximately half the arms, and the lower legs are assumed to be approximately half the legs.
b) Body part skin surface areas selected were based on recommendations of US EPA (2004a) as discussed in Table 2.7 above.
c) Time-weighted averages of skin surface areas (SSAs) were calculated based on a 9-month period during spring, summer, and fall where each season has a 3-month duration.
d) n/ap = The SSA calculation is not applicable to the receptor.

2.4 Source Allocation and Cancer Risk Level

2.4.1 Definition of Source Allocation

As with the 1996 *Rationale*, source allocation is applied in the derivation of HHCV in order to account for concurrent exposures to the same substance via multiple

pathways of exposure. The use of source allocation helps to prevent potential exposure at a SCS from exceeding a TDI or TC.

A default Source Allocation Factor (SAF) of 0.2 is applied in the derivation of most HHCVs for non-cancer. This means that one-fifth of the TDI or TC was allocated for most component values, which translates to a target HQ of 0.2. A target Cancer Risk Level (CRL) level of 1 x 10^{-6} (i.e., one in a million) was allocated to each component value based on cancer. There are some exceptions, however, where these target risk levels (HQ=0.2 and CRL=10^{-6}) were set at different levels or applied in a different way (see further below).

2.4.2 Notes and Exceptions to the Target Risk Levels

HHCVs Based on Multiple Pathways of Exposure

- The target CRL is one per one million (10^{-6}) *per component value*. A component value may be one medium and one pathway (e.g. S3 if inhalation of airborne soil is the driver) or one medium and two pathways (e.g., S1). If two cancer-based component values considered for the same land use happen to be approximately the same value (e.g. S1 and S-IA-1), and one of these HHCVs forms the basis of the SCS, then the SCS corresponds to an incremental cancer risk of approximately two in a million for one medium and three pathways. GW1 and SGW1 component values that are based on established drinking water standards or guidelines may not follow this logic. This is described below.

GW1 Components Based on Established Drinking Water Standards or Guidelines

- Established drinking water standards or guidelines, where available, were selected as human health GW1 component values for GW1 (see further in Section 2.7.5.2). Health-based drinking water standards are generally developed with the application of SAFs to account for concurrent exposure via other media. Therefore, an SAF or CRL was not applied to the GW1 component values that are based on drinking water standards or guidelines. However, for non-carcinogens, an SAF applied to health-based drinking water criteria is developed on a substance-specific basis rather than being based on a default percentage. In addition, some drinking water criteria are based on feasibility rather than human health. Consequently, GW1 component values based on established drinking water criteria should not be assumed to be based on an SAF/HQ of 0.2 or a CRL of 10^{-6}.

Petroleum Hydrocarbons (PHCs)

- CCME (2008) has compiled and analyzed PHC media concentration data to derive SAFs specific for these substances – 0.5, 0.5, 0.6, and 0.8 for fractions F1, F2, F3, and F4, respectively. For the derivation of MOE soil and GW

standards, these data and analyses were considered adequate to depart from the default of 0.2; however, taking into account the considerable potential exposures from consumer products, an SAF of 0.5 was used for all PHC fractions.

S-IA Components

- As described in Section 2.7.3.4, a Source Depletion Multiplier (SDM) was incorporated into the S-IA component values in order to account for the depletion of a volatile substance in soil over time. S-IA components are based on an initial IAC which is up to 100-fold higher than the health-based IAC and would not be consistent with a target HQ of 0.2 or 1. Although the initial IAC is not expected to actually occur at a site, the S-IA components are based on a 3- to 5-year lag time between the start of subsurface vapour intrusion and reaching an IAC which corresponds to the target HQ of 0.2. A further protection is built in such that the SDM doesn't result in an exceedence of short term effects concentrations, but in situations where no reference short term effects concentrations could be found, the potential health risks during this lag time cannot be precisely ascertained.

Lead

- For some substances, a threshold for non-cancer effects may not exist, or may not be possible to discern. In such instances, establishing a guideline or standard cannot be based on target HQ. Instead, the guideline or standard may be based on a policy decision regarding an acceptable level of adverse effect or uncertainty. Lead is an example of such a substance.

2.5 Selection of Toxicological Reference Values (TRVs)

2.5.1 Definition of a TRV

The term Toxicological Reference Value (TRV) refers to a health effects-based value that is useful for quantitative health risk assessment. TRVs are based on particular health effects and are differentiated primarily by the route of exposure (i.e., ingestion, inhalation, dermal) and by whether the basis of the TRV is a cancer or non-cancer effect. TRVs based on non-cancer effects are further differentiated by the duration of exposure (acute, chronic). Values which incorporate consideration of risk management or technological or economic feasibility are not considered to be TRVs.

Several different agencies derive TRVs, and may use different names to refer to the same type of TRV. Four main types of TRVs, described in Table 2.21 below, were used in the derivation of HHCVs.

Table 2.21: TRVs used in the derivation of HHCVs

Category of TRV	Type of Dose-Response Relationship	Units	Term Used in This Document	Terms Used by Other Agencies
oral* chronic or subchronic non-cancer	threshold	$mg_{chem}/kg_{BodyWeight}/day$	Tolerable Daily Intake (TDI)	Reference Dose (RfD); Acceptable Daily Dose
inhalation chronic non-cancer	threshold	mg_{chem}/m^3_{air}	Tolerable Concentration (TC)	Reference Concentration (RfC); chronic Reference Exposure Level (cREL)
oral* cancer	non-threshold	per mg/kg/day *or* $(mg/kg/day)^{-1}$	Oral Cancer Slope Factor (CSF_O)	
inhalation cancer	non-threshold	per mg/m^3 *or* $(mg/m^3)^{-1}$	Inhalation Unit Risk (IUR)	Inhalation Cancer Slope

* note: oral TRVs are applied to both oral and dermal exposures in the derivation of HHCVs

A central assumption in non-cancer risk assessment is that a range of exposures from zero to a threshold dose or concentration will not result in adverse effects. TRVs for non-cancer effects are based on these threshold doses or concentrations, which are estimated using points of departure from quantitative dose-response data. Points of departure can be a no-observed-adverse-effect level (NOAEL), a lowest-observed-adverse-effect level (LOAEL), or a specified benchmark dose or concentration. Points of departure may be adjusted for discontinuous to continuous exposure and are divided by uncertainty factors to derive the non-cancer TRV. Uncertainty factors account for individual sensitivity and variability, interspecies variability (if animal data are used), and extrapolation between different points of departure or duration of exposures. Thus, a TRV for threshold non-cancer toxicity is a dose or air concentration for a substance at which adverse effects are not expected to occur in populations of humans for the duration of exposure specified.

Note that for some substances, a threshold for non-cancer effects may not be possible to establish, or may simply not exist. In such instances, establishing a guideline or standard for the substance cannot be based on a dose or concentration at which adverse effects are not expected to occur. Instead, the guideline or standard may be based on a policy decision regarding a tolerable or acceptable level of adverse effect or uncertainty, or the standard may be based on a risk management approach.

A TRV for non-threshold cancer effects estimates the increased risk or incidence of cancer per unit exposure of a chemical. A central assumption in risk assessment for genotoxic (non-threshold) carcinogens is that there is no exposure without risk (i.e., no threshold exists) and that the risk of adverse effects is linearly proportional to the exposure. TRVs for cancer risk are excess lifetime cancer risks resulting from continuous exposure. The cancer TRVs used in the derivation of HHCVs are referred to as an Oral Cancer Slope Factor (CSF_O) or an Inhalation Unit Risk (IUR).

A CSF_O is combined with a Cancer Risk Level (CRL) in order to calculate a Risk-Specific Dose (RSD, in mg/kg/day), while a IUR is combined with a CRL in order to calculate a Risk-Specific Concentration (RSC, in mg/m^3). The CRL represents an incidence of cancer (e.g., one case of cancer per million people) and is often expressed using exponents for the sake of brevity (e.g., 10^{-6} for 1 case of cancer in 1 000 000 people; 10^{-5} for 1 case of cancer in 100 000 people, etc.). A target or acceptable CRL is established by policy in order to derive human health-based media-specific standards or criteria (such as the HHCVs) for non-threshold carcinogens. A target CRL is applied to the particular source of exposure that a standard or criterion is intended to address (e.g., a target CRL may be applied per site, per facility, per pathway of exposure, etc.). In the case of the derivation of the SCS, a CRL of 10^{-6} was applied per HHCV (each component value reflects one medium and either one or two pathways of exposure).

2.5.2 Process Used to Select TRVs

Several health and environmental agencies have derived oral and inhalation TRVs for chronic and/or sub-chronic exposure to substances. SDB reviewed TRVs from multiple agencies, using the process described below, to select TRVs for the derivation of HHCVs:

1) All available TRVs were identified for each substance, and within each TRV category (oral chronic non-cancer, oral sub-chronic non-cancer, inhalation chronic non-cancer, oral cancer slope factor, and inhalation unit risk). Draft and provisional TRVs were also identified and considered based on the merits of each derivation.
    - Note: California EPA's more recent derivations of Public Health Goals (PHGs) for Chemicals in Drinking Water (CalEPA DW), include derivation of TRVs. With earlier PHG derivations, although TRVs are not directly provided, ingestion TRVs can be "extracted" by removing the factors not relevant to TRV derivation. The following two equations illustrate how a PHG derivation can be used to obtain a non-cancer oral TRV (a tolerable daily intake; TDI).

$$\boxed{\mathrm{PHG} = \frac{\mathrm{NOAEL} \times RelativeSourceContribution \times BodyWeight}{UncertaintyFactors \times DrinkingWaterIngestionRate}}$$

$$\downarrow$$

$$\boxed{\mathrm{TDI} = \frac{\mathrm{NOAEL}}{UncertaintyFactors}}$$

2) For each substance, the derivation of each TRV within each category was critically analysed and compared in order to select the most toxicologically defensible TRV. The criteria used to critically compare TRVs included (note that not all criteria were relevant for each particular case, but were used as applicable):

- weight of evidence and the choice of critical health effect (observed changes considered to be biologically significant)
- scientific calibre or merits of the critical study/studies including
  - number of treatment groups
  - type of controls used
  - regime of doses
  - route(s) of exposure
  - number of study subjects, subjects per treatment group
  - duration of exposure
  - excess mortality
  - interpretation of dose-response data by source agency
  - confounding factors (particularly with respect to epidemiological data)
- whether based on human or animal data
- animal species used in critical animal study or studies
- species of metal in critical study or studies
- methods of dose-response modelling and dose adjustment used
- identification of point of departure (for example, a $BMDL_{10}$ might be preferred over a NOAEL or LOAEL)
- severity and/or biological significance of endpoint
- confidence in and/or relevance of the overall derivation, including with respect to any data published since the TRV was derived

3) For each substance, and within each TRV category, the TRV considered most appropriate for use in deriving HHCVs was selected. TRVs were selected based on the defensibility or merits of a derivation, and not on the basis of a hierarchy of agencies (no one agency was viewed as a preferred source of TRVs over other agencies). In addition, the recency of the derivation was not *per se* a criterion for selection.

- Some TRVs were modified (mainly with respect to the uncertainty factors applied) on the grounds of toxicological defensibility and based on the judgement of Ministry toxicologists.
- If a TRV selected for an inorganic substance was based on a *compound* form of the substance, the TRV was modified for percent composition of the toxic element by mass. For example, arsenic trioxide (As_2O_3) is 75.74% arsenic; a TRV for arsenic trioxide would be multiplied by approximately 0.76 to obtain a TRV for arsenic.
- For some carcinogenic substances, the mechanism of action for carcinogenicity is considered non-genotoxic (epigenetic) by some agencies but genotoxic by others. If the weight-of-evidence supports a genotoxic mechanism, then a cancer potency factor (a CSF_O or IUR) was selected. If the weight-of-evidence supports a non-genotoxic mechanism, the TRV for cytotoxicity was then considered with the non-carcinogenic TRVs, and no cancer potency factor was selected. If, however, the weight-of-evidence supports both mechanisms of action, then a cancer potency factor was selected.
- For some inorganics, TRVs for different chemical species were available within one TRV category (e.g., oral non-cancer). If there were no other relevant differences between the available TRVs, the TRV for the more soluble species was often selected. This was to avoid underestimating the human health risks at contaminated sites that might have the more soluble forms of these inorganics.
- Derivation of some TRVs was based on route-to-route extrapolation. All other factors being equal, a TRV was considered preferable if it was based on a study where the route of exposure was relevant to the exposure scenario for an HHCV. If a TRV based on a route-to-route extrapolation is the only TRV available for the particular TRV category, that TRV may or may not have been selected. Toxicokinetic data (or at least a blood:air partition coefficient) were considered in order to support selecting a route extrapolated TRV.
- Proxy TRVs: For some substances, oral non-cancer or oral cancer TRVs were not available. A proxy TRV was assigned for some of these substances, based on known TRVs for related substances.
- TRVs were selected for chromium III in order to derive HHCVs for total chromium.

2.5.3 Sources of TRVs

Table 2.22 lists the agencies and sources from which SDB identified available TRVs. Note that not all agencies derive all types of toxicity values for all substances.

Table 2.22: Source Agencies for Toxicological Reference Values (TRVs)

Agency Deriving TRVs	Name of Agency's Program, Document, or TRV	Abbreviation Used Here
Agency for Toxic Substances and Disease Registry	Minimal Risk Levels (MRLs)	ATSDR
California Environmental Protection Agency	Air Toxic Hotspots Program	CalEPA ATH
	Chronic Reference Exposure Level (REL)	CalEPA ChREL
	Child-Specific Reference Dose	CalEPA chRD
	Public Health Goals (PHGs) for Chemicals in Drinking Water	CalEPA DW
	Air Resources Board	CalEPA ARB
Canadian Council of Ministers of the Environment	Canada-Wide Standards – Supporting Technical Documents. Canadian Soil Quality Guidelines – Environmental and Human Health.	CCME
European Commission	*Ambient Air Pollution by As, Cd and Ni compounds*. Position Paper. (October 2000) *Opinion of the Scientific Committee on Food on the Risk Assessment of Dioxin-like PCBs in Food*. European Commission, Health and Consumer Protection Directorate-General. (Adopted on 30 May 2001)	EC
Health Canada	Guidelines for Canadian Drinking Water Quality, Supporting Documents	HC DW
	Canadian Environmental Protection Act (CEPA) – Priority Substances List – Supporting Documentation: *Health-Based Tolerable Daily Intakes/Concentrations and Tumourigenic Doses/Concentrations for Priority Substances* (Aug. 1996)	HC 1996
	First Priority Substances List (PSL1) Assessments	HC PSL1
	Second Priority Substances List (PSL2) Assessments	HC PSL2
National Institute of Public Health & Environmental Protection, Netherlands	*Re-Evaluation of Human-Toxicological Maximum Permissible Risk Levels* (March 2001)	RIVM 2001
New York State Department of Health and New York State Department of Environmental Conservation	NYS. 2006. New York State Brownfield Cleanup Program *Development of Soil Cleanup Objectives Technical Support Document*. New York State Department of Health and New York State Department of Environmental Conservation. September 2006. [Appendix A. Fact Sheets Containing a Summary of Data Used to Identify Toxicity Values (Reference Dose, Reference Concentration, Oral Potency Factor, and Inhalation Unit Risk) Used in the Calculation of Soil Cleanup Objectives Based on the Potential for Chronic Toxicity in Adults and Children from Chronic Exposures to Soil Substances.]	NYS DOH or NYS DEC

Agency Deriving TRVs	Name of Agency's Program, Document, or TRV	Abbreviation Used Here
Ontario Ministry of the Environment	Ambient Air Quality Criteria (24-hour, incorporates no averaging time adjustments)	MOE 24-h AAQC
Total Petroleum Hydrocarbon Criteria Working Group	Total Petroleum Hydrocarbon Criteria Working Group Series – Volume 4: *Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH)* (1997)	TPHCWG 1997
Toxicological Excellence for Risk Assessment	Toxicological reviews	TERA
United States Environmental Protection Agency	Integrated Risk Information System	IRIS
	Provisional Peer Reviewed Toxicity Value	US EPA PPRTV
	Region III	US EPA Region III
	Superfund Health Effects Assessment Summary Tables	HEAST
	Health Effects Support Document	HESD
	National Center for Environmental Assessment, Health Risk Assessment	US EPA NCEA
World Health Organization and International Programme on Chemical Safety	*Air Quality Guidelines for Europe*, 2nd Edition. WHO Regional Publications, European Series, No. 91. Copenhagen. (2000)	WHO Air 2000
	Concise International Chemical Assessment Documents	WHO CICAD
	Joint Expert Committee on Food Additives	WHO JECFA
	Environmental Health Criteria Monographs	WHO EHC
	Joint Meeting on Pesticide Residues Monographs and Evaluations	WHO JMPR
	Guidelines for Drinking-Water Quality	WHO DW

2.5.4 TRVs Selected for Derivation of HHCVs

The TRVs selected for each substance are provided in Table 2.23. Each was chosen as the most defensible TRV for use in deriving the HHCVs.

Table 2.23: Toxicological Reference Values (TRVs) for Derivation of Human Health Soil & Groundwater Standards

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Acenaphthene	83329	6.0E-02	IRIS 1994	6.0E-01	ATSDR 1995	none selected		7.3E-03	Kalberlah et al 1995 (TEF=0.001) & IRIS 1992	1.1E-03	Kalberlah et al 1995 (TEF=0.001) & CalEPA ATH 2005/1993
Acenaphthylene	208968	6.0E-02	IRIS 1994 (proxy)	6.0E-01	ATSDR 1995 (proxy)	none selected		7.3E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992	1.1E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993
Acetone	67-64-1	9.0E-01	IRIS 2003	3.0E+00	modified from IRIS 2003	1.2E+01	MOE 24-h AAQC 2005	none selected		none selected	
Aldrin	309002	3.0E-05	IRIS 1988; ATSDR 2002	4.0E-05	US EPA PPRTV 2005	none selected		none selected		none selected	
Anthracene	120127	3.0E-01	IRIS 1993	3.0E+00	modified from IRIS 1993	none selected		none selected	Kalberlah et al 1995 (no TEF) & IRIS 1992	none selected	Kalberlah et al 1995 (no TEF) & CalEPA ATH 2005/1993
Antimony	various	4.0E-04	IRIS 1991	none selected		2.0E-04	IRIS 1995	none selected		none selected	
Arsenic	7440382	3.0E-04	IRIS 1993; CalEPA ChREL 2000; ATSDR (Sept. 2005 draft)	none selected		3.0E-05	CalEPA ChREL 2000	1.5E+00	CalEPA ATH 2005	1.5E+00	WHO Air 2000
Barium	7440393	2.0E-01	IRIS 2005	none selected		1.0E-03	RIVM 2001	none selected		none selected	
Benzene	71432	4.0E-03	IRIS 2003		none selected	3.0E-02	IRIS 2003	8.5E-02	HC DW (Sept. 2007 draft)	2.2E-03	IRIS 2000
Benz[a]anthracene	56553	none selected		none selected		none selected		7.3E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992	1.1E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Benzo[a]pyrene	50328	none selected		none selected		none selected		7.3E+00	Kalberlah et al 1995 (TEF=1) & IRIS 1992	1.1E+00	Kalberlah et al 1995 (TEF=1) & CalEPA ATH 2005/1993
Benzo[b]fluoranthene	205992	none selected		none selected		none selected		7.3E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992	1.1E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993
Benzo[ghi]perylene	191242	none selected		none selected		none selected		7.3E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992	1.1E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993
Benzo[k]fluoranthene	207089	none selected		none selected		none selected		7.3E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992	1.1E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993
Beryllium	7440417	2.0E-03	IRIS 1998; CalEPA chREL 2001; ATSDR 2002; WHO CICAD 2001	none selected		7.0E-06	CalEPA chREL 2001	none selected		2.4E+00	IRIS 1998; CalEPA ATH 2005; WHO CICAD 2001
1,1'-Biphenyl	92-52-4	3.8E-02	WHO CICAD 1999	none selected		none selected		none selected		none selected	
Bis(2-chloroethyl)ether	111-44-4	none selected		none selected		none selected		2.5E+00	CalEPA ATH 2005	none selected	
Bis(2-chloroisopropyl) ether	108-60-1	4.0E-02	IRIS 1990	none selected		none selected		none selected		none selected	
Bis(2-ethylhexyl) phthalate	117817	6.0E-02	ATSDR 2002	1.0E-01	ATSDR 2002	none selected		none selected		none selected	
Boron	7440428	2.0E-01	IRIS 2004	none selected		none selected		none selected		none selected	
Bromodichloromethane	75-27-4	2.0E-02	IRIS 1991; ATSDR 1989	none selected		none selected		6.2E-02	IRIS 1993	none selected	
Bromoform	75252	2.0E-02	IRIS 1991	3.0E-02	US EPA PPRTV 2005	none selected		7.9E-03	IRIS 1991	1.1E-03	IRIS 1991

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Bromomethane	74-83-9	3.0E-04	modified from ATSDR 1992	3.0E-03	ATSDR 1992	5.0E-03	IRIS 1992; CalEPA chREL 2000	none selected		none selected	
Cadmium	7440439	3.2E-05	modified from CalEPA DW 2006	none selected		3.00E-05	modified from MOE 24 hour AAQC 2007	none selected		9.8	HC 1996
Carbon Tetrachloride	56235	7.0E-04	IRIS 1991; CalEPA DW 2000	7.0E-03	ATSDR 2005	2.0E-03	USEPA Region III 2004	none selected		none selected	
Chlordane	57749	3.3E-05	CalEPA chRD 2005	6.0E-04	ATSDR 1994	7.0E-04	IRIS 1998	1.3E+00	CalEPA DW 1997	1.0E-01	IRIS 1998
p-Chloroaniline	106478	2.0E-03	WHO CICAD 2003	none selected		none selected		none selected		none selected	
Chlorobenzene	108-90-7	6.0E-02	CalEPA DW 2003	1.9E-01	modified from CalEPA DW 2003	1.0E+00	CalEPA chREL 2000	none selected		none selected	
Chloroform	67663	1.0E-02	IRIS 2001	1.0E-01	ATSDR 1997	9.8E-02	ATSDR 1997	3.1E-02	CalEPA ARB 1990	5.3E-03	CalEPA ATH 2005
2-Chlorophenol	95578	3.0E-03	RIVM 2001	3.0E-03	ATSDR 1999	none selected		none selected		none selected	
Chromium Total	various	1.5E+00	IRIS 1998	none selected		6.0E-02	RIVM 2001	none selected		none selected	
Chromium VI	18540299	8.3E-03	modified from IRIS 1998	none selected		1.0E-04	IRIS 1998	none selected		4.0E+01	WHO Air 2000
Chrysene	218019	none selected		none selected		none selected		7.3E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992	1.1E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993
Cobalt	7440484	1.0E-03	modified from ATSDR 2004	1.0E-02	ATSDR 2004	5.0E-04	RIVM 2001	none selected		none selected	
Copper	7440508	3.0E-02	HC DW 1992	none selected		none selected		none selected		none selected	
Cyanide (CN-)	various	2.0E-02	CalEPA DW 1997; IRIS 1993; CCME 1997	5.0E-02	ATSDR 2006	8.0E-03	MOE 24-hr 2005	none selected		none selected	
Dibenz[a,h]anthracene	53703	none selected		none selected		none selected		7.3E+00	Kalberlah et al 1995 (TEF=1) & IRIS 1992	1.1E+00	Kalberlah et al 1995 (TEF=1) & CalEPA ATH 2005/1993

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Dibromochloromethane	124481	2.0E-02	IRIS 1991	2.0E-01	modified from IRIS 1991	none selected		8.4E-02	IRIS 1992	none selected	
1,2-Dichlorobenzene	95-50-1	3.0E-01	ATSDR 2006	6.0E-01	ATSDR 2006	6.0E-01	RIVM 2001	none selected		none selected	
1,3-Dichlorobenzene	541-73-1	2.0E-02	ATSDR 2006 (proxy)	2.0E-02	ATSDR 2006	none selected		none selected		none selected	
1,4-Dichlorobenzene	106-46-7	3.0E-02	IRIS (May 2006 draft)	7.0E-02	ATSDR 2006	6.0E-02	ATSDR 2006	1.7E-02	IRIS (May 2006 draft); HC DW 1987	4.0E-03	IRIS (May 2006 draft)
3,3'-Dichlorobenzidine	91941	none selected		none selected		none selected		1.2E+00	CalEPA ATH 2005	none selected	
Dichlorodifluoromethane	75718	2.0E-01	IRIS 1995	none selected		none selected			none selected	none selected	
DDD	72548	5.0E-04	RIVM 2001	none selected		none selected		2.4E-01	IRIS 1988	none selected	
DDE	72559	5.0E-04	RIVM 2001	none selected		none selected		3.4E-01	IRIS 1988	none selected	
DDT	50293	5.0E-04	RIVM 2001; IRIS 1996	none selected		none selected		3.4E-01	IRIS 1991	none selected	
1,1-Dichloroethane	75-34-3	4.0E-02	CalEPA DW 2003	4.0E-01	modified from CalEPA DW 2003	1.7E-01	modified from HEAST 1984	none selected		none selected	
1,2-Dichloroethane	107-06-2	2.0E-02	modified from ATSDR 2001	2.0E-01	ATSDR 2001	4.0E-01	CalEPA chREL 2000	9.1E-02	IRIS 1991	2.6E-02	IRIS 1991
1,1-Dichloroethylene	75354	5.0E-02	IRIS 2002	none selected		7.0E-02	CalEPA chREL 2000	none selected		none selected	
1,2-*cis*-Dichloroethylene	156592	3.0E-02	modified from RIVM 2001	3.0E-01	ATSDR 1996; modified from RIVM 2001	1.5E-01	modified from RIVM 2001	none selected		none selected	
1,2-*trans*-Dichloroethylene	156605	2.0E-02	IRIS 1989	2.0E-01	ATSDR 1996; modified from IRIS 1989	6.0E-02	RIVM 2001	none selected		none selected	
2,4-Dichlorophenol	120832	3.0E-03	RIVM 2001	3.0E-03	ATSDR 1999		none selected	none selected		none selected	
1,2-Dichloropropane	78875	9.0E-02	ATSDR 1989; CalEPA DW 1999	none selected		4.0E-03	IRIS 1991	3.6E-02	CalEPA DW 1999	none selected	
1,3-Dichloropropene	542756	3.0E-02	IRIS 2000; ATSDR (Sept. 2006 draft)	4.0E-02	ATSDR (Sept. 2006 draft)	2.0E-02	IRIS 2000	9.1E-02	CalEPA DW 1999	4.0E-03	IRIS 2000
Dieldrin	60-57-1	5.0E-05	IRIS 1990; ATSDR 2002	1.0E-04	ATSDR 2002	none selected		none selected		none selected	
Diethyl Phthalate	84662	5.0E+00	WHO CICAD 2003	8.0E+00	modified from IRIS 1993	none selected		none selected		none selected	

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Dimethylphthalate	131113	5.0E+00	WHO CICAD 2003 (proxy)	none selected		none selected		none selected		none selected	
2,4-Dimethylphenol	105679	2.0E-02	IRIS 1990	2.0E-01	modified from IRIS 1990	none selected		none selected		none selected	
2,4-Dinitrophenol	51285	2.0E-03	IRIS 1991	2.0E-02	modified from IRIS 1991	none selected		none selected		none selected	
2,4- and 2,6-Dinitrotoluene	121142	2.0E-03	IRIS 1993; ATSDR 1998	4.0E-03	ATSDR 1998	none selected		6.8E-01	IRIS 1990	none selected	
1,4-Dioxane	123911	1.0E-01	ATSDR 2006	6.0E-01	ATSDR 2006	3.6E+00	ATSDR 2006	1.1E-02	IRIS 1990	none selected	
Dioxin/Furan	1746016	2.3E-09	WHO JECFA 2002	2.0E-08	ATSDR 1998	4.0E-08	CalEPA ChREL 2000	none selected		none selected	
Endosulfan	115297	2.0E-03	ATSDR 2000	5.0E-03	ATSDR 2000	none selected		none selected		none selected	
Endrin	72-20-8	2.5E-04	CalEPA DW 1999	2.0E-03	ATSDR 1996	none selected		none selected		none selected	
Ethylbenzene	100414	1.0E-01	IRIS 1991; RIVM 2001; WHO DW 2003	none selected		1.0E+00	IRIS 1991	none selected		none selected	
Ethylene dibromide (1,2-Dibromoethane)	106934	9.0E-03	IRIS 2004	2.5E-02	modified from CalEPA DW 2003	8.0E-04	CalEPA ChREL 2001	3.6E+00	CalEPA DW 2003	6.0E-01	IRIS 2004
Fluoranthene	206440	4.0E-02	IRIS 1993	4.0E-01	modified from IRIS 1993	none selected		7.3E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992	1.1E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993
Fluorene	86737	4.0E-02	IRIS 1990	4.0E-01	modified from IRIS 1990	none selected		none selected	Kalberlah et al 1995 (TEF=0) & IRIS 1992	none selected	Kalberlah et al 1995 (TEF=0) & CalEPA ATH 2005/1993
Heptachlor	76448	3.0E-05	CalEPA chRD 2005	none selected		none selected		4.1E+00	CalEPA DW 1999	none selected	
Heptachlor Epoxide	1024573	none selected		none selected		none selected		5.5E+00	CalEPA DW 1999	none selected	
Hexachlorobenzene	118741	3.0E-05	modified from ATSDR (int) 2002	1.0E-04	ATSDR 2002	none selected		1.2E+00	CalEPA DW 2003	none selected	

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Hexachlorobutadiene	87683	3.4E-04	HC PSL2 2000	none selected		none selected		7.8E-02	IRIS 1991	2.2E-02	IRIS 1991
gamma-Hexachlorocyclohexane	58899	1.2E-05	CalEPA DW 1999	none selected		none selected		none selected		none selected	
Hexachloroethane	67721	1.0E-03	IRIS 1991	1.0E-02	ATSDR 1997	none selected		1.4E-02	IRIS 1994	4.0E-03	IRIS 1994
n-Hexane	110543	none selected		none selected		2.5E+00	MOE 24-h AAQC 2005	none selected		none selected	
Indeno[1,2,3-cd]pyrene	193395	none selected		none selected		none selected		7.3E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992	1.1E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993
Lead	7439921	none selected		none selected		none selected		none selected		none selected	
Mercury	Various	3.0E-04	IRIS 1995	3.0E-03	modified from IRIS 1995	9.0E-05	CalEPA ChREL 2000	none selected		none selected	
Methoxychlor	72-43-5	2.0E-05	CalEPA chRD 2005	none selected		none selected		none selected		none selected	
Methyl Ethyl Ketone	78933	6.0E-01	IRIS 2003	none selected		5.0E+00	IRIS 2003	none selected		none selected	
Methyl Isobutyl Ketone	108101	1.0E+00	modified from IRIS 2003	none selected		3.0E+00	IRIS 2003	none selected		none selected	
Methyl Mercury	22967926	1.0E-04	IRIS 2001	none selected			none selected	none selected		none selected	
Methyl tert-Butyl Ether (MTBE)	1634044	3.0E-02	modified from HC 1996	3.0E-01	ATSDR 1996; modified from HC 1996	3.0E+00	IRIS 1993	1.8E-03	CalEPA DW 1999; CalEPA ATH 2005	2.6E-04	CalEPA DW 1999; CalEPA ATH 2005
Methylene Chloride	75092	6.0E-02	IRIS 1988; ATSDR 2000; RIVM 2001	none selected		4.0E-01	CalEPA chREL 2000	7.5E-03	IRIS 1995	2.3E-05	HC 1996
2-(1-) Methylnaphthalene	91576	4.0E-03	IRIS 2003	none selected		none selected		none selected	Kalberlah et al 1995 (no TEF) & IRIS 1992	none selected	Kalberlah et al 1995 (no TEF) & CalEPA ATH 2005/1993
Molybdenum	7439987	5.0E-03	IRIS 1993	none selected		1.2E-02	RIVM 2001	none selected		none selected	

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Naphthalene	91203	2.0E-02	IRIS 1998	2.0E-01	modified from IRIS 1998	3.7E-03	ATSDR 2005	none selected	Kalberlah et al 1995 (no TEF) & IRIS 1992	none selected	Kalberlah et al 1995 (no TEF) & CalEPA ATH 2005/1993
Nickel	Various	2.0E-02	IRIS 1996	none selected		6.0E-05	modified from TERA 1999	none selected		2.4E-01	IRIS 1991
Pentachlorophenol	87865	1.0E-03	ATSDR 2001	1.0E-03	ATSDR 2001	none selected		1.2E-01	IRIS 1993	none selected	
Petroleum Hydrocarbons F1											
Aliphatic C6-C8		5.0E+00	TPHCWG 1997; CCME 2000	none selected		1.8E+01	TPHCWG 1997; CCME 2000	none selected		none selected	
C>8-C10		1.0E-01	TPHCWG 1997; CCME 2000	1.0E+00	modified from TPHCWG 1997 & CCME 2000.	1.0E+00	TPHCWG 1997; CCME 2000	none selected		none selected	
Aromatic C>8-C10		4.0E-02	TPHCWG 1997; CCME 2000	none selected		2.0E-01	TPHCWG 1997; CCME 2000	none selected		none selected	
Petroleum Hydrocarbons F2											
Aliphatic C>10-C12		1.0E-01	TPHCWG 1997; CCME 2000	1.0E+00	modified from TPHCWG 1997 & CCME 2000.	1.0E+00	TPHCWG 1997; CCME 2000	none selected		none selected	
C>12-C16		1.0E-01	TPHCWG 1997; CCME 2000	1.0E+00	modified from TPHCWG 1997 & CCME 2000.	1.0E+00	TPHCWG 1997; CCME 2000	none selected		none selected	
Aromatic C>10-C12		4.0E-02	TPHCWG 1997; CCME 2000	none selected		2.0E-01	TPHCWG 1997; CCME 2000	none selected		none selected	
C>12-C16		4.0E-02	TPHCWG 1997; CCME 2000	none selected		2.0E-01	TPHCWG 1997; CCME 2000	none selected		none selected	
Petroleum Hydrocarbons F3											
Aliphatic C>16-C21		2.0E+00	TPHCWG 1997; CCME 2000	none selected		none selected		none selected		none selected	

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
C>21-C34		2.0E+00	TPHCWG 1997; CCME 2000	none selected		none selected		none selected		none selected	
Aromatic C>16-C21		3.0E-02	TPHCWG 1997; CCME 2000	3.0E-01	modified from TPHCWG 1997 & CCME 2000.	none selected		none selected		none selected	
C>21-C34		3.0E-02	TPHCWG 1997; CCME 2000	3.0E-01	modified from TPHCWG 1997 & CCME 2000.	none selected		none selected		none selected	
Petroleum Hydrocarbons F4											
Aliphatic C>34		2.0E+01	TPHCWG 1997; CCME 2000	none selected		none selected		none selected		none selected	
Aromatic C>34		3.0E-02	TPHCWG 1997; CCME 2000	3.0E-01	modified from TPHCWG 1997 & CCME 2000.	none selected		none selected		none selected	
Phenanthrene	85018	none selected		none selected		none selected		none selected	Kalberlah et al 1995 (TEF=0) & IRIS 1992	none selected	Kalberlah et al 1995 (TEF=0) & CalEPA ATH 2005/1993
Phenol	108952	3.0E-01	IRIS 2002	3.0E-01	IRIS 2002	3.0E-02	MOE 24-h AAQC 2004	none selected		none selected	
Polychlorinated Biphenyls	1336363	2.0E-05	ATSDR 2000; WHO CICAD 2003	3.0E-05	ATSDR 2000	5.0E-04	RIVM 2001			1.0E-01	IRIS 1997
Pyrene	129000	3.0E-02	IRIS 1993	3.0E-01	modified from IRIS 1993	none selected		7.3E-03	Kalberlah et al 1995 (TEF=0.001) & IRIS 1992	1.1E-03	Kalberlah et al 1995 (TEF=0.001) & CalEPA ATH 2005/1993
Selenium	7782492	5.0E-03	IRIS 1991; CalEPA ChREL 2001	none selected		none selected		none selected		none selected	
Silver	7440224	5.0E-03	IRIS 1996	none selected		none selected		none selected		none selected	

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Styrene	100425	1.2E-01	RIVM 2001; HC PSL1 1993; HC 1996	none selected		2.6E-01	modified from WHO Air 2000	none selected		none selected	
1,1,1,2-Tetrachloroethane	630206	3.0E-02	IRIS 1996	none selected		none selected		2.6E-02	IRIS 1991	7.4E-03	IRIS 1991
1,1,2,2-Tetrachloroethane	79345	1.0E-02	US EPA HESD (Sept. 2006 draft)	5.0E-01	ATSDR (Sept. 2006 draft)	none selected		2.0E-01	IRIS 1994	5.8E-02	IRIS 1994
Tetrachloroethylene	127184	1.4E-02	HC 1996; WHO DW 2003	1.4E-01	modifed from HC 1996 & from WHO DW 2003	2.5E-01	WHO Air 2000	none selected		none selected	
Thallium	7440280	1.4E-05	CalEPA DW 1999	1.4E-04	modified from CalEPA DW 1999		none selected	none selected		none selected	
Toluene	108883	8.0E-02	IRIS 2005	8.0E-01	modified from IRIS 2005	5.0E+00	IRIS 2005	none selected		none selected	
1,2,4-Trichlorobenzene	120-82-1	1.0E-02	IRIS 1996	1.0E-01	modified from IRIS 1996	8.0E-03	modified from WHO EHC 1991	none selected		none selected	
1,1,1-Trichloroethane	71-55-6	2.0E+00	IRIS 2007	7.0E+00	IRIS 2007	1.0E+00	CalEPA chREL 2000	none selected		none selected	
1,1,2-Trichloroethane	79-00-5	4.0E-03	IRIS 1995	4.0E-02	modified from IRIS 1995		none selected	5.7E-02	IRIS 1994	1.6E-02	IRIS 1994
Trichloroethylene	79016	1.5E-03	HC DW 2005	none selected		4.0E-02	USEPA NCEA (Aug 2001 draft)	1.3E-02	CalEPA DW 1999	2.0E-03	CalEPA 1990 as described in Cal EPA ATH 2005
Trichlorofluoromethane	75694	3.0E-01	IRIS 1992	none selected		none selected		none selected		none selected	
2,4,5-Trichlorophenol	95954	3.0E-03	RIVM 2001	3.0E-03	ATSDR 1999	none selected		none selected		none selected	
2,4,6-Trichlorophenol	88062	3.0E-03	RIVM 2001	3.0E-03	ATSDR 1999	none selected		1.1E-02	IRIS 1994	none selected	
Uranium	238	6.0E-04	HC DW 1999	6.0E-04	HC DWQ 1999	3.0E-04	ATSDR 1999	none selected		none selected	
Vanadium	7440622	2.1E-03	CalEPA DW 2000	2.1E-03	CalEPA DW 2000	1.0E-03	WHO Air 2000	none selected		none selected	
Vinyl Chloride	75014	3.0E-03	ATSDR 2006; IRIS 2000	none selected		1.0E-01	IRIS 2000	1.4E+00	IRIS 2000	8.8E-03	IRIS 2000

SUBSTANCE	CAS	Oral Chronic Non-Cancer[a]		Oral Sub-Chronic Non-Cancer[a]		Inhalation Chronic Non-Cancer[a]		Oral Slope Factor		Inhalation Unit Risk	
		TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/kg/d)	Ref.[b]	TRV selected (mg/m^3)	Ref.[b]	TRV selected $(mg/kg/d)^{-1}$	Ref.[b]	TRV selected $(mg/m^3)^{-1}$	Ref.[b]
Xylene Mixture	1330207	2.0E-01	IRIS 2003; ATSDR 2007	4.0E-01	ATSDR 2007	7.0E-01	CalEPA chREL 2005	none selected		none selected	
Zinc	7440666	3.0E-01	IRIS 2005	none selected		none selected		none selected		none selected	

a) TRVs based on developmental effects appear with their values and references underlined.
b) Agency document abbreviations found in the Ref. columns are described in Table 2.22 above.

2.6 Development of Relative Absorption Factors (RAFs)

Relative Absorption Factors (RAFs) are used in the derivation of HHCVs to account for the proportional difference between the amount of a substance absorbed under assumed exposure conditions in soil or GW, and the amount absorbed under the conditions of the critical toxicity study on which the TRV is based. The RAFs are based on either estimated or measured absorption. RAFs are substance-specific because they depend on unique physical-chemical properties of each substance. RAFs *are also TRV-specific* because they depend on the absolute absorption in the critical study of the TRV.

2.6.1 Definition and Calculation of a Relative Absorption Factor

A RAF is the ratio of the absorbed fraction of a substance from a particular exposure medium (in this case, soil or groundwater) under circumstances of environmental exposure, to the fraction absorbed from the dosing vehicle (study medium) used in the critical toxicity study upon which the TRV is based. Thus, *an RAF of 1 does not indicate that absorption is complete*, but rather that absorption is estimated to be the same as that in the critical study.

To estimate an RAF, two factors must be estimated:

- the absorption efficiency for the chemical via the route and medium of exposure under the assumed exposure conditions in the exposure scenario, and
- the absorption efficiency for the route and medium of exposure in the experimental study which is the basis of the TRV used for the substance

Thus, the RAF is calculated as follows:

$$\text{RAF} = \frac{\text{Absolute absorption in the exposure scenario (soil or GW)}}{\text{Absolute absorption estimated for the critical study}}$$

Absorption in the critical study used in the TRV is specific to the exposure pathway (the medium and the exposure route) and the animal species. To use a TRV for a different exposure scenario involves taking into consideration the absorption efficiency in this exposure scenario being modelled relative to the absorption efficiency in the exposure scenario of the critical study. This is the foundation of the calculation of an RAF.

RAFs are generally determined by dividing the absolute absorption for the medium and route in question, by the absolute absorption for the medium and route in the critical study used in deriving the TRV. As discussed by US EPA (2007), the absolute

absorption of the chemical in the exposure medium in a human receptor scenario may be less than or greater than that in the exposure medium used in the critical study that formed the basis of the TRV. (The National Environmental Policy Institute (NEPI 2000b) has noted that in some cases, volatile organic compounds (VOCs) ingested in a soil matrix decreased bioavailability, while in other cases bioavailability was not affected or actually increased. Thus, assuming a relative absorption of 100% for the human exposure medium could result in either an underestimate or overestimate of exposure at the site.

2.6.2 Determination of Relative Absorption Factors (RAFs) for Use in Derivation of Soil and Groundwater Standards

Table 2.24 below shows the final RAFs that were estimated for use in the derivation of soil and GW standards, with respect to the TRVs on which the soil standards are based. To follow the flow of logic in the determination of the RAFs, see Tables 2.35a and 2.35b at the end of section 2, and follow from left to right the substance-specific information in each row.

As a first step in the determination of RAFs, estimates of absolute absorption were identified for the animal species and dosing medium used in the critical study. Subsequently, RAFs were determined by comparison with oral absorption data for soil, oral absorption data for water, and dermal absorption data for soil.

Reviews from agencies and/or organizations such as the United States Environmental Protection Agency (US EPA), National Environmental Policy Institute (NEPI 2000a;b), California Environmental Protection Agency (Cal EPA), Massachusetts Department of Environmental Protection (MDEP 1992), and Agency for Toxic Substances and Disease Registry (ATSDR) were used to obtain information and estimates of absorption. If absorption estimates were not sufficient or not available from reviews, primary literature was consulted.

For absolute oral absorption in the critical study of the TRV, the first source consulted for percentage estimates and advice was Exhibit 4-1 of Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (US EPA 2004a) when available and relevant. When estimates and advice were not available in US EPA (2004a), reviews from other agencies or organizations were consulted.

The following is an outline of the process used to determine the RAFs:

- As per US EPA (2004a), a default of 100% absolute oral absorption in the critical study was applied to all organic compounds not in their list.

- As per US EPA (2004a), the absolute oral absorption in the critical study was assumed to be complete (100%) for any substance if the absolute oral absorption in the critical study was estimated in the literature to be near complete (> 50%).

- When determining oral absorption from soil or water, relative to oral absorption in the critical study, if appropriate quantitative data were lacking, an RAF of 100% was assumed. That is, the default assumption was that oral absorption of the substance from soil or water under circumstances of environmental exposure is the same as oral absorption from the dosing vehicle (study medium) used in the critical toxicity study upon which the TRV is based.

- For environmental exposures with the same or similar route and medium (dosing vehicle) as used in the critical study of the TRV, the RAF was assumed to be 100%. For example, the oral RAF for absorption from drinking water relative to oral absorption in the critical study was assumed to be 100% if the TRV was based on a drinking water study. Again, a RAF of 1 (i.e., 100%) does not indicate that absorption is complete, but rather that absorption from environmental exposure was estimated to be the same as absorption in the critical study upon which the TRV is based.

- For some substances, if drinking water standards or guidelines were available, they were used in lieu of the calculation of the GW1 (groundwater ingestion) pathway component and also used to calculate the S-GW1 (soil to groundwater) pathway component. Since TRVs were not used in these cases, oral RAFs for drinking water relative to oral absorption in a critical study were not needed and thus were not estimated.

- Estimates of absolute dermal absorption of substances from soil, including the default of 10% absolute dermal absorption for semi-volatile organic compounds (SVOCs), were obtained from US EPA (2004a; Exhibit 3-4) for the substances available. Section 3.2.2.4 of US EPA (2004a) describes that the default of 10% for SVOCs was determined from experimental values (Exhibit 3-4) which are considered representative of this chemical class.

- As per US EPA (2004a; section 3.2.2.4) no default values are presented for volatile organic compounds (VOCs) because these substances would tend to be volatilized from the soil adhering to skin, and thus should be accounted for via the inhalation route only. Based on available information, US EPA Region III (1995) recommended a default dermal absorption of 0.05% for VOCs such as benzene and a default of 3% for VOCs with vapour pressures less than that of benzene. NEPI (2000b) discusses that due to rapid volatilization, liquid phase VOCs applied directly to human skin show only slight absorption, and that in a real dermal exposure scenario, the VOC bioavailability is expected to be minimal due to low adsorbed phase concentrations and slow release of the desorption resistant fraction. For the calculation of soil and groundwater brownfield standards, a default of 3% absolute dermal absorption from

soil was used for all VOCs based on the analysis of US EPA Region III (1995). This low percentage default takes into consideration that from dermally adhered soil, dermal absorption of VOCs competes with high rates of volatilization to air. Note that since oral absorption in the critical study (upon which the TRV is based) was estimated to be 100% for most VOCs, the relative dermal absorption (the RAF) for VOCs is equal to the absolute dermal absorption, i.e., 3%.

- As described in US EPA (2004a; Section 3.2.2.6), limited data suggest that dermal absorption of a substance from soil is time-dependent; however, information is insufficient to determine whether that absorption in linear, sublinear, or supralinear with time. US EPA (2004a) advises against scaling the absorption factor for event time. As such, dermal absorption estimates from studies using exposure durations less than or greater than 24 hours were not scaled to determine dermal absorption estimates for a 24-hour period.

- When using chemical-specific data to estimate dermal absorption, non-occluded data were preferred to occluded data because they are more relevant to a dermal exposure scenario. However, occluded data were also considered in determining the absorption estimates.

- For several inorganic substances, quantitative data were insufficient to determine estimates of absolute dermal absorption. Section 2.6.2.1 below describes the determination of absolute dermal absorption fractions for these substances.

- An order-of-magnitude approach was sometimes used to determine a dermal RAF of 1%, 10%, or 100% under the following circumstances:
    - If dermal absorption of a substance could be significant but is not quantified,
    - If dermal absorption is not quantified, but is qualified relative to oral absorption,
    - If the range of reported absorptions is considerably wide, or
    - If an absolute dermal absorption rate has been determined by default and is approximately an order of magnitude lower than the estimated absolute oral absorption.

  This approach reflects the intrinsic variability in the analysis of absorption values and does not impart a level of precision that is not supported by data.

- Note that substances for which no oral TRVs were used do not require any oral or dermal RAFs (e.g., n-hexane). Oral and dermal RAFs are also not required for lead because the Ministry has retained the human health soil and groundwater lead standards from the 1996 *Rationale* document.

Table 2.24 provides a brief summary of the final RAFs. For references and a full understanding of how these RAFs were estimated, the reader is guided to Tables 2.35a

and 2.35b at the end of section 2. These tables show the located and selected estimates of absolute absorption and the subsequently determined estimates of RAFs for each substance.

Since soil may reduce absorption, an RAF of 100% may be considered conservative for some substances. However, for some others, the soil matrix may increase absorption. Also note that quantitative data for the development of RAFs for the inhalation route were generally not available. As a result, inhalation RAFs were assumed to be equal to 1, i.e., 100% relative absorption was assumed for all substances via the inhalation pathway relative to absorption in the critical study.

Table 2.24: Relative Absorption Factors (RAFs) Used in Derivation of HHCVs

Substance	Oral RAF_{soil}[b]	Oral RAF_{water}[c]	Dermal RAF_{soil}[d]
acenaphthene	1	1	0.13
acenaphthalene	1	1	0.13
acetone	1	1	0.03
aldrin	1	nr[e]	0.1
anthracene	1	1	0.13
antimony	1	nr	0.1
arsenic	0.5	nr	0.03
barium	1	nr	0.1
benzene	1	nr	0.03
benz[*a*]anthracene	1	nr	0.13
benzo[*a*]pyrene	1	nr	0.13
benzo[*b*]fluoranthene	1	nr	0.13
benzo[*g*,*h*,*i*]perylene	1	nr	0.13
benzo[*k*]fluoranthene	1	nr	0.13
beryllium	1	nr	0.1
1,1'-biphenyl	1	1	0.1
bis(2-chloroethyl) ether	1	1	0.03
bis(2-chloroisopropyl) ether	1	1	0.03
bis(2-ethylhexyl)phthalate	1	nr	0.1
boron	1	nr	0.01
bromodichloromethane	1	nr	0.03
bromoform	1	nr	0.03
bromomethane	1	1	0.03
cadmium	1	nr	0.01
carbon tetrachloride	1	nr	0.03

Substance	Oral RAF_{soil}[b]	Oral RAF_{water}[c]	Dermal RAF_{soil}[d]
chlordane	1	nr	0.04
p-chloroaniline	1	1	0.1
chlorobenzene	1	nr	0.03
chloroform	1	nr	0.03
2-chlorophenol	1	1	0.03
chromium total	1	nr	0.1
chromium VI	1	1	0.1
chrysene	1	nr	0.13
cobalt	1	1	0.01
copper	1	nr	0.06
cyanide (CN^-)	1	nr	0.1
dibenz[*a*,*h*]anthracene	1	nr	0.13
dibromochloromethane	1	nr	0.03
1,2-dichlorobenzene	1	nr	0.03
1,3-dichlorobenzene	1	1	0.03
1,4-dichlorobenzene	1	nr	0.03
3,3'-dichlorobenzidine	1	1	0.1
dichlorodifluoromethane	1	1	0.03
DDD	1	nr	0.03
DDE	1	nr	0.03
DDT	1	nr	0.03
1,1'-dichloroethane	1	nr	0.03
1,2-dichloroethane	1	nr	0.03
1,1'-dichloroethylene	1	nr	0.03
1,2-*cis*-dichloroethylene	1	nr	0.03
1,2-*trans*-dichloroethylene	1	nr	0.03

Substance	Oral RAF_{soil}[b]	Oral RAF_{water}[c]	Dermal RAF_{soil}[d]
2,4-dichlorophenol	1	nr	0.03
1,2-dichloropropane	1	nr	0.03
1,3-dichloropropene	1	nr	0.03
dieldrin	1	nr	0.1
diethyl phthalate	1	1	0.1
dimethylphthalate	1	1	0.1
2,4-dimethylphenol	1	1	0.03
2,4-dinitrophenol	1	1	0.1
2,4- & 2,6-dinitrotoluene	1	1	0.1
1,4-dioxane	1	nr	0.03
PCDD/F[f]	1	nr	0.03
endosulfan	1	1	0.1
endrin	1	nr	0.1
ethylbenzene	1	nr	0.03
ethylene dibromide	1	nr	0.03
fluoranthene	1	1	0.13
fluorene	1	1	0.13
heptachlor	1	nr	0.1
heptachlor epoxide	1	nr	0.1
hexachlorobenzene	1	nr	0.1
hexachlorobutadiene	1	nr	0.03
γ-HCH[g]	1	nr	0.04
hexachloroethane	1	1	0.03
n-hexane	nr	nr	nr
indeno[1,2,3-*c*,*d*]pyrene	1	nr	0.13
lead	nr	nr	nr
mercury	0.5	nr	0.1
methoxychlor	1	nr	0.1
methyl ethyl ketone	1	1	0.03
methyl isobutyl ketone	1	1	0.03
methyl mercury	1	1	0.06
methyl tert-butyl ether	1	nr	0.03
methylene chloride	1	nr	0.03
2-(1-) methylnaphthalene	1	1	0.13
molybdenum	1	nr	0.01
naphthalene	1	1	0.13
nickel	1	nr	0.2
pentachlorophenol	1	nr	0.25
petroleum hydrocarbons F1			
aliphatic C_6-C_8	1	1	0.2
aliphatic $C_{>8}$-C_{10}	1	1	0.2
aromatic $C_{>8}$-C_{10}	1	1	0.2
petroleum hydrocarbons F2			
aliphatic $C_{>10}$-C_{12}	1	1	0.2
aliphatic $C_{>12}$-C_{16}	1	1	0.2
aromatic $C_{>10}$-C_{12}	1	1	0.2
aromatic $C_{>12}$-C_{16}	1	1	0.2

a) See Tables 2.34a and 2.34b at end of section 2 for a description of how these RAFs were estimated.

b) **Oral RAF_{soil}**: Oral absorption of substance from soil relative to absorption in critical study of TRV.

c) **Oral RAF_{water}**: Oral absorption of substance from water relative to absorption in critical study of TRV.

d) **Dermal RAF_{soil}**: Dermal absorption of substance from soil relative to absorption in critical study of TRV.

e) **nr**: RAFs were not required for some substances. Substances for which drinking water standards or guidelines were available do not require an oral RAF_{water}. Substances for which no oral TRVs were used do not require any oral or dermal RAFs (e.g., n-hexane). Oral and dermal RAFs are also not required for lead because the Ministry has retained the human health soil and groundwater lead standards from the 1996 *Rationale* document.

f) polychlorinated dibenzo-*para*-dioxin and polychlorinated dibenzofuran

g) *gamma*-hexachlorocyclohexane

2.6.2.1 Determination of Absolute Dermal Absorption Fractions for Inorganic Substances *with Insufficient Quantitative Data*

For several inorganics, quantitative data are insufficient to determine estimates of absolute dermal absorption. To help determine absolute dermal absorption fractions for inorganics with no, little, or poor quantitative data, available data from other inorganics were reviewed (see Table 2.25) Data-derived estimates of absolute dermal absorption of other inorganics available from US EPA (2004a), CalEPA (2000), NYS (2006), and MDEP (1992) were summarized and considered. Note that dermal absorption estimates from these agencies which were not based on substance-specific data were not included.

Data-derived absolute absorption factors from the above-mentioned agencies were located for arsenic, cadmium, chromium, lead, mercury, nickel, and silver. For each substance, the midpoint of the highest and lowest agency estimates was determined. The geometric mean of these midpoints was then computed.

The geometric mean of the midpoints of the agencies' data-derived absolute absorption factors was 1%. The value of 1% was thus selected for use as the absolute dermal absorption factor for all inorganic substances with insufficient quantitative data to determine substance-specific dermal absorption factors.

Table 2.25 Determination of Absolute Dermal Absorption Fractions for Inorganics with Insufficient Dermal Absorption Data

Inorganic Chemical	Range of Agency Estimates of Absolute Absorption (based on primary literature)			Notes on Agency Estimates [and additional notes]
	low	high	midpoint	
As	0.03	0.04	0.035	Based on Wester et al. (1993), US EPA (2004a) recommends 3% and CalEPA (2000) recommends 4%. MDEP (1992) selected 3% based on EPA studies where extraction of As from soil averaged 3%.
Cd	0.001	0.001	0.001	US EPA (2004a) and CalEPA (2000) recommend 0.1% based on data from Wester et al (1992) and on USEPA (1992). [Hostynek et al (1993) report *in vitro* experiments with human skin with $CdCl_2$ where a 30-min. exposure resulted in penetration of 0.6% of the applied dose (and skin retention of 2.7%).]
Cr	0.01	0.04	0.025	MDEP (1992) selected 1% for Cr based on tests (Sheehan *et al*. 1991) where <1% of soil-adsorbed Cr was extracted with pH 5 solution over 24 hours. NYS (2006) selected 4%, which was derived from studies by Wahlberg and Skog (1963) estimating the per cent of applied aqueous solutions of sodium chromate that disappeared from skin of guinea pigs. [NEPI (2000a) discusses an *in vivo* guinea pig study reporting <1% dermal absorption and an extraction study on chromite ore with human sweat reporting 0.1% for Cr VI and 0.3% for total Cr.]
Pb	0.006	0.006	0.006	MDEP (1992) selected 0.6% based on dermal absorption efficiency in humans for lead as lead acetate reported at 0.3% (12 hrs) or 0.6% (24 hrs) (Moore et al. 1980).
Hg	0.04	0.1	0.07	CalEPA (2000) recommends 10% using an order-of-magnitude approach in consideration of available data (Baranowska-Dutkiewicz 1982; Wester et al. 1995) that suggest 1% would be too low. Based on data from Hursh et al. (1989), Landa (1978), Baranowska-Dutkiewicz (1982), & Skog and Wahlberg (1964), MDEP (1992) selected 4% for elemental Hg, 6.5% for inorganic Hg, & 4.5% for organic Hg. [NEPI (2000a) discusses that absorption in guinea pigs ranges from 2% to 4.5%.]
Ni	0.01	0.04	0.025	CalEPA (2000) recommends 4% based on results of Fullerton *et al*. (1986), the data suggesting 1% would be too low. MDEP (1992) selected 3.5% as a realistic estimate, based on Fullerton et al. (1986). NYS (2006) selected 1% derived from human *in vivo* & *in vitro* studies by Hostynek et al. (2001) and Tanojo et al. (2001). [Hostynek *et al*. (2001) discuss dermal absorption in various studies: Humans, 0.5% in urine, 0.05% in plasma, and 5.3% in skin; Human skin *in vitro*, < 0.066% penetrated; Human skin *in vitro*, 1% penetrated, 64% retained in skin.]
Ag	0.01	0.01	0.01	MDEP 1992 selected 1% based Snyder et al. (1975) reporting that < 1% of dermally applied Ag compounds absorbed through intact human skin, and Wahlberg (1965) reporting that approximately 1% of the applied dose was dermally absorbed by guinea pigs.
geometric mean of midpoints of absolute absorption			**0.01**	Geometric mean of midpoints of data-derived absolute dermal absorption estimates for inorganics from US EPA (2004a), CalEPA (2000), NYS (2006), and MDEP (1992).

2.7 Calculations to Derive Soil and Groundwater Component Values

Rates of exposure to soil or groundwater via various pathways (i.e., "media exposure rates") were used in conjunction with TRVs and RAFs to calculate "substance-specific concentrations" in soil or groundwater. These were then used to derive the human health-based component values for each substance.

Figure 2.3 illustrates the scheme of equations used to calculate the various HHCVs. (Note that the names of the different HHCVs are explained in Table 2.1 and the equation

symbols are explained below. The equations used in the derivation of component values have been retained from the 1996 *Rationale* (MOEE, 1996) with minor modifications. The equations are specific to various media and routes of exposure (e.g., exposure via dermal contact with soil). Time-activity patterns and behavioural trends, such as the frequency of time spent at the residence (e.g., number of days per week or number of weeks per year) are adjusted depending on the exposure scenario and land-use category. Definitions of the abbreviations used are given after the equations that are presented in Sections 2.3.1 to 2.3.6.

Figure 2.3: Relational Scheme of Equations Used to Derive Human Health Based Soil and Groundwater Component Values

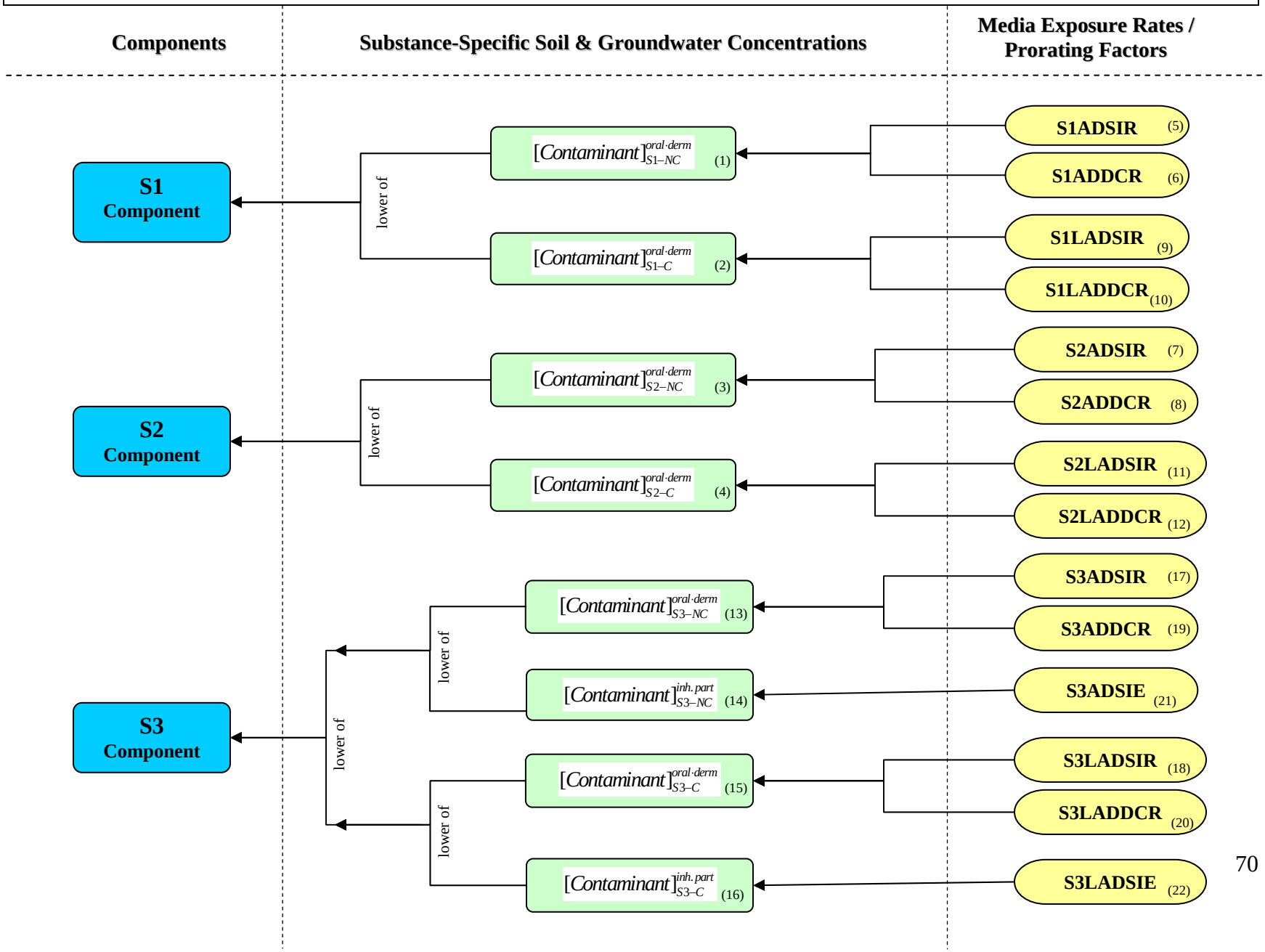


Figure 2.3 (cont'd)

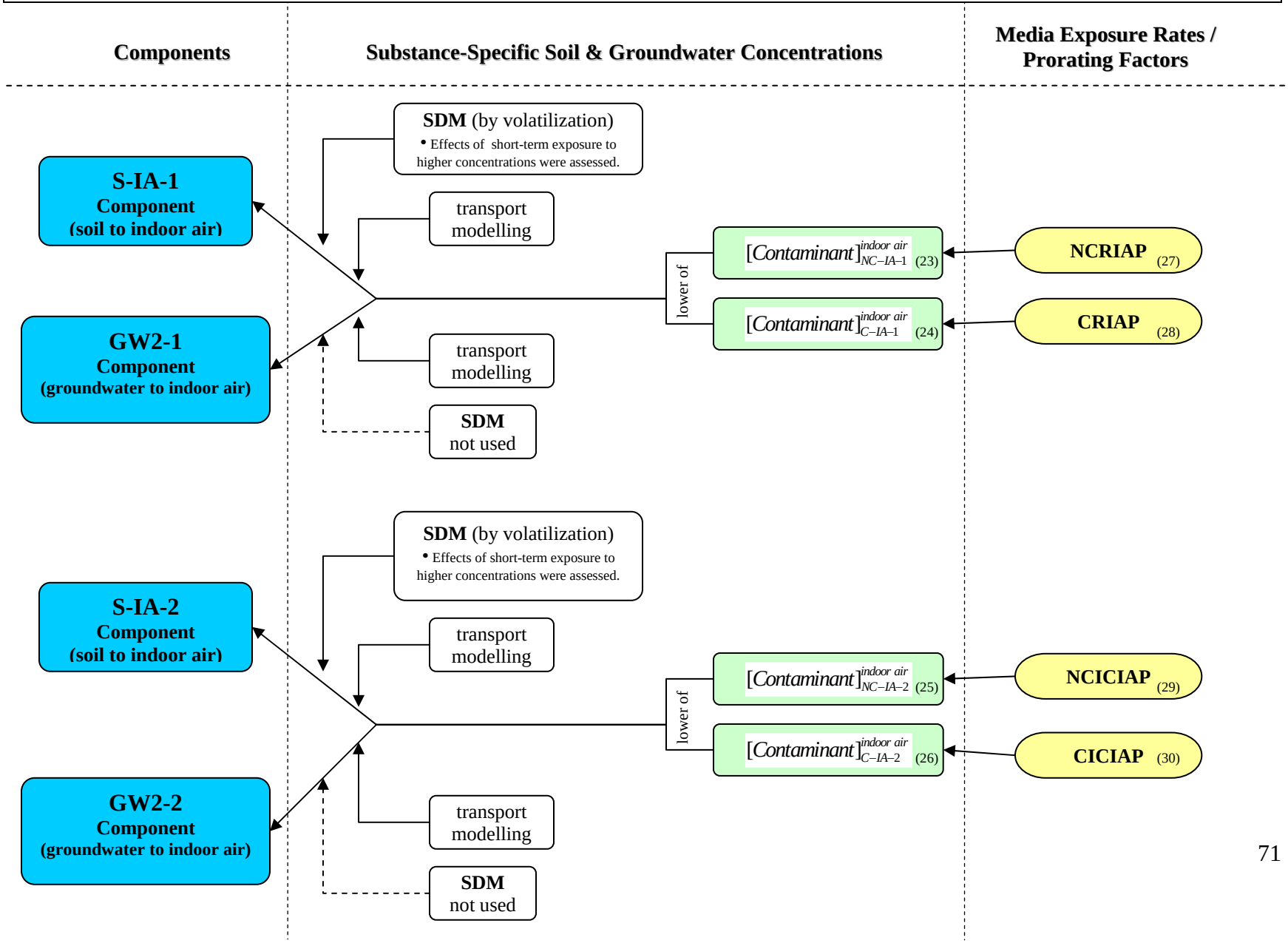
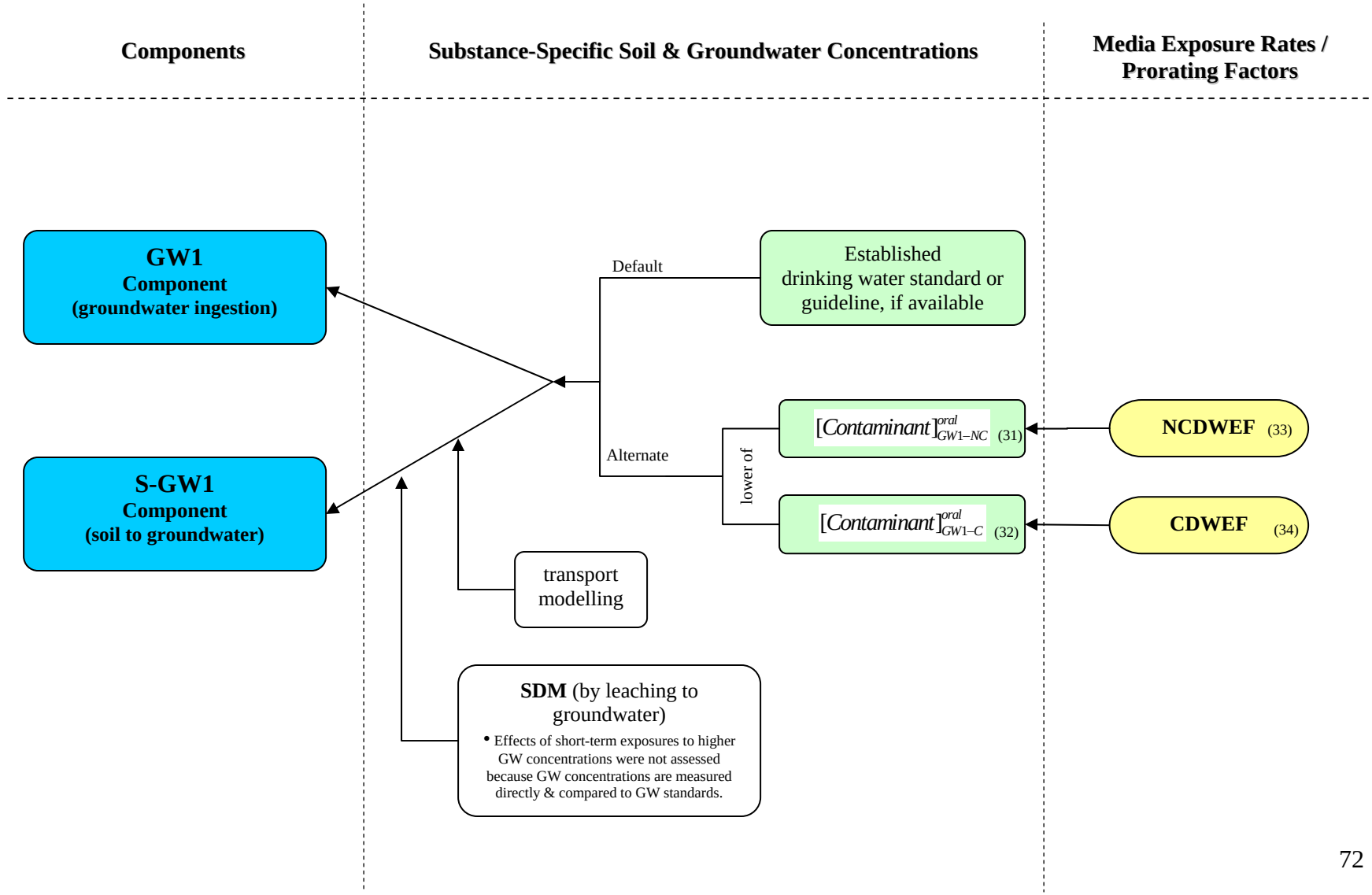


Figure 2.3 (cont'd)



* Subscript numbers appearing in parentheses indicate the corresponding equations, discussed in more detail below.

The following is a description of the equations used to calculate the various soil and groundwater component values for human health. Figure 2.3 above can be used as a guide while reading the text.

Note that the values selected for use in these equations are described in detail in Sections 2.2 (Exposure Scenarios and Selection of Exposure Values), 2.4 (Source Allocation Factors and Cancer Risk Levels), 2.5 (Toxicological Reference Values), and 2.6 (Relative Absorption Factors).

2.7.1 S1 and S2 Components – Direct Soil Contact

2.7.1.1 Use of S1 and S2 Components

The S1 component pertains to surface soils for R/P/I land uses and presumes a residential setting in which all age categories may be present. The S2 component pertains to surface soils for the I/C/C land use category, which presumes environmental exposures to adults while working.

2.7.1.2 Derivation of S1 and S2 Components

S1 and S2 CVs are protective of direct contact with soil by the receptor of concern and are applied to surface soil. Incidental ingestion and dermal contact are the human exposure pathways considered. The S1 and S2 CVs are calculated using an oral Tolerable Daily Intake (TDI) for non-carcinogenic (threshold) substances or an oral cancer slope factor (CSF_O) for carcinogens.

The equations used to derive the S1 and S2 components are essentially the same, but differ with respect to the receptor of concern and the activity patterns pertinent to the land use. The differences in the exposure values used are noted below in the descriptions of average daily soil ingestion rate (ADSIR) and average daily dermal contact rates (ADDCR).

S1 and S2 CVs were calculated using Equations 1 to 4 below:

$$[Contaminant]_{S1-NC}^{oral-derm} = \frac{SAF \times TDI \times C}{\left(S1ADSIR \times RAF_{oral}\right) + \left(S1ADDCR \times RAF_{derm}\right)} \quad \text{(Equation 2.1)}$$

$$\left[Contaminant\right]_{S1-C}^{oral-derm} = \frac{ILCR \times C}{\left[\left(S1LADSIR \times RAF_{oral}\right) + \left(S1LADDCR \times RAF_{derm}\right)\right] \times CSF} \quad \text{(Equation 2.2)}$$

$$[Contaminant]_{S2-NC}^{oral-derm} = \frac{SAF \times TDI \times C}{\left(S2ADSIR \times RAF_{oral}\right) + \left(S2ADDCR \times RAF_{derm}\right)} \qquad \text{(Equation 2.3)}$$

$$\left[Contaminant\right]_{S2-C}^{oral-derm} = \frac{CRL \times C}{\left[\left(S2LADSIR \times RAF_{oral}\right) + \left(S2LADDCR \times RAF_{derm}\right)\right] \times CSF} \qquad \text{(Equation 2.4)}$$

where:

$[Contaminant]_{S1-NC}^{oral-derm}$ = Concentration of non-cancer substance in soil for S1 ($mg_{substance}/kg_{soil}$)
$[Contaminant]_{S1-C}^{oral-derm}$ = Concentration of carcinogenic substance in soil for S1 ($mg_{substance}/kg_{soil}$)
$[Contaminant]_{S2-NC}^{oral-derm}$ = Concentration of non-cancer substance in soil for S2 ($mg_{substance}/kg_{soil}$)
$[Contaminant]_{S2-C}^{oral-derm}$ = Concentration of carcinogenic substance in soil for S2 ($mg_{substance}/kg_{soil}$)
SAF = Source Allocation Factor = 0.2 (unitless) as default
CRL = Cancer Risk Level ($1x10^{-6}$; unitless)
C = unit conversion factor (10^6 mg_{soil}/kg_{soil})
TDI = Tolerable Daily Intake (substance-specific) ($mg_{substance}/kg_{BW}$/day)
CSF = Oral Cancer Slope Factor (substance-specific) (per $mg_{substance}/kg_{BW}$/day)
S1ADSIR = Average Daily Soil Ingestion Rate for S1 (mg_{soil}/kg_{BW}/day)
S2ADSIR = Average Daily Soil Ingestion Rate for S2 (mg_{soil}/kg_{BW}/day)
S1ADDCR = Average Daily Soil Dermal Contact Rate for S1 (mg_{soil}/kg_{BW}/day)
S2ADDCR = Average Daily Soil Dermal Contact Rate for S2 (mg_{soil}/kg_{BW}/day)
S1LADSIR = Lifetime Average Daily Soil Ingestion Rate for S1 (mg_{soil}/kg_{BW}/day)
S2LADSIR = Lifetime Average Daily Soil Ingestion Rate for S2 (mg_{soil}/kg_{BW}/day)
S1LADDCR = Lifetime Average Daily Soil Dermal Contact Rate for S1 (mg_{soil}/kg_{BW}/day)
S2LADDCR = Lifetime Average Daily Soil Dermal Contact Rate for S2 (mg_{soil}/kg_{BW}/day)
RAF_{oral} = Relative Absorption Factor for oral exposure (substance-specific; unitless)
RAF_{derm} = Relative Absorption Factor for dermal exposure (substance-specific; unitless)

The lower of the non-cancer and cancer substance concentrations for S1 (calculated in Equations 1 and 2, respectively) is selected as the S1 component. Similarly, the lower of the non-cancer and cancer substance concentrations for S2 (calculated in Equations 3 and 4, respectively) is selected as the S2 component.

2.7.1.3 Derivation of Soil Exposure Rates for Use in S1 and S2 Calculations

For non-cancer substances, the average daily soil ingestion rate (ADSIR) for S1 and S2 (S1ADSIR and S2ADSIR, respectively) and the average daily dermal contact rate (ADDCR) for S1 and S2 (S1ADDCR and S2ADDCR, respectively) are calculated using the following equations:

$$\text{S1ADSIR} = \frac{\text{SIR} \times \text{EF}_a \times \text{EF}_b \times \text{ED}}{\text{BW} \times \text{AP} \times \text{C}} \qquad \text{(Equation 2.5)}$$

$$S1ADDCR = \frac{SSA \times SA \times EF_a \times EF_b \times ED}{BW \times AP \times C} \quad \text{(Equation 2.6)}$$

$$S2ADSIR = \frac{SIR \times EF_a \times EF_b \times ED}{BW \times AP \times C} \quad \text{(Equation 2.7)}$$

$$S2ADDCR = \frac{SSA \times SA \times EF_a \times EF_b \times ED}{BW \times AP \times C} \quad \text{(Equation 2.8)}$$

For carcinogenic substances, the lifetime average daily soil ingestion rate (LADSIR) for S1 and S2 (S1LADSIR and S2LADSIR, respectively) and the average daily dermal contact rate (LADDCR) for S1 and S2 (S1LADDCR and S2LADDCR, respectively) are calculated using the following equations:

$$S1LADSIR = \frac{\left[\left(\frac{SIR_1 \times ED_1}{BW_1}\right) + \left(\frac{SIR_2 \times ED_2}{BW_2}\right) + \ldots + \left(\frac{SIR_5 \times ED_5}{BW_5}\right)\right] \times \left[EF_a \times EF_b\right]}{AP \times C} \quad \text{(Equation 2.9)}$$

$$S1LADDCR = \frac{\left[\left(\frac{SSA_1 \times SA_1 \times ED_1}{BW_1}\right) + \left(\frac{SSA_2 \times SA_2 \times ED_2}{BW_2}\right) + \ldots + \left(\frac{SSA_5 \times SA_5 \times ED_5}{BW_5}\right)\right] \times \left[EF_a \times EF_b\right]}{AP \times C}$$

(Equation 2.10)

$$S2LADSIR = \frac{SIR \times EF_a \times EF_b \times ED}{BW \times AP \times C} \quad \text{(Equation 2.11)}$$

$$S2LADDCR = \frac{SSA \times SA \times EF_a \times EF_b \times ED}{BW \times AP \times C} \quad \text{(Equation 2.12)}$$

The exposure values used in Equations 5 to 12 are shown in Tables 2.7 and 2.8. Differences in the exposure values are due to the receptors and land uses considered. For S1, the toddler resident (0.5 – 4 years) was the receptor considered for non-carcinogens, whereas time-weighted exposure values for the composite resident receptor were used for carcinogens, assuming continual exposure throughout all life stages. S2 considers the adult worker (20 years old and above) for carcinogens and non-carcinogens. Note that for carcinogens in the S1 calculations, the exposure duration is 76 years, whereas for S2 calculations it is 56 years.

Table 2.26: Exposure Values Used in Derivation of Average Daily Soil Ingestion Rates for S1 and S2

Exposure Factor	Symbol[a]	Unit	Non-Cancer			Cancer	
			S1ADSIR	S2ADSIR	$S2ADSIR_D$[c]	S1LADSIR[a]	S2LADSIR
(Lifetime) Average Daily Soil Ingestion Rate	*(L)ADSIR*	*mg/kg/day*	*9.07E+00*	*7.56E-01*	*1.58E+00*	*1.12E+00*	*7.56E-01*
Daily Soil Ingestion Rate	SIR_1	mg/day	200 (C[b])	100 (CT or C)	100 (CT or C)	30 (C*)	100 (CT or C)
	SIR_2					200 (C)	
	SIR_3					50 (CT-sli)	
	SIR_4					50 (CT-sli)	
	SIR_5					50 (CT-sli)	
Exposure Frequency	EF_a	days/week	7 (C*)	5 (CT)	7 (n/a)	7 (C*)	5 (CT)
Exposure Frequency	EF_b	weeks/year	39 (CT)	39 (CT)	52 (n/a)	39 (C*)	39 (CT)
Exposure Duration	ED_1	years	4.5 (n/a)	56 (n/a)	56 (n/a)	0.5 (n/a)	56 (CT)
	ED_2					4.5 (n/a)	
	ED_3					7 (n/a)	
	ED_4					8 (n/a)	
	ED_5					56 (CT)	
Body Weight	BW_1	kg	16.5 (CT)	70.7 (CT)	63.1 (CT)	8.2 (CT)	70.7 (CT)
	BW_2					16.5 (CT)	
	BW_3					32.9 (CT)	
	BW_2					59.7 (CT)	
	BW_3					70.7 (CT)	
Averaging Period	AP	years	4.5 (n/a)	56 (n/a)	56 (n/a)	76 (n/a)	56 (CT)
Unit Conversion	C	days/year	365 (n/a)	365 (n/a)	365 (n/a)	365 (n/a)	365 (n/a)

a) For calculation of S1LADSIR, the SIR, ED, and BW factors are numbered to respectively match the age categories of infant, toddler, child, teen, and adult.

b) The symbols in parentheses represent the level of conservatism for the exposure value. As in Tables 2.5 to 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable.

c) In instances where the TRV selected for the chemical was based on developmental effects (see further in Table 2.23), the body weight of an adult female was used for the calculation of S2ADSIR because some of the developmental TRVs are based on doses administered to a pregnant female. In addition, pro-rating for less than continuous exposure was not applied (see further in Section 2.7.7). An analagous calculation was not performed for S1ADSIR (see further in Section 2.7.7).

Table 2.27: Exposure Values Used in Derivation of Average Daily Dermal Contact Rates, S1 and S2							
Exposure Factor	**Symbol***	**Unit**	**Non-Cancer**			**Cancer**	
			S1ADDCR	**S2ADDCR**	**S2ADDCR$_D$[c]**	**S1LADDCR[a]**	**S2LADDCR**
(Lifetime) Average Daily Dermal Contact Rate	*(L)ADDCR*	*mg/kg/day*	*1.58E+01*	*5.14E+00*	*9.77E+00*	*4.89E+00*	*5.14E+00*
Average Skin Surface Area Exposed	SSA_1	cm^2	1745 (sli)	3400 (sli)	3090 (sli)	1105 (sli)	3400 (sli)
	SSA_2					1745 (sli)	
	SSA_3					2822 (sli)	
	SSA_4					3858 (sli)	
	SSA_5					4343 (sli)	
Soil Adherence Factor	SA_1	$mg/cm^2/day$	0.2 (C[b])	0.2 (C)	0.2 (C)	0.07 (C)	0.2 (C)
	SA_2					0.2 (C)	
	SA_3					0.2 (C)	
	SA_4					0.07 (C)	
	SA_5					0.07 (C)	
Exposure Frequency	EF_a	days/week	7 (C*)	5 (CT)	7 (n/a)	7 (C*)	5 (CT)
Exposure Frequency	EF_b	weeks/year	39 (CT)	39 (CT)	52 (n/a)	39 (CT)	39 (CT)
Exposure Duration	ED_1	years	4.5 (n/a)	56 (n/a)	56 (n/a)	0.5 (n/a)	56 (CT)
	ED_2					4.5 (n/a)	
	ED_3					7 (n/a)	
	ED_4					8 (n/a)	
	ED_5					56 (CT)	
Body Weight	BW_1	kg	16.5 (CT)	70.7 (CT)	63.1 (CT)	8.2 (CT)	70.7 (CT)
	BW_2					16.5 (CT)	
	BW_3					32.9 (CT)	
	BW_4					59.7 (CT)	
	BW_5					70.7 (CT)	
Averaging Period	AP	years	4.5 (n/a)	56 (n/a)	56 (n/a)	76 (CT)	56 (CT)
Unit Conversion	C	days/year	365 (n/a)	365 (n/a)	365 (n/a)	365 (n/a)	365 (n/a)

a) For calculation of S1LADDCR, the SIR, ED, and BW factors are numbered to respectively match the age categories of infant, toddler, child, teen, and adult.
b) The symbols in parentheses represent the level of conservatism for the exposure value. As in Tables 2.5 to 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable.
c) In instances where the TRV selected for the chemical was based on developmental effects (see further in Table 2.23), the body weight and skin surface area of an adult female were used for the calculation of S2ADDCR because some of the developmental TRVs are based on doses administered to a pregnant female. In addition, pro-rating for less than continuous exposure was not applied (see further in Section 2.7.7). An analagous calculation was not performed for S1ADDCR (see further in Section 2.7.7).

2.7.2 S3 Component – Soil Ingestion, Dermal Soil Contact, & Inhalation of Airborne Soil

2.7.2.1 Use of S3 Component

The S3 component pertains to subsurface soils (below 1.5 m depth) for the I/C/C land use category and presumes restricted access to the soil. The S3 sub-surface calculation limits the contribution of the one site to the receptor's risk.

The S3 category is based on an exposure scenario where an adult receptor, a subsurface worker, may come into direct contact with contaminated soil during a short but intense exposure, such as excavation work. This includes exposures via incidental soil ingestion and dermal contact with soil as with other exposure scenarios, and also includes inhalation exposure to soil particles resuspended into air. The pathway of inhalation of particles for the S3 receptor is included in the development of the revised MOE soil standards. A subsurface worker is considered to be the receptor who is most exposed to soil at depth. As noted above, the intent of the calculations is to limit environmental exposures as opposed to exposures resulting from chemical emissions from on-going work operations themselves.

The dermal soil adherence factor used in the S3 scenario is higher than that used in the S2 scenario. As such, for some soil substances, the S3 component value could be lower than the S2 component value. In the interests of being protective, the soil standards for I/C/C soils and for subsurface R/P/I soils use the lower of the S2 and S3 components.

2.7.2.2 Derivation of S3 Component

The S3 health-based soil component is protective of direct soil contact and inhalation of airborne soil. The exposure pathways considered are incidental ingestion and dermal contact with soil and inhalation of soil particles suspended in air. The S3 component is calculated using a Tolerable Daily Intake (TDI) and Tolerable Concentration (TC) for non-carcinogens, and an oral cancer slope factor (CSF_O) and inhalation unit risk (IUR) for carcinogens. Because the exposure duration for this exposure scenario is not considered to be chronic exposure, non-cancer TRVs developed for sub-chronic exposure durations were used for non-carcinogens when available. When these were not available, chronic TRVs were used.

Exposure values for the adult were used for deriving risk-based concentrations for carcinogens and non-carcinogens in the S3 category. The calculations for soil ingestion and dermal contact are essentially the same as those used for the S1 and S2 components, but with changes to the receptor of concern and the activity patterns. The exposure values are noted below in the descriptions of average daily soil ingestion rate (ADSIR), average daily dermal contact rates (ADDCR), and average daily soil inhalation exposure (ADSIE).

The concentrations of substances in soil for the S3 category were derived using the equations below.

The numerically lower result of Equations 2.13 and 2.14 moves forward as the S3 soil substance concentration protective of non-carcinogenic effects as a result of soil ingestion, dermal contact, and soil particle inhalation pathways.

$$[Contaminant]_{S3-NC}^{oral \cdot dermal} = \frac{SAF \times TDI \times C}{\left(S3ADSIR \times RAF_{oral}\right) + \left(S3ADDCR \times RAF_{derm}\right)} \quad \text{(Equation 2.13)}$$

$$[Contaminant]_{S3-NC}^{inh.part} = \frac{SAF \times TC}{S3ADSIE \times RAF_i} \quad \text{(Equation 2.14)}$$

Where:

$[Contaminant]_{S3-NC}^{oral \cdot derm}$ = Concentration of non-cancer substance in soil for S3 for ingestion and dermal contact exposure ($mg_{substance}/kg_{soil}$)

$[Contaminant]_{S3-NC}^{inh.part}$ = Concentration of non-cancer substance in soil for S3 for exposure via inhalation of soil particles ($mg_{substance}/kg_{soil}$)

SAF = Source Allocation Factor = 0.2 (unitless) as default

TDI = Tolerable Daily Intake (substance-specific) ($mg_{substance}/kg_{BW}$/day) [Sub-chronic TDI if available; otherwise, chronic TDI is used.]

TC = Tolerable Concentration (substance-specific) ($mg_{substance}/m^3$)

C = unit conversion factor (10^6 mg_{soil}/kg_{soil})

RAF_{oral} = Relative Absorption Factor for oral exposure (substance-specific; unitless)

RAF_{derm} = Relative Absorption Factor for dermal exposure (substance-specific; unitless)

RAF_i = Relative Absorption Factor for inhalation (substance-specific; unitless)

S3ADSIR = Average Daily Soil Ingestion Rate for S3 (mg_{soil}/kg_{BW}/day)

S3ADDCR = Average Daily Soil Dermal Contact Rate for S3 (mg_{soil}/kg_{BW}/day)

S3ADSIE = Average Daily Soil Inhalation Exposure for S3 (kg_{soil}/m^3)

The numerically lower result of equations 2.15 and 2.16 moves forwards as the S3 soil substance concentration protective of carcinogenic effects as a result of soil ingestion, dermal contact, and soil particle inhalation pathways.

$$[Contaminant]_{S3-C}^{oral \cdot derm} = \frac{ILCR \times C}{[\left(S3LADSIR \times RAF_{oral}\right) + \left(S3LADDCR \times RAF_{derm}\right)] \times CSF} \quad \text{(Equation 2.15)}$$

$$[Contaminant]_{S3-C}^{inh.part} = \frac{CRL}{S3LADSIE \times RAF_i \times IUR} \quad \text{(Equation 2.16)}$$

where:

$[Contaminant]_{S3-C}^{oral \cdot derm}$ = Concentration of carcinogen in soil for S3 for ingestion and dermal contact exposure ($mg_{substance}/kg_{soil}$)

$[Contaminant]_{S3-C}^{inh.part}$ = Concentration of carcinogen in soil for S3 for exposure via inhalation of soil

	particles ($mg_{substance}/kg_{soil}$)
CRL	= Cancer Risk Level ($1x10^{-6}$; unitless)
CSF	= oral Cancer Slope Factor (substance-specific; per $mg_{substance}/kg_{BW}$/day)
IUR	= Inhalation Unit Risk (substance-specific; per $mg_{substance}/m^3$)
C	= unit conversion factor (10^6 mg_{soil}/kg_{soil})
RAF_{oral}	= Relative Absorption Factor for oral exposure (substance-specific; unitless)
RAF_{derm}	= Relative Absorption Factor for dermal exposure (substance-specific; unitless)
RAF_i	= Relative Absorption Factor for inhalation (substance-specific; unitless)
S3LADSIR	= Lifetime Average Daily Soil Ingestion Rate for S3 (mg_{soil}/kg_{BW}/day)
S3LADDCR	= Lifetime Average Daily Soil Dermal Contact Rate for S3 (mg_{soil}/kg_{BW}/day)
S3LADSIE	= Lifetime Average Daily Soil Inhalation Exposure for S3 (kg_{soil}/m^3)

The oral cancer slope factor (CSF_O) and inhalation unit risk (IUR) are applied on the basis of the exposure period averaged over a 56 year averaging time.

The numerically lower value of the S3 non-cancer and S3 cancer concentrations (calculated in Equations 2.13 to 2.16) moves forward as the S3 component.

2.7.2.3 Derivation of Soil Exposure Rates for Use in S3 Calculations

For non-cancer substances, the average daily soil ingestion rate for S3 (S3ADSIR) and the average daily dermal contact rate for S3 (S3ADDCR) are calculated using Equations 2.17 and 2.19, respectively. For carcinogenic substances, the lifetime average daily soil ingestion rate for S3 (S3LADSIR) and the lifetime average daily dermal contact rate for S3 (S3LADDCR) are calculated using Equations 2.18 and 2.20, respectively:

$$S3ADSIR = \frac{SIR \times EF_a \times EF_b \times ED}{BW \times AP \times C} \qquad \text{(Equation 2.17)}$$

$$S3LADSIR = \frac{SIR \times EF_a \times EF_b \times ED}{BW \times AP \times C} \qquad \text{(Equation 2.18)}$$

$$S3ADDCR = \frac{SSA \times SA \times EF_a \times EF_b \times ED}{BW \times AP \times C} \qquad \text{(Equation 2.19)}$$

$$S3LADDCR = \frac{SSA \times SA \times EF_a \times EF_b \times ED}{BW \times AP \times C} \qquad \text{(Equation 2.20)}$$

The exposure values used in Equations 2.17 to 2.20 are shown in Tables 2.28 and 2.29.

Table 2.28: Exposure Values Used in Derivation of Average Daily Soil Ingestion Rate S3					
Exposure Factor	**symbol**	**unit**	**S3ADSIR**	**S3ADSIR$_D$[b]**	**S3LADSIR**
(Lifetime) Average Daily Soil Ingestion Rate	*(L)ADSIR*	*mg/kg/day*	*7.56E-01*	*1.58E+00*	*2.02E-02*
Daily Soil Ingestion Rate	SIR	mg/day	100 (mod[a])	100 (mod)	100 (mod)
Exposure Frequency	EF_a	days/week	5 (CT)	7 (n/a)	5 (CT)
Exposure Frequency	EF_b	weeks/year	39 (CT)	52 (n/a)	39 (CT)
Exposure Duration	ED	years	1.5 (n/a)	1.5 (n/a)	1.5 (C)
Body Weight	BW	kg	70.7 (CT)	63.1 (CT)	70.7 (CT)
Averaging Period (Averaging Time)	AP	years	1.5 (n/a)	1.5 (n/a)	56 (CT)
Unit Conversion	C	days/year	365 (n/a)	365 (n/a)	365 (n/a)

a) The symbols in parentheses represent the level of conservatism for the exposure value. As in Tables 2.5 to 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable. See further in Section 2.3.4.

b) In instances where the TRV selected for the chemical was based on developmental effects (see further in Table 2.23), the body weight of an adult female was used for the calculation of S3ADSIR because some of the developmental TRVs are based on doses administered to a pregnant female. In addition, pro-rating for less than continuous exposure was not applied (see further in Section 2.7.7).

Table 2.29: Exposure Values Used in Derivation of Average Daily Dermal Contact Rates, S3					
Exposure Factor	**symbol**	**unit**	**S3ADDCR**	**S3ADDCR$_D$[b]**	**S3LADDCR**
(Lifetime) Average Daily Dermal Contact Rate	*(L)ADDCR*	*mg/kg/day*	*5.14E+00*	*9.77E+00*	*1.38E-01*
Average Skin Surface Area Exposed	SSA	cm^2	3400 (sli[a])	3090 (sli)	3400 (sli)
Soil Adherence Factor	SA	$mg/cm^2/day$	0.2 (0.2)	0.2 (0.2)	0.2 (0.2)
Exposure Frequency	EF_a	days/week	5 (CT)	7 (n/a	5 (CT)
Exposure Frequency	EF_b	weeks/year	39 (CT)	52 (n/a)	39 (CT)
Exposure Duration	ED	years	1.5 (n/a)	1.5 (n/a)	1.5 (C)
Body Weight	BW	kg	70.7 (CT)	63.1 (CT)	70.7 (CT)
Averaging Period (Averaging Time)	AP	years	1.5 (n/a)	1.5 (n/a)	56 (CT)
Unit Conversion	C	days/year	365 (n/a)	365 (n/a)	365 (n/a)

a) The symbols in parentheses represent the level of conservatism for the exposure value. As in Tables 2.5 to 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable. See further in Section 2.3.4.

b) In instances where the TRV selected for the chemical was based on developmental effects (see further in Table 2.23), the body weight and skin surface area of an adult female were used for the calculation of S3ADDCR because some of the developmental TRVs are based on doses administered to a pregnant female. In addition, pro-rating for less than continuous exposure was not applied (see further in Section 2.7.7).

For non-cancer substances, the average daily soil inhalation exposure for S3 (S3ADSIE) is calculated using Equation 2.21. For carcinogenic substances, the average daily soil inhalation exposure for S3 (S3LADSIE) is calculated using Equation 2.22.

$$S3ADSIE = \frac{[PM_{10}] \times FPM_{inh} \times IR_w \times EF_a \times EF_b \times EF_c \times ED \times BW_{assumed}}{BW_w \times AP \times C_1 \times C_2 \times C_3 \times IR_{assumed}} \quad \text{(Eqn. 2.21)}$$

$$S3LADSIE = \frac{[PM_{10}] \times FPM_{inh} \times IR_w \times EF_a \times EF_b \times EF_c \times ED \times BW_{assumed}}{BW_w \times AP \times C_1 \times C_2 \times C_3 \times IR_{assumed}} \quad \text{(Eq. 2.22)}$$

The exposure values used in Equations 2.21 and 2.22 are shown in Table 2.30 below.

Table 2.30: Exposure Values Used in Derivation of Average Daily Soil Inhalation Exposure, S3

Exposure Factor	symbol	unit	S3ADSIE	$S3ADSIE_D$[b]	S3LADSIE
(Lifetime) Average Daily Soil Inhalation Exposure	*(L)ADSIE*	kg_{soil}/m^3	*2.33E-08*	*1.19E-07*	*6.25E-10*
Fraction of PM_{10} that is deposited	FPM_{inh}	unitless	0.6 (C[a])	0.6 (C)	0.6 (C)
Concentration in air of particles ≤ 10 µm in diameter	$[PM_{10}]$	$\mu g_{soil}/m^3$	100 (CT)	100 (CT)	100 (CT)
Inhalation rate for the worker during the exposure period	IR_w	m^3/hour	1.5 (CT)	1.5 (CT)	1.5 (CT)
Exposure Frequency	EF_a	hours/day	9.8 (C*)	24 (n/a)	9.8 (C*)
Exposure Frequency	EF_b	days/week	5 (CT)	7 (n/a)	5 (CT)
Exposure Frequency	EF_c	weeks/year	39 (CT)	52 (n/a)	39 (CT)
Exposure Duration	ED	years	1.5 (n/a)	1.5 (n/a)	1.5 (CT)
Body weight of adult worker	BW_w	kg_{BW}	70.7 (CT)	63.1 (CT)	70.7 (CT)
Averaging Period	AP	years	1.5 (n/a)	1.5 (n/a)	56 (CT)
Unit Conversion	C_1	$\mu g_{soil}/mg_{soil}$	1000 (n/a)	1000 (n/a)	1000 (n/a)
Unit Conversion	C_2	days/year	365 (n/a)	365 (n/a)	365 (n/a)
Unit Conversion	C_3	mg_{soil}/kg_{soil}	1E+06 (n/a)	1E+06 (n/a)	1E+06 (n/a)
Body weight assumed in development of inhalation TRVs[c]	$BW_{assumed}$	kg_{BW}	70 (n/a)	70 (n/a)	70 (n/a)
Inhalation rate assumed in development of inhalation TRVs[c]	$IR_{assumed}$	m^3/day	20 (n/a)	20 (n/a)	20 (n/a)

a) The symbols in parentheses represent the level of conservatism for the exposure value. As in Tables 2.5 to 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable.

b) In instances where the TRV selected for the chemical was based on developmental effects (see further in Table 2.23), the body weight of an adult female was used for the calculation of S3ADSIE because

some of the developmental TRVs are based on doses administered to a pregnant female. In addition, pro-rating for less than continuous exposure was not applied (see further in Section 2.7.7).

c) The value of 20 m^3/day for $IR_{assumed}$ and 70 kg for $BW_{assumed}$ are common exposure values for the average adult used in TRV development by US EPA and several U.S. state jurisdictions.

It is generally assumed that the concentration of the substance in the particle-phase is equal to the concentration of the substance in soil. However, this assumption may underestimate the concentration of substance in the PM10 fraction because smaller particulate fractions sometimes contain substance concentrations that are enriched relative to larger fractions.

2.7.3 S-IA-1 and S-IA-2 Components – Soil to Indoor Air

2.7.3.1 Use of S-IA-1 and S-IA-2 Components

These soil components pertain to surface and subsurface soils for R/P/I (S-IA-1) and for I/C/C (S-IA-2) land uses.

The S-IA-1 category is based on an exposure scenario where a toddler (for non-carcinogens) and composite receptor (for carcinogens) may inhale substances that volatilize from soil and are transported to indoor air. The S-IA-2 category is based on an exposure scenario where an adult receptor, an indoor worker (for both carcinogens and non-carcinogens), may inhale substances that volatilize from soil and are transported to indoor air.

2.7.3.2 Derivation of S-IA-1 and S-IA-2 Components

These components are derived for a substance by first calculating acceptable health-based Indoor Air Concentrations (IAC) for the substance (Equations 2.23, 2.24, 2.25, and 2.26). This involves an inhalation TRV (a Tolerable Concentration for non-cancer or an Inhalation Unit Risk for cancer) and the appropriate prorating factor based on the land use, receptor, and the type of TRV (cancer or non-cancer).

$$[Contaminant]_{NC-IA-1}^{indoor\ air} = \frac{TC \times SAF \times C}{NCRIAP} \qquad \text{(Equation 2.23)}$$

$$[Contaminant]_{C-IA-1}^{indoor\ air} = \frac{CRL \times C}{CRIAP \times IUR} \qquad \text{(Equation 2.24)}$$

$$[Contaminant]_{NC-IA-2}^{indoor\ air} = \frac{TC \times SAF \times C}{NCICIAP} \qquad \text{(Equation 2.25)}$$

$$[Contaminant]_{C-IA-2}^{indoor\ air} = \frac{CRL \times C}{CICIAP \times IUR} \qquad \text{(Equation 2.26)}$$

where:

$[Contaminant]_{NC}^{indoor\ air}$	= non-carcinogen health-based indoor air concentration (µg/m^3)
$[Contaminant]_{C}^{indoor\ air}$	= carcinogen health-based indoor air concentration (µg/m^3)
TC	= Tolerable Concentration (substance-specific; $mg_{substance}/m^3$)
IUR	= Inhalation Unit Risk (substance-specific; per mg/m^3)
SAF	= Source Allocation Factor (0.2; unitless, as default)
CRL	= Cancer Risk Level (decision of 1 x 10^{-6}; unitless)
C	= unit conversion factor (1000 $ug_{substance}/mg_{substance}$)
NCRIAP	= non-cancer residential indoor air prorating (factor)
CRIAP	= cancer residential indoor air prorating (factor)
NCICIAP	=non-cancer industrial/commercial indoor air prorating (factor)
CICIAP	=cancer industrial/commercial indoor air prorating (factor)

The lower of Equations 2.23 and 2.24 moves forward for the derivation of the S-IA-1 component value (for the R/P/I land use category). The lower of Equations 2.25 and 2.26 moves forward for the derivation of the S-IA-2 component value (for I/C/C land use). The health-based IAC is then combined with hydrogeological transport modelling (see Section 7.4) and a Source Depletion Multiplier (SDM; see Sections 2.3.3.4 and 7.4) to calculate a S-IA component value. A SDM is incorporated to account for the depletion of a finite amount of the substance in soil due to volatilization into indoor air.

2.7.3.3 Derivation of Prorating Factors for Use in S-IA-1 and S-IA-2 Calculations

The calculation of health-based IAC includes prorating factors. In general, these prorating factors account for the various exposure frequencies of the pertinent receptors.

The prorating factors NCRIAP (for R/P/I land use) and NCICIAP (for I/C/C land use) are calculated using Equations 2.27 and 2.29, respectively, for non-cancer effects. The prorating factors CRIAP (for R/P/I land use) and CICIAP (for I/C/C land use) are calculated using Equations 2.28 and 2.30, respectively, for cancer effects.

$$\text{NCRIAP} = \frac{\text{EF}_a \times \text{EF}_b \times \text{EF}_c \times \text{ED}}{\text{AP} \times \text{C}} \qquad \text{(Equation 2.27)}$$

$$\text{CRIAP} = \frac{\left[\text{EF}_a \times \text{EF}_b\right] \times \left[\left(\text{EF}_{c1} \times \text{ED}_1\right) + \left(\text{EF}_{c2} \times \text{ED}_2\right) + \ldots + \left(\text{EF}_{c5} \times \text{ED}_5\right)\right]}{\text{AP} \times \text{C}} \qquad \text{(Equation 2.28)}$$

$$NCICIAP = \frac{EF_a \times EF_b \times EF_c \times ED}{AP \times C} \qquad \text{(Equation 2.29)}$$

$$CICIAP = \frac{EF_a \times EF_b \times EF_c \times ED}{AP \times C} \qquad \text{(Equation 2.30)}$$

The exposure values used in Equations 2.27 – 2.30 are shown in Tables 2.31 and 2.32 below. The receptors considered for the R/P/I land use category are the toddler (for non-cancer) and composite receptor (for cancer). The receptor considered for the I/C/C land use category is the indoor worker. In addition, for inhalation TRVs based on developmental effects, the adult female is the receptor considered for both the R/P/I and the I/C/C land use categories.

Note that the calculation of health-based IAC does not require body weights or inhalation rates for the receptors. This is because the TRVs and the acceptable indoor air concentrations pertain to the same medium – air – and can be expressed with the same units.

Table 2.31: Exposure Values Used in Derivation of Residential Indoor Air Prorating, S-IA-1 and GW2-1

Exposure Factor	symbol	Unit	NCRIAP	$NCRIAP_D$[c]	CRIAP
(Non-Cancer or Cancer) Residential Indoor Air Prorating	*(N)CRIAP*	Unitless	*0.96*	*1.0*	*0.90*
Exposure Frequency	EF_a	weeks/year	50 (CT)	52 (n/a)	50 (CT)
Exposure Frequency	EF_b	days/week	7 (C*)	7 (n/a)	7 (C*)
Exposure Frequency	EF_{c1}	hours/day	24 (C*)	24 (n/a)	24 (C*)
	EF_{c2}				24 (C*)
	EF_{c3}				22.23 (C*)
	EF_{c4}				21.83 (C*)
	EF_{c5}				22.50 (C*)
Exposure Duration	ED_1	Years	4.5 (n/a)	56 (n/a)	0.5 (n/a)
	ED_2				4.5 (n/a)
	ED_3				7 (n/a)
	ED_4				8 (n/a)
	ED_5				56 (CT)
Averaging Period	AP	Years	4.5 (n/a)	56 (n/a)	76 (CT)
Unit Conversion	C	hours/year	8760 (n/a)	8760 (n/a)	8760 (n/a)

a) For calculation of NCRIAP, the EF_c and ED factors are numbered to respectively match the age categories of infant, toddler, child, teen, and adult.
b) The symbols in parentheses represent the level of conservatism for the exposure values. As in Tables 2.5 to 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable.

c) In instances where the TRV selected for the chemical was based on developmental effects (see further in Table 2.23), pro-rating for less than continuous exposure was not applied (see further in Section 2.7.7).

Table 2.32: Exposure Values Used in Derivation of Industrial/Commercial Indoor Air Prorating for S-IA-2 and GW2-2

Exposure Factor	symbol	Unit	NCICIAP	$NCICIAP_D$[b]	CICIAP
(Non-Cancer or Cancer) Industrial/Commercial Indoor Air Prorating	*(N)CICIAP*	Unitless	*0.28*	*1.0*	*0.28*
Exposure Frequency	EF_a	weeks/year	50 (CT)	52 (n/a)	50 (CT)
Exposure Frequency	EF_b	days/week	5 (CT)	7 (n/a)	5 (CT)
Exposure Frequency	EF_c	hours/day	9.8 (C*)	24 (n/a)	9.8 (C*)
Exposure Duration	ED	years	56 (n/a)	56 (n/a)	56 (n/a)
Averaging Period	AP	years	56 (n/a)	56 (n/a)	56 (n/a)
Unit Conversion	C	hours/year	8760 (n/a)	8760 (n/a)	8760 (n/a)

a) The symbols in parentheses represent the level of conservatism for the exposure value. As in Tables 2.5 to 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable.

b) In instances where the TRV selected for the chemical was based on developmental effects (see further in Table 2.23), pro-rating for less than continuous exposure was not applied (see further in Section 2.7.7).

2.7.3.4 Source Depletion Multiplier (SDM) in Derivation of S-IA-1 and S-IA-2

S-IA components are back-calculated from the health-based IAC (computed in Equations 2.23 to 2.26) multiplied by a substance-specific source depletion multiplier (SDM), which is inversely related to the soil half-life of the substance. Thus, the S-IA components incorporate a time lag between the start of substance depletion and the attainment of the health-based IAC. In the development of the 1996 soil criteria, a single SDM of 31 (unitless) was used for volatile organic compounds. In the updated approach, substance-specific SDMs are derived from half-lives calculated for depletion of the compound through the specific pathway by which exposure is occurring. The magnitude of the SDM is dependent on the soil half-life of the substance, which in turn (for the S-IA category) depends on the volatility of the substance. Generally, the higher the volatility, the higher the SDM (to a maximum SDM of 100). Substances with relatively low volatility would not significantly deplete in soil via volatilization.

Source depletion is based on the assumption of a finite source, where the soil concentration depletes over time via volatilization and transport to indoor air. As substances in indoor air escape the affected buildings via air exchange or are inhaled and metabolized by receptors, the indoor air concentrations and potential exposures will also decrease. Due to the assumption of a finite amount of the substance, these soil standards should not be used in situations where there is a continuous source or where other specific assumptions relating to the SDM are not consistent with conditions at a particular

property. Further details on the transport modelling used to establish the SDM are provided in Section 7.

The S-IA component values are based on IACs that are up to 100-fold greater than the health-based IAC calculated in Equations 2.23 to 2.26 above (see also Table 2.33 below). The IACs from which S-IA component values are back-calculated are not expected to actually occur at a former Brownfield. Nevertheless, a series of constraints on the potential initial IAC were used:

- If the initial IAC is more than 10-fold greater than the health-based IAC, then the SDM is calculated such that the soil concentration depletes so that the health-based IAC will occur within 3 years.
- If the initial IAC is up to 10-fold greater than the health-based IAC, then the SDM is calculated such that the soil concentration depletes so that the health-based IAC will occur within 5 years.
- Incremental lifetime cancer risk from the S-IA exposure pathway does not exceed 1 x 10^{-6}.
- Where an inhalation TRV for acute or subchronic exposures was available for which there was confidence, the SDM does not exceed the ratio of the subchronic or acute TRV to the chronic TRV. Acute or subchronic inhalation TRVs were obtained mainly from ATSDR (intermediate Minimal Risk Levels) or by modification of chronic non-cancer inhalation TRVs that were based on subchronic studies.
- For chemicals where the chronic inhalation TRV is based on a developmental health effect (see Table 2.23), the SDM value does not exceed one (i.e., the health-based IAC and initial IAC are identical).

Table 2.33: Initial Indoor Air Concentration (IAC) and Source Depletion

Increase with respect to Health-Based IAC	**Time for Depletion to Health-Based IAC**
≤ 100-fold	3 years
≤ 10-fold	5 years

The initial IAC is expected to continuously decrease to the health-based IAC (i.e., the health-based concentrations computed in Equations 2.23 to 2.26) within the allotted 3 or 5 years.

2.7.4 GW2-1 and GW2-2 - Groundwater to Indoor Air

Note: As illustrated in Figure 2.1, the derivations of the GW2 components run in parallel with the derivations of the S-IA components.

2.7.4.1 Use of GW2-1 and GW2-2 Components

The groundwater-to-indoor-air (GW2) components are groundwater (GW) concentrations derived for the protection of indoor air quality from subsurface vapour intrusion of volatile substances. They are intended to prevent the exceedance of acceptable health-based Indoor Air Concentration (IAC) from substances volatilizing from GW into indoor air. The GW2 components pertain to groundwater (GW) standards for potable or non-potable use for R/P/I (GW2-1) and for I/C/C (GW2-2) land uses.

The GW2-1 category is based on an exposure scenario where a toddler (for non-carcinogens) and composite receptor (for carcinogens) may come into contact with substances that volatilize from GW into indoor air. The GW2-2 category is based on an exposure scenario where an adult receptor, an indoor worker (for both carcinogens and non-carcinogens), may come into contact with substances that volatilize from GW into indoor air.

2.7.4.2 Derivation of GW2-1 and GW2-2

GW2-1 and GW2-2 are derived by first calculating a health-based IAC for the substance (Equations 2.23, 2.24, 2.25, and 2.26). This involves an inhalation TRV (a Tolerable Concentration for non-cancer or an Inhalation Unit Risk for cancer) and the appropriate prorating factor based on the land-use, receptor, and the type of TRV (cancer or non-cancer). Equations 2.23 to 2.26 are found above in the S-IA section.

As with S-IA, the numerically lower result of Equations 2.23 and 2.24 moves forward for the derivation of the GW2-1 component value (for R/P/I land use); the numerically lower result of Equations 2.25 and 2.26 moves forward for the derivation of the GW2-2 component value (for I/C/C land use). The health-based IAC is then combined with hydrogeological transport modelling (see Section 7.4).

It is important to note that Source Depletion Multipliers (SDMs) are not applied in the calculation of GW2-1 or GW2-2.

2.7.4.3 Derivation of Prorating Factors for Use in GW2-1 and GW2-2 Calculations

The calculation of health-based IAC includes prorating factors. In general, these prorating factors account for the various exposure frequencies of the pertinent receptors.

The prorating factors NCRIAP (for R/P/I land use) and NCICIAP (for I/C/C land use) are calculated using Equations 2.27 and 2.29, respectively, for non-cancer effects. The

prorating factors CRIAP (for R/P/I land use) and CICIAP (for I/C/C land use) are calculated using Equations 2.28 and 2.30, respectively, for cancer effects. Equations 2.27 to 2.30 are found above in the S-IA section.

The receptors considered for R/P/I land use are the toddler (for non-cancer) and composite receptor (for cancer). The receptor considered for the I/C/C land use category is the indoor worker. In addition, for inhalation TRVs based on developmental effects, the adult female is the receptor considered for both the R/P/I and the I/C/C land use categories.

Note that the calculation of acceptable indoor air concentrations does not require body weights or inhalation rates for the receptors. This is because the TRVs and the acceptable indoor air concentrations pertain to the same medium , that is, air, and can be expressed with the same units.

2.7.5 GW1 Component – Ingestion of Groundwater

2.7.5.1 Use of GW1 Component

The GW1 component pertains to groundwater for all property uses that have potable GW. The receptors considered are the toddler (for non-cancer) and composite receptor (for cancer). It is assumed that the GW is ingested as the primary source of drinking water.

2.7.5.2 Derivation of GW1 Component

If a drinking water standard or guideline was available for a given substance, as a default this value was used as the GW1 component. Note that these drinking water criteria were current as of September 2007. Also note that established drinking water standards and guidelines are generally developed with the application of Source Allocation Factors (SAFs) to account for concurrent exposure via other media.

2.7.5.2.1 Selection of Established Drinking Water Standard or Guideline

The selection of an established drinking water standard or guideline for use as the GW1 component for each substance followed this sequence of preference:

1. Ontario Drinking-Water Quality Standards (ODWQS) Ontario Regulation 169/03 Drinking Water Quality Standards under the *Safe Drinking Water Act, 2002*, Consolidation period: from June 7, 2007. (Government of Ontario, 2007).

2. Canadian Drinking Water Quality Guidelines (CDWQG; March 2007 summary) (HC 2007).
3. United States Environmental Protection Agency (US EPA) National Primary Drinking Water Standards, maximum concentration limits (MCLs) (US EPA, 2003).
4. California Environmental Protection Agency (Cal EPA) MCLs (September 2003) (Cal EPA, 2003).
5. World Health Organization (WHO) drinking water guideline values (WHO, 2006).

The ODWQSs are preferred because they are Ontario drinking water standards. CDWQGs use information that is appropriate for Canada, integrating data from all provinces and territories including Ontario. The US EPA, Cal EPA, and WHO incorporate information that may be more appropriate for their own jurisdictions than for Ontario.

Drinking water standards or guidelines listed for groups of substances were divided among the substances in that group. For example, the Ontario Drinking Water Quality Standard for "aldrin + dieldrin" is 0.7 µg/L. Since a separate GW1 value is required for each of the chemicals within this group, 0.35 µg/L was allotted to aldrin and 0.35 µg/L to dieldrin. This method was applied to these groups of substances:

- aldrin and dieldrin
- trihalomethanes – i.e., bromoform, chloroform, and dibromochloromethane
- DDT, DDD, and DDE
- heptachlor and heptachlor epoxide

Among the polycyclic aromatic hydrocarbons (PAHs), benzo[*a*]pyrene (B[*a*]P) is the only PAH with a drinking water criterion. The ODWQS for B[*a*]P of 0.01 µg/L was derived by Health Canada in 1988 (and reaffirmed in 2005) from a cancer potency factor and estimated values for body weight and drinking water ingestion rate (HC 1988). By applying toxic equivalency factors (TEFs) for carcinogenic PAHs from MOEE (1996) to the ODWQS for B[*a*]P, GW1 component values were estimated for the other carcinogenic PAHs.

2.7.5.2.2 Derivation of GW1 Component when an Established Drinking Water Standard or Guideline is not Available

For substances without an established drinking water standard or guideline, oral TRVs and estimated GW exposure rates were used to calculate risk-based substance concentrations in GW for non-cancer effects (Equation 2.31) and cancer effects (Equation 2.32). The non-cancer equation uses an oral TDI and Source Allocation Factor (SAF)/HQ default of 0.2. The cancer equation uses an oral cancer slope factor (CSF_O) and a target cancer risk level (CRL) of one in one million. The lower of these health effects-based concentrations moves forward as the GW1 component.

Note that the values calculated by these equations are not to be used or considered as drinking water guidelines or standards. The latter are based on a more extensive decision-making process considering factors such as background groundwater substance concentrations and technological feasibility.

$$[Contaminant]_{GW1-NC}^{oral} = \frac{SAF \times TDI \times C}{NCDWEF \times RAF_{oral}} \quad \text{(Equation 2.31)}$$

$$[Contaminant]_{GW1-C}^{oral} = \frac{CRL \times C}{CDWEF \times RAF_{oral} \times CSF} \quad \text{(Equation 2.32)}$$

where:

$[Contaminant]_{GW1-NC}^{oral}$ = Concentration of non-cancer substance in groundwater for GW1 ($\mu g_{substance}/L_{water}$)
$[Contaminant]_{GW1-C}^{oral}$ = Concentration of cancer substance in groundwater for GW1 ($\mu g_{substance}/L_{water}$)
SAF = Source Allocation Factor (0.2; unitless)
CRL = Cancer Risk Level ($1x10^{-6}$; unitless)
TDI = Tolerable Daily Intake (substance-specific; $mg_{substance}/kg_{BW}$/day)
CSF = oral Cancer Slope Factor (substance-specific; per $mg_{substance}/kg_{BW}$/day)
C = unit conversion factor (1000 $\mu g_{substance}/mg_{substance}$)
NCDWEF = Non-Cancer Drinking Water Exposure Factor (L/kg_{BW}/day)
CDWEF = Cancer Drinking Water Exposure Factor (L/kg_{BW}/day)
RAF_{oral} = Relative Absorption Factor, oral from water (substance-specific; unitless)

2.7.5.3 Derivation of Groundwater Exposure Rates for Use in GW1 Equations

The receptors considered for GW1 are the toddler (for non-cancer) and the composite receptor (for cancer). Due to the nature of cancer risk assessment, time-weighted exposure values were used for the composite receptor, who is assumed to be continually exposed during the various life stages. In addition, for chemicals where the selected oral TRV is based on developmental effects, the receptor considered is an adult female.

The estimates of exposure via ingestion of groundwater are the Non-Cancer Drinking Water Exposure Factor (NCDWEF) and the Cancer Drinking Water Exposure Factor (CDWEF). They are calculated using Equations 2.33 and 2.34:

$$\text{NCDWEF} = \frac{\text{DWIR} \times \text{EF}_a \times \text{EF}_b \times \text{ED}}{\text{BW} \times \text{AP} \times \text{C}} \quad \text{(Equation 2.33)}$$

$$\text{CDWEF} = \left(\frac{\text{DWIR}_1 \times \text{ED}_1}{\text{BW}_1} + \frac{\text{DWIR}_2 \times \text{ED}_2}{\text{BW}_2} + \ldots + \frac{\text{DWIR}_5 \times \text{ED}_5}{\text{BW}_5} \right) \times \frac{\text{EF}_a \times \text{EF}_b}{\text{AP} \times \text{C}} \quad \text{(Equation 2.34)}$$

The exposure values used in these equations are shown in Table 2.34 below. Differences in the values used in the two equations are mainly due to the receptors considered. For non-cancer effects, GW1 considers the toddler (0.5 – 4 years old). For cancer effects, GW1 assumes the individual receptor is continually exposed through all life stages and the exposure values are combined as time-weighted averages.

Table 2.34: Exposure Values for Calculations of Drinking Water Exposure Factors for Non-Cancer (NCDWEF) and for Cancer (CDWEF), for Use in GW1

Exposure Factor	Symbol*	Units	NCDWEF	CDWEF*
(Non-Cancer or Cancer) Drinking Water Exposure Factor	*(N)CDWEF*	*L/kg$_{BW}$/day*	*6.75E-02*	*3.37E-02*
Drinking water intake rate	$DWIR_1$	L/day	1.162 (C)	0.64 (C)
	$DWIR_2$			1.162 (C)
	$DWIR_3$			1.338 (C)
	$DWIR_4$			1.692 (C)
	$DWIR_5$			2.280 (C)
Exposure Frequency	EF_a	days/week	7 (C*)	7 (C*)
Exposure Frequency	EF_b	weeks/year	50 (CT)	50 (CT)
Exposure Duration	ED_1	years	4.5 (n/a)	0.5 (n/a)
	ED_2			4.5 (n/a)
	ED_3			7 (n/a)
	ED_4			8 (n/a)
	ED_5			56 (CT)
Body Weight	BW_1	kg_{BW}	16.5 (CT)	8.2 (CT)
	BW_2			16.5 (CT)
	BW_3			32.9 (CT)
	BW_4			59.7 (CT)
	BW_5			70.7 (CT)
Averaging Period	AP	years	4.5 (n/a)	76 (CT)
Unit conversion	C	days/year	365 (n/a)	365 (n/a)

a) For calculation of NCRIAP, the EF_c and ED factors are numbered to respectively match the age categories of infant, toddler, child, teen, and adult.

b) The symbols in parentheses represent the level of conservatism for the exposure value. As in Tables 2.5 to Table 2.18 above, the symbols represent: CT = central tendency; sli = slightly more than average; C = conservative; C* = conservative value, but does not numerically affect overall calculation; n/a = not applicable.

2.7.6 S-GW1 Component – Soil to Groundwater

2.7.6.1 Use of S-GW1 Component

The S-GW1 components are soil concentrations that are intended to prevent the exceedance of acceptable GW concentrations from substances that leach from soil into GW. The S-GW1 components pertain to surface and subsurface soil standards for all property uses that have potable groundwater. The receptors considered are the toddler (for non-cancer) and composite receptor (for cancer). It is assumed that the GW is the primary source of drinking water.

2.7.6.2 Derivation of S-GW1 Component

The S-GW1 component for the substance is derived by first selecting or calculating the acceptable groundwater concentration of the substance (the GW1 component, above). For a description of the derivation of the GW1 component, see section 2.3.5, in particular Equations 2.31 to 2.34.

In the derivation of the S-GW1 component from GW1, a Source Depletion Multiplier (SDM) and hydrogeological transport modelling are applied (see Section 7.5) to determine a health effects-based soil concentration that prevents exceedance of the acceptable GW concentration. SDMs are used to account for depletion of a fixed amount of a substance in soil over time, due to leaching from soil to GW. A higher concentration is allowed in the GW for a less-than-chronic duration because the source is depleting and the concentration is expected to decrease. In Section 2.3.3, human health considerations for the use of SDMs for the soil-to-indoor-air (S-IA) category are discussed. Short-term exposures to these l GW concentrations were not assessed for health effects because GW substance concentrations are directly measured and compared to health-based GW standards.

2.7.7 Exposure Assessment for Chemicals with Developmental Toxicity

Certain aspects of the derivation of human health-based component values based on developmental effects are unique. Note that in Table 2.23, TRVs based on developmental effects appear with the TRV value and the reference underlined.

Pro-Rating for Exposure Frequency

Pro-rating for exposure frequency is not applied in the derivation of human health-based component values based on developmental effects because the relevant duration of exposure is assumed to be short-term. This is because a single exposure to a chemical

with developmental toxicity, rather than repeated or extended exposure, may be sufficient to elicit an adverse developmental effect. See further discussion in US EPA 1991b, pp. 45-46.

Use of TRVs Based on Dose Administered to Pregnant Female

Although several developmental TRVs are based on the dose administered to a pregnant female, rather than the dose administered to a juvenile, calculations of HHCVs based on these TRVs may use a toddler rather than an adult female receptor (e.g., calculation of S1 ADSIR). As toddlers have higher media contact rates per unit body weight than adults, an HHCV based on the pregnant female receptor would be protective of the developmental effect elicited during gestation, but might not be protective of any secondary effects of the chemical which could be elicited during exposure as a child. .

For example, the soil ingestion rate of the toddler resident is estimated to be 9.07 mg_{soil}/kg_{BW}/day (see Table 2.26), in contrast to the adult female receptor at 0.79mg_{soil}/kg_{BW}/day. The ratio of these values is approximately 11:1. If an HHCV for soil were based on an adult female, and toddler receptors are relevant to the exposure scenario, one would need to verify that all of the TRVs or thresholds for the other toxic effects of the chemical are at least 11-fold higher than the TRV used to derive the HHCV.

Such a verification would be very difficult because TRVs for secondary and other effects of chemicals generally do not exist. Although many developmental TRVs are ‘mismatched’ with toddler receptors, the HHCVs are based on that combination in order to ensure that all known potential adverse effects of the chemicals are addressed.

2.8 Exceptions and Limitations

2.8.1 Exceptions to the Typical Process of Derivation

As described in Figure 2.1 and Section 2.4, the typical process of derivation for the HHCVs was to combine the scenario-specific media exposure rates and pro-rating factors calculated in Section 2.4 with TRVs and other variables (as illustrated in Fig. 2.1) in order to compute an HHCV. There are some instances, however, where the HHCVs were developed or established using a different approach. Some examples are listed below.

1. Lead

Regarding lead, the Ministry has retained the human health standards from the 1996 Rationale document. A more thorough review is required for lead due to recent scientific information including a weight of evidence supporting an association between health effects and blood lead levels below 10 µg/dL.

2. *Uranium*

CCME developed generic guidelines for uranium in 2007 that were designated as the HHCVs for this update.

3. HHCVs for Agricultural and Other Sites

Higher media exposure rates associated with such factors as rates of direct contact with soil (US EPA 1997) may apply at some agricultural sites than were estimated for the residential component values. As explained in Section 2.3.2, due to a high degree of variability and uncertainty in such possible exposures, the residential scenario is used for agricultural land use. As a result, for some sites (mostly those with widespread contamination where source size is significantly larger than that assumed by the generic CSM) the degree of protection conferred by the agricultural values may be less than that of other human health-based SCS.

The delineation of the residential exposure scenario did not include quantification of exposure from consumption of foods that are contaminated as a result of being cultivated in contaminated soils or groundwater. As a result, the agricultural values may not be appropriate for all situations that involve the cultivating and consumption of foods. Any application of these standards should consider all relevant factors.

4. HHCVs for Ingestion of Groundwater

A drinking water standard from Ontario (or, if a drinking water standard was not available from Ontario, a drinking water standard from another jurisdiction) was used in the place of an ingestion TRV in the calculation of several HHCVs for ingestion of groundwater. It is unknown whether all of these drinking water standards were derived according to a target cancer risk of 10^{-6} or an HQ of 0.2 (see further in Section 2.4). In addition, some of these standards may have been derived based on considerations other than human health. See also Section 2.6.

5. *S-IA Component*

As described in Section 2.7, the S-IA component values incorporate a time lag between the start of substance depletion and the attainment of the health-based IAC. As a result, where the COC is a highly volatile substance, there is no acute or sub-chronic TRV, and there is very little time between the measurement of the soil concentration and exposure to a resident or worker, the S-IA values may represent a greater risk than for other situations..

2.8.2 Limitations of the HHCVs

As with any mathematical model, the equations and input values used to calculate the component values are only as valid as the assumptions upon which they are based (NYS 2006). While the calculations and input values were chosen in consideration of the available science, their usefulness and applicability have certain limitations:

1. uncertainty is inherent in the estimates of exposure and toxicity
2. some general factors and issues were not considered in the equations
3. the underlying assumptions of the component values are not valid under all potential conditions at contaminated sites (NYS 2006).

Each of these limitations is described further below:

1. *Uncertainty in Estimates of Exposure and Toxicity*

Uncertainty is inherent to the quantities used to derive a health-based concentration. Some examples of the uncertainties in exposure and toxicity assessment are described below:

Derivation of TRVs

There are numerous sources of uncertainty in deriving toxicological reference values. Uncertainty factors are used to try to ensure that despite these uncertainties, the TRV will

denote a concentration at which exposure would not result in deleterious health effects. Nevertheless, uncertainty factors do not address all aspects of the toxicity of a chemical, and agencies often revise TRVs as new scientific information comes available.

Methods for Estimation of Absolute Dermal Absorption

For some chemicals, dermal absorption from soil was estimated using results from studies where the chemical was applied to skin in a solution that may have resulted in higher rates of absorption than might actually be expected were the chemical applied as part of soil (NYS 2006). As a result, some estimates of absolute dermal absorption may be over-estimates.

2. *General Factors and Issues Not Considered in the Equations*

Effect of Lifestage on Potency of Carcinogen

The cancer calculations assume that the potency of a carcinogen is unaffected by the lifestage of the human that is exposed. However, the potency of a carcinogen may be greater during particular life stages such as infancy.

Exposure to Multiple Chemicals

The HHCVs are derived for exposure to single chemicals. At many contaminated sites, multiple chemical substances are present and human exposure may be to multiple chemicals. Although there are some HHCVs and SCS which are based on the toxicity of a mixture of chemicals, the HHCVs were not derived to confer any particular level of protection for exposures to multiple chemicals. However, the likelihood of synergistic interactions between chemicals is low when the total dose from environmental exposures is low (ATSDR 2005).

Acute Toxicity Due to Soil Ingestion

Short-term rates of ingestion of soil may be significantly higher than long-term average rates of soil ingestion (consider the example of a child who has episodes of pica). The human health-based soil concentrations that were derived assume a relatively constant daily rate of soil ingestion and do not address the potential acute effects that may result from a higher acute exposure to soil.

3. *Underlying Assumptions May Not Hold at All Sites*

When the assumptions made in the derivation of the component values are not valid at a particular site, the SCS may not be applicable and alternative approaches may be needed to identify substances of concern. Some examples are listed below.

Relative Absorption Factors

Many of the relative absorption factors used for dermal and ingestion routes of exposure to soil assume that the substances are not in a free phase, i.e., that they are incorporated into the soil matrix. At a site where substances are present in free phase, the exposure may be higher than that estimated in the derivation of the HHCVs.

Transport of Chemicals from Subsurface to Indoor Air

Human health-based indoor air concentrations are used in the Johnson and Ettinger model to calculate human health-based component values for subsurface vapour intrusion. There are a number of precluding conditions, however, which affect the validity of the Johnson and Ettinger model at different sites and potentially limit the applicability of these component values to certain sites. (see Section 7)

Application of Brownfields SCS to Non-Brownfields Risk Assessments

Most of the assumptions and exposure values used to derive the SCS were based on the specific objectives and relevant exposure scenarios of the Brownfields program under *O. Reg*. 153/04. A non-Brownfields risk assessment (e.g., a community-based risk assessment a human health risk assessment prepared in support of an Environmental Assessment) may have different objectives or a different array of relevant exposure scenarios than those used to derive the SCS. As a result, the SCS should not be applied to a non-Brownfields risk assessment unless the applicability of these criteria has been carefully determined beforehand.

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Table 2.35a: Estimation of Oral Relative Absorption Factors (RAFs) for Use with Oral TRVs in Brownfield Standards

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
ESTIMATES FOR SUBSTANCES LACKING SUFFICIENT DATA, PETROLEUM HYDROCARBONS, AND FOR PAHs											
Chemicals lacking sufficient data for quantitative analysis						-	-	**1**	When data are insufficient to quantitatively estimate oral absorption from soil relative to oral absorption in the critical study, a 100% RAF is assumed.	**1**	When data are insufficient to quantitatively estimate oral absorption from water relative to oral absorption in the critical study, a 100% RAF is assumed.
Petroleum Hydrocarbons						low - 97%	Oral absorption of PHCs ranges from low or variable absorption to very high absorption efficiencies up to 97% (ATSDR 1999a).	**1**	Default. CCME 2000 also assumes RAF of 100% for PHCs.	**-**	-
Polycyclic Aromatic Hydrocarbons (PAHs)						58-89%	US EPA (2004, Exhibit 4-1) estimates absolute oral absorption of 58-89% for PAHs, based on rats dosed via diet or starch solution. Also, NEPI 2000b reports studies showing that the various PAHs have similar absorption estimates.	**1**	NEPI (2000b) reports absorption in the range of 25-90% for PAHs (data from Stroo et al 1999). 7-76% (Magee et al 1996). Few studies exist on absorption of PAHs from soil matrix; those located report a similar range of absorption efficiencies as diet, thus 100% RAF is assumed.	**-**	**-**
ESTIMATES FOR SPECIFIC SUBSTANCES											
Ace-naphthene	SVOC	ch NC	IRIS 1994	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default
		sch NC	ATSDR 1995								
		C	based on B(a)P	mice	diet						
Ace-naphthylene	SVOC	ch NC	IRIS 1994 (proxy)	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default
		sch NC	ATSDR 1995 (proxy)								
		C	based on B(a)P	mice	diet						

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Acetone	VOC	ch & sch NC	IRIS 2003	rats	drinking water	100%	default for organics USEPA RAGS (2004)	**1**	High water solubility & low KOC suggest oral bioavailability from soil will be high but quantitative data are lacking (ATSDR 1994). There are conflicting data regarding the effect of vehicle on the GI absorption of acetone (ATSDR 1994), thus 100% RAF is assumed.	**1**	same dosing medium as critical study
Aldrin	SVOC	ch NC	IRIS 1988	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	US EPA PPRTV 2005	dogs	diet						
Anthracene	SVOC	ch & sch NC	IRIS 1993	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default
Antimony		ch NC	IRIS 1991	rats	Sb tartrate in water	15%	US EPA RAGS (2004) Exhibit 4-1, based on rats dosed via water.	**1**	default	not required for GW1 and S-GW1 components	
Arsenic		ch NC	IRIS 1993	human	drinking water	95%	US EPA RAGS (2004) Exhibit 4-1, based on humans assumed to be exposed via water.	**0.5**	NEPI (2000a) reports that numerous studies in lab animals indicate that As in soil is typically one-half to one-tenth as bioavailable as soluble As forms (RAF 0.1 to 0.5) although some studies report higher bioavailabilities.	not required for GW1 and S-GW1 components	
		C	CalEPA ATH 2005								
Barium		ch NC	IRIS 2005	mice	drinking water	7%	US EPA RAGS (2004) Exhibit 4-1, based on dogs exposed to $BaCl_2$ in water.	**1**	Studies (not soil) report 1% to >80% depending on age & feeding status (ATSDR 2007a). Default 100% RAF is selected.	not required for GW1 and S-GW1 components	
Benzene	VOC	ch NC	IRIS 2003	human	RtR from inhalation	80-97%	ATSDR 1999a for TPHs states that published absorption rates for oral doses of BTEXs in animal studies range from ~80-97%.	**1**	Oral absorption from soil relative to oral absorption in critical studies is not clear, thus 100% RAF is assumed.	not required for GW1 and S-GW1 components	
		C	HC DW (Sept. 2007 draft)	rats & mice	corn oil by oral gavage	80-97%					
Benz[a] anthracene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**1**	25-90% (Stroo et al 1999 reported in NEPI 2000b). 7-76% (Magee et al 1996). Few studies exist on absorption of PAHs from soil matrix. Those which exist report a similar range of absorption efficiencies as diet, thus 100% RAF is assumed.	not required for GW1 and S-GW1 components	
Benzo[a] pyrene	non-VOC	C	IRIS 1992	mice	diet	58-89%		**1**		not required for GW1 and S-GW1 components	
Benzo[b] fluoranthene	non-VOC	C	based on B(a)P	mice	diet	58-89%		**1**		not required for GW1 and S-GW1 components	
Benzo[g,h,i] perylene	non-VOC	C	based on B(a)P	mice	diet	58-89%		**1**		not required for GW1 and S-GW1 components	
Benzo[k] fluoranthene	non-VOC	C	based on B(a)P	mice	diet	58-89%		**1**		not required for GW1 and S-GW1 components	

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Beryllium		ch NC	IRIS 1998	dogs	diet	<1%	GI absorption is probably <1% (Deubner et al 2001). USEPA RAGS 2004 Exhibit 4-1 suggests 0.7% for rats exposed via water.	**1**	default	not required for GW1 and S-GW1 components	
1,1'-Biphenyl	SVOC	ch NC	WHO CICAD 1999	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
Bis (2-chloroethyl) ether	VOC	C	CalEPA ATH 2005	mice	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
Bis (2-chloro isopropyl) ether	VOC	ch NC	IRIS 1990	mice	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
Bis (2-ethylhexyl) phthalate	non-VOC	ch NC	ATSDR 2002	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2002	mice	diet						
Boron		ch NC	IRIS 2004	rats	diet (as boric acid)	90%	ATSDR (draft Sept 2007a) indicates oral absorption of boric acid in humans to be >90%, while oral absorption of B in animals to be 81-92%.	**1**	default	not required for GW1 and S-GW1 components	
Bromo-dichloro-methane	VOC	ch NC	IRIS 1991	rats	corn oil by oral gavage	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	IRIS 1993	mice	corn oil by oral gavage						
Bromoform	VOC	ch NC	IRIS 1991	rats	oral gavage, vehicle not reported	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	US EPA PPRTV 2005	rats	oral gavage in corn oil						
		C	IRIS 1991								
Bromo-methane	VOC	ch & sch NC	ATSDR 1992	rats	oral gavage, by solution in arachis oil	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Cadmium		non-C	modified from CalEPA DW 2006	human	several human studies; urinary Cd concentrations were associated with oral intake	10%	The derivation by CalEPA DW draft 2006 is based on an absorbed fraction in women of 10%.	**1**	Studies suggest moderate reductions in Cd bioavailability from soil as compared to soluble forms (NEPI 2000a). NEPI (2000a) mentions studies reporting relative bioavailability of Cd in soil of 43% and 62–85%. Schroder et al. (2003) report range 10-116% for relative bioavailability of Cd from soils in dosed juvenile swine. Because the range of relative bioavailability is generally in the high percentages, 100% RAF is selected.	not required for GW1 and S-GW1 components	
Carbon Tetrachloride	VOC	ch NC	IRIS 1991	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2005	rats	oral gavage in corn oil						
Chlordane	SVOC	ch NC	CalEPA chRD 2005	rats	pre- & post-natal dosing in peanut oil supplemented peanut butter	100%	US EPA RAGS (2004) Exhibit 4-1 suggests 80% based on assumed aqueous gavage in rats. Because fats and oils enhance GI absorption of organochlorines, absorption could be higher.	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 1994	rats	diet						
		C	CalEPA DW 1997	mice	diet						
p-Chloroaniline	SVOC	ch NC	WHO CICAD 2003	rats	gavage in water	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
Chloro-benzene	VOC	ch & sch NC	CalEPA DW 2003	dogs	orally, by gelatin capsule	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
Chloroform	VOC	ch NC	IRIS 2001	dogs	orally: in a toothpaste base & gelatin capsules	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 1997								
		C	CalEPA ARB 1990	rats, mice	various						
2-Chlorophenol	VOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	same dosing medium as critical study
		sch NC	ATSDR 1999	rats	drinking water						

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Chromium Total		ch NC	IRIS 1998	rats	Cr_2O_3 in bread	1.3%	US EPA RAGS (2004) Exhibit 4-1, based on oral absorption of Cr III in rats from diet/water.	**1**	<2% absolute absorption in rats dosed with chromium-containing soil (Witmer et al. 1989; 1991, as reported in NEPI 2000a). This is similar to absolute absorption assumed for critical study, thus 100% RAF is selected.	not required for GW1 and S-GW1 components	
Chromium VI		ch NC	modified from IRIS 1998	rats	drinking water	2.5%	US EPA RAGS (2004) Exhibit 4-1 suggests 2.5% based on absorption of Cr VI in rats via water. [NEPI 2000a & ATSDR 2000a report absorption of Cr VI to be up to 10%.]	**1**	<2% absolute absorption in rats dosed with chromium-containing soil (Witmer et al. 1989; 1991, as reported in NEPI 2000a). This is similar to absolute absorption assumed for critical study, thus 100% RAF is selected.	**1**	Means of absolute absorption from various studies of Cr VI given to humans in drinking water: 3.4%, 5.7%, or 2% (NEPI 2000a). This is similar to absolute absorption assumed for critical study, thus 100% RAF is selected.
Chrysene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**1**	See B(a)P	not required for GW1 and S-GW1 components	
Cobalt		ch & sch NC	ATSDR 2004	human	$CoCl_2$ as 2% solution in either water or milk	18-97%	GI absorption of Co in humans varies considerably: 18-97% (ATSDR 2004a).	**1**	default	**1**	Since critical studies were based on absorption from water and milk, 100% RAF is assumed.
Copper		ch NC	HC DWQ 1992	human	TRV based on dietary copper requirements	24-60%, 97%	Average absorption efficiencies ranged from 24% to 60% in presumably healthy adults (ATSDR 2004b). Early estimates of Cu absorption in humans ranged from 15-97% (Shils et al. 2006).	**1**	Cu in soil is bound to organic molecules (ATSDR 2004b). However, data to estimate oral absorption from soil relative to oral absorption in critical study were not found. Thus 100% RAF is selected.	not required for GW1 and S-GW1 components	
Cyanide (CN-)		ch NC	CalEPA DW 1997	rats	diet	>47%	US EPA (2004, Exhibit 4-1) suggests >47% for cyanide in water for rats. ATSDR 2006 reports absorption of cyanide to be up to 72%.	**1**	Appropriate data to estimate oral absorption from soil relative to oral absorption in critical study were not found, thus 100% RAF assumed.	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2006	rats	drinking water						
Dibenz[a,h] anthracene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**1**	See B(a)P	not required for GW1 and S-GW1 components	
Dibromo-chloro-methane	VOC	ch NC	IRIS 1991	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	mod from IRIS 1991	rats	oral gavage in corn oil						
		C	IRIS 1992	mice	oral gavage in corn oil						
1,2-Dichloro-benzene	VOC	ch NC	ATSDR 2006	mice	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2006	rats	oral gavage in corn oil						
1,3-Dichloro-benzene	VOC	ch & sch NC	ATSDR 2006 (proxy)	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
1,4-Dichloro-benzene	VOC	ch NC	IRIS May 2006 draft	dogs	99.9% pure chemical in gelatin capsules	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2006	dogs	99.9% pure chemical in gelatin capsules						
		C	IRIS May 2006 draft	mice	>99% pure chemical in corn oil by gavage						
3,3'-Dichloro-benzidine	non-VOC	C	CalEPA ATH 2005	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
Dichloro-difluoro-methane	VOC	ch NC	IRIS 1995	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
DDD	SVOC	ch NC	RIVM 2001	rats	diet	70-90%	US EPA RAGS (2004) Exhibit 4-1, based on rats dosed DDT in vegetable oil.	**1**	default	not required for GW1 and S-GW1 components	
		C	IRIS 1988	mice	diet	70-90%					
DDE	SVOC	ch NC	RIVM 2001	rats	diet	70-90%		**1**		not required for GW1 and S-GW1 components	
		C	IRIS 1988	mice & ham-sters	diet	70-90%					
DDT	SVOC	ch NC	RIVM 2001	rats	diet	70-90%		**1**		not required for GW1 and S-GW1 components	
		C	IRIS 1991	mice & rats	diet	70-90%					
1,1'-Dichloro-ethane	VOC	ch & sch NC	CalEPA DW 2003	cats	inhalation RtR to oral assuming 50% pulmonary retention & cat inhalation rate & body weight	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
1,2-Dichloro-ethane	VOC	ch & sch NC	ATSDR 2001	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	IRIS 1991	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**			
1,1'-Dichloro-ethylene	VOC	ch NC	IRIS 2002	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
1,2-cis-Dichloro-ethylene	VOC	ch & sch NC	mod from RIVM 2001; ATSDR 1996	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
1,2-trans-Dichloro-ethylene	VOC	ch & sch NC	IRIS 1989 ATSDR 1996	mice	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
2,4-Dichloro-phenol	VOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 1999	rats	drinking water						
1,2-Dichloro-propane	VOC	ch NC	ATSDR 1989	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	CalEPA DW 1999	mice	gavage in corn oil						
1,3-Dichloro-propene	VOC	ch & sch NC	IRIS 2000 & ATSDR Sept 2006 draft	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	CalEPA DW 1999	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004				
Dieldrin	SVOC	ch NC	IRIS 1990 & ATSDR 2002	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2002	monkey	dissolved in ethanol & injected into marshmallows	100%	default for organics USEPA RAGS 2004				
Diethyl Phthalate	SVOC	ch NC	WHO CICAD 2003	mice	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
		sch NC	mod from IRIS 1993	rats	diet						
Dimethyl-phthalate	SVOC	ch NC	WHO CICAD 2003 (proxy)	mice	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	Default
2,4-Dimethyl-phenol	VOC	ch & sch NC	IRIS 1990	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	Default
2,4-Dinitro-phenol	SVOC	ch & sch NC	IRIS 1991	human	ingested as a drug, assume taken with food	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	Default
2,4- and 2,6-Dinitrotoluene	SVOC	ch NC	IRIS 1993	dogs	fed 98% pure 2,4-DNT in gelatin capsules	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	Default
		sch NC	ATSDR 1998	dogs	fed DNT in gelatin capsules						
		C	IRIS 1990	rats	diet						

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
1,4-Dioxane	VOC	ch NC	ATSDR 2006	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2006	rats	drinking water						
		C	IRIS 1990	rats	drinking water						
Dioxins / Furans	non-VOC	ch NC	WHO JECFA 2002	rats	2 studies: oral & subcutaneous injection	50-83%	US EPA RAGS (2004) Exhibit 4-1, based on multiple studies.	**1**	Oral absorption of TCDD in soil relative to corn oil is reported up to 100% (NEPI 2000b).	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 1998	guinea pigs	diet						
Endosulfan	SVOC	ch NC	ATSDR 2000	dogs	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
		sch NC	ATSDR 2000	rats	diet						
Endrin	SVOC	ch NC	CalEPA DW 1999	dogs	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 1996	dogs	diet						
Ethylbenzene	VOC	ch NC	IRIS 1991	rats	gavage in olive oil	80-97%	ATSDR 1999a for TPHs states that published absorption rates for oral doses of BTEXs in animal studies range from ~80-97%.	**1**	default	not required for GW1 and S-GW1 components	
Ethylene dibromide	VOC	ch NC	IRIS 2004	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	modified from CalEPA DW 2003	rats	inhalation, RtR to oral assuming rat inhalation rate & body weight	100%	default for organics USEPA RAGS 2004				
		C	CalEPA DW 2003	rats, mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004				
Fluoranthene	non-VOC	ch & sch NC	IRIS 1993	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default
		C	based on B(a)P	mice	diet						
Fluorene	SVOC	ch & sch NC	IRIS 1990	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Heptachlor	SVOC	ch NC	CalEPA chRD 2005	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	CalEPA DW 1999	mice	diet						
Heptachlor Epoxide	SVOC	C	CalEPA DW 1999	mice	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
Hexachloro-benzene	SVOC	chronic & sch NC	ATSDR 2002	monkey	in glucose in gelatin capsules	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	CalEPA DW 2003	rats	diet						
Hexachloro-butadiene	VOC	ch NC	HC PSL2 2000	mice	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	IRIS 1991	rats	diet						
gamma-Hexachloro-cyclohexane	SVOC	ch NC	CalEPA DW 1999	mice	diet	99.4%	absorption of technical grade HCH in a rat study was 95.8%, in another study with gamma-HCH in feed was 99.4% (ATSDR 2005a).	**1**	default	not required for GW1 and S-GW1 components	
Hexachloro-ethane	VOC	ch NC	IRIS 1991	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
		sch NC	ATSDR 1997	rats	diet						
		C	IRIS 1994	mice	gavage, corn oil						
n-Hexane	VOC	none selected									
Indeno [1,2,3-cd] pyrene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**1**	See B(a)P	not required for GW1 and S-GW1 components	
Lead		none selected									
Mercury		ch & sch NC	IRIS 1995	rats	3 studies with $HgCl_2$: subcutaneous injection, forcible feeding (vehicle not reported), and gavage in water	7%	US EPA (2004) Exhibit 4-1 suggests 7% for $HgCl_2$ and other soluble salts based on rats dosed via water. ATSDR (1999b) states that in earlier studies absorption rate of $HgCl_2$ was reported as low, but more recent studies report absorption in 10-40% range (eg. 30-40% for male rats in DW for 8 weeks; in standard diet 1% for adult mice vs. 38% for suckling mice).	**0.5**	Revis et al. (1989;1990, as cited in NEPI 2000a & MADEP 1992) reported that relative absorption in mice fed Hg in soil was 40% of absorption in mice fed non-soil Hg, but some report study design limitations (NEPI 2000a). Sheppard et al (1995, in NEPI 2000a) reported 66% RAF in mice for Hg in soil+chow vs. Hg in chow alone. Taken together, the oral absorption of Hg in soil relative to diet is about half.	not required for GW1 and S-GW1 components	
Methoxychlor	SVOC	ch NC	CalEPA chRD 2005	mice	fed chemical in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
Methyl Ethyl Ketone	VOC	ch NC	IRIS 2003	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	same dosing medium as critical study

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Methyl Isobutyl Ketone	VOC	ch NC	modified from IRIS 2003	rats & mice	RtR from inhalation studies	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default
Methyl Mercury		ch NC	IRIS 2001	human	epidemiological studies - dietary intake	95%	US EPA RAGS (2004) Exhibit 4-1, based on humans exposed via water.	**1**	default	**1**	Although MeHg in water could be more highly absorbed than MeHg in diet depending on type of food (ATSDR 1999), it is assumed here that they have generally the same absorption efficiency, i.e., RAF 100%.
Methyl tert-Butyl Ether (MTBE)	VOC	ch & sch NC	mod from HC 1996	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	CalEPA DW 1999	rats	3 data sets: olive oil by gavage (used twice), & inhalation	100%	default for organics USEPA RAGS 2004	**1**			
Methylene Chloride	VOC	ch NC	IRIS 1988	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	IRIS 1995	mice	2 studies: drinking water & inhalation	100%	default for organics USEPA RAGS 2004	**1**			
2-(1-) Methyl-naphthalene	VOC	ch NC	IRIS 2003	mice	diet	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default
Molybdenum		ch NC	IRIS 1993	human	diet	up to 93%	Vyskocil & Viau (1999) state that lit shows oral absorption of Mo in humans in range of 28-77%. Turnlund et al. (1995; 1999) report oral absorption in humans from diet in range of 57% to 93%.	**1**	default	not required for GW1 and S-GW1 components	
Naphthalene	VOC	ch & sch NC	IRIS 1998	rats	corn oil by oral gavage	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Nickel		ch NC	IRIS 1996	rats	diet	<5%	US EPA (2004, Exhibit 4-1) recommends 4%, based on humans exposed via diet/water. Human studies have found under non-fasting conditions, bioavailability of soluble Ni salts ranged from 2-5% in the presence of food (according to studies cited in Birmingham and McLaughlin, 2006). Other studies report 1% (rats) and 1-3% (dogs) absorption of Ni administered in diet (NEPI 2000a). Absolute absorption in critical study is assumed to be <5%.	**1**	Bioavailability of Ni in soil relative to Ni in water was 34-63% in rats (depending on soil type) (Griffin et al 1990 as reported in NEPI 2000a). Also, data indicate Ni taken in or with food reduces GI absorption (NEPI 2000a). From the studies summarized in NEPI (2000a), it appears that absorption from soil < absorption from water & absorption from diet < absorption from water. However, data is not sufficient to estimate oral absorption from soil relative to oral absorption from diet (as per critical study). Thus 100% RAF is selected.	not required for GW1 and S-GW1 components	
Pentachloro -phenol	SVOC	ch NC	ATSDR 2001	mink	diet	76%	US EPA RAGS (2004) Exhibit 4-1, based on rats exposed via diet.	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2001	mink	diet	76%					
		C	IRIS 1993	mice	diet	76%					
Petroleum Hydrocarbons F1											
Aliphatic C6-C8	VOC	ch NC	TPHCWG 1997	rats, mice	RtR from inhalation studies	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
C>8-C10	VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
Aromatic C>8-C10	VOC	ch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
Petroleum Hydrocarbons F2											
Aliphatic C>10-C12	VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
C>12-C16	SVOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
Aromatic C>10-C12	VOC	ch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
C>12-C16	SVOC	ch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
Petroleum Hydrocarbons F3											
Aliphatic C>16-C21	SVOC	ch NC	TPHCWG 1997	rats	diet	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
C>21-C34	SVOC	ch NC	TPHCWG 1997	rats	diet	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
Aromatic C>16-C21	SVOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
C>21-C34	Non-VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Petroleum Hydrocarbons F4											
Aliphatic C>34	non-VOC	ch NC	TPHCWG 1997	rats	diet	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
Aromatic C>34	non-VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See Petroleum Hydrocarbons at top of table.	**1**	Default. See also Petroleum Hydrocarbons at top of table.	**1**	default
Phenanthrene	SVOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**1**	See B(a)P	not required for GW1 and S-GW1 components	
Phenol	VOC	ch & sch NC	IRIS 2002	rats	oral gavage, likely in water	100%	default for organics USEPA RAGS 2004	**1**	In 3 men given a single oral dose of phenol in food or drink, ~90% (range 85-98%) of the dose was excreted in urine in 14h (ATSDR draft Sept 2006). Phenol generally does not adhere very strongly to soils (ATSDR draft Sept 2006). Default 100% RAF is selected.	**1**	Urine concentrations in rats were >90% of administered dose given in drinking water (ATSDR Sep 2006 draft). Absolute oral absorption in TRV critical study is assumed 100% (USEPA 2004 default for organics) but may be <100%. Thus 100% RAF is selected.
Poly-chlorinated Biphenyls	SVOC	ch NC	ATSDR 2000	monkey	self-ingested capsules with chemical in a glycerol/corn oil mixture	80-96%	US EPA (2004) Exhibit 4-1, based on rats exposed via squalene, emulsion, or corn oil.	**1**	NEPI (2000b) reports absolute oral absorption from soil to be 66-96%, or 40-70% (NEPI 2000b). As this is a similar to the range absolute oral absorption assumed for the critical studies, 100% RAF is assumed.	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2000	monkey	by syringe into back of mouth prior to feeding						
		C	IRIS 1997	rats	diet						
Pyrene	non-VOC	ch & sch NC	IRIS 1993	mice	gavage in corn oil	58-89%	See PAHs at top of table.	**1**	See B(a)P	**1**	default
		C	based on B(a)P	mice	diet						
Selenium		ch NC	IRIS 1991	human	diet	30-80%	US EPA (2004) Exhibit 4-1, based on humans exposed via diet.	**1**	Studies in humans & experimental animals indicate ingested Se compounds are readily absorbed, often >80% (ATSDR 2003). Default 100% RAF is selected.	not required for GW1 and S-GW1 components	
Silver		ch NC	IRIS 1996	human	i.v., but USEPA converted LOAEL to oral intake to derive TRV.	4%	US EPA (IRIS 1996) states that 4% was used to convert i.v. to oral intake, based on 4.4% conservative estimate of retention by a 70 kg human. Thus, absolute oral absorption of 4% is selected.	**1**	default	not required for GW1 and S-GW1 components	
Styrene	VOC	ch NC	RIVM 2001	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
1,1,1,2-Tetrachloro-	VOC	ch NC	IRIS 1996	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	**1**	default

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
ethane		C	IRIS 1991	mice	oral gavage in corn oil						
1,1,2,2-Tetrachloro-ethane	VOC	ch NC	US EPA HESD Sep. 2006 draft	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR Sep. 2006 draft	rats	diet						
		C	IRIS 1994	mice	oral gavage in corn oil						
Tetrachloro-ethylene	VOC	ch & sch NC	HC 1996 & WHO DW 2003	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
Thallium		ch & sch NC	CalEPA DW 1999	rats	drinking water	100%	US EPA RAGS (2004) Exhibit 4-1, based on rats dosed with aqueous Tl.	**1**	Limited human & animal studies suggest Tl compounds are readily absorbed orally (ATSDR 1992). Default 100% RAF is selected.	not required for GW1 and S-GW1 components	
Toluene	VOC	ch & sch NC	IRIS 2005	rats	gavage in corn oil	80-97%	ATSDR 1999 for TPHs states that published absorption rates for oral doses of BTEXs in animal studies range from ~80-97%.	**1**	Binding to soil does not prevent oral absorption (ATSDR 2000). Default 100% RAF is selected.	not required for GW1 and S-GW1 components	
1,2,4-Trichloro-benzene	VOC	ch & sch NC	IRIS 1996	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
1,1,1-Trichloro-ethane	VOC	ch & sch NC	IRIS 2007	mice	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
1,1,2-Trichloro-ethane	VOC	ch & sch NC	IRIS 1995	mice	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	IRIS 1994	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**			
Trichloro-ethylene	VOC	ch NC	HC DWQ 2005	rats	drinking water	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	CalEPA DW 1999	mice	2 studies: oral gavage in corn oil & inhalation	100%	default for organics USEPA RAGS 2004	**1**			
Trichloro-fluoromethane	VOC	ch NC	IRIS 1992	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
2,4,5-Trichloro-phenol	SVOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**1**	Data are insufficient to quantitatively estimate or compare oral absorption from food vs. from water (ATSDR 1999c). Default 100% RAF is selected.	**1**	same dosing medium as critical study
		sch NC	ATSDR 1999	rats	drinking water						

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
2,4,6-Trichloro-phenol	SVOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**1**	Data are insufficient to quantitatively estimate or compare oral absorption from food vs. from water (ATSDR 1999c). Default 100% RAF is selected.	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 1999	rats	drinking water						
		C	IRIS 1994	rats	diet						
Uranium		ch & sch NC	modified from HC DWQ 1999 & CalEPA DW 2001	weanling rats probably ~3 weeks old	uranyl nitrate [UN] hexahydrate in drinking water	0.06-2.8%, but high-end up to 34.5%	CCME (2007) states animal studies show GI absorption ~1%. Wrenn et al (1985; cited in CalEPA DW, 2001) report <0.5% in rats. Absorption of UN in hamsters was 0.77% (Harrison & Stather, 1981). In rats gavaged with UN, 0.6% - 2.8% (La Touche et al, 1987). Tracy et al (1992) reported 0.06% in rats & rabbits administered UN hexahydrate. Frelon et al (2005) reported 0.4% for each of 5 different chemical forms of U in water ingested by rats. Absorption increases in neonatal rats & pigs vs. adults, with fasting, & with increased solubility of the U compound (ATSDR 1999d). Sullivan & Gorham (1982, as cited in CalEPA DW, 2001) report absorption of at least 34.5% in 1-day-old miniature swine given UN. An estimate of oral absorption of U by rats in the critical study is likely 0.06% - 2.8%, up to a high-end estimate of 34.5%. Note the high-end estimate from 1-day-old miniature swine is included because the rats in the critical study were weanlings.	**1**	Frelon et al (2005) looked at gastrointestinal absorption of U in rats and concluded that the initial speciation of U has little, if any, influence on its gastrointestinal absorption when ingested with water; however, they state that elsewhere it has been shown that chemical form of radionuclides when incorporated in solid food influences gastrointestinal absorption considerably. If food and soil affect U absorption similarly, this would indicate that gastrointestinal absorption of U in soil is < U in water. However, no information could be located to enable the development of a RAF. CCME (2007) indicates there may be evidence that absorption of U in soil may be < absorption of U in DW, but state that data were insufficient to define RAF other than 100%. Default 100% RAF is selected.	not required for GW1 and S-GW1 components	
Vanadium		ch & sch NC	CalEPA DW 2000	rats	sodium metavanadate ($NaVO_3$) in solution (probably aqueous) given intragastrically	<1% to 16.8%	US EPA RAGS (2004) Exhibit 4-1 recommends 2.6%, based on rats dosed via gavage. Absorption of V through gastrointestinal tract of animals is low, studies reporting absolute absorption in the range of <1% to 2.6% (ATSDR 1992a) up to 16.8% (Azay et al 2001).	**1**	default	**1**	same dosing medium as critical study
Vinyl Chloride	VOC	ch NC	ATSDR 2006 & IRIS 2000	rats	diet	100%	default for organics USEPA RAGS 2004	**1**	default	not required for GW1 and S-GW1 components	
		C	IRIS 2000	rats	diet						

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF ORAL SOIL RAF (Oral absorption of chemical from soil relative to critical study in TRV)		ESTIMATE OF ORAL WATER RAF (Oral absorption of chemical from drinking water relative to critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study					
				species	dosing regimen	%	notes[b]	**oral RAF_S**	**notes[b]**	**oral RAF_W**	**notes[b]**
Xylenes Mixture	VOC	ch NC	IRIS 2003 & ATSDR 2007	rats	gavage in corn oil	80-97%	ATSDR 1999a for TPHs states that published absorption rates for oral doses of BTEXs in animal studies range from ~80-97%.	**1**	default	not required for GW1 and S-GW1 components	
		sch NC	ATSDR 2007	mice	gavage in corn oil	80-97%					
Zinc		ch NC	IRIS 2005	human	diet + zinc supplements	8-81%	USEPA RAGS Exhibit 4-1 (2004) states that Zn absorption in humans from diet is highly variable & they suggest no value for absolute oral absorption. ATSDR 2005b states that oral absorption of Zn in humans ranges from 8 to 81% (variable but ranges up to a high percentage). Dietary protein facilitates oral Zn absorption (ATSDR 2005b) & dietary phytate reduces oral Zn absorption (ATSDR 2005b).	**1**	default	not required for GW1 and S-GW1 components	

a) ch NC = chronic non-cancer; C = cancer; sch NC = sub-chronic non-cancer.
b) References for RAFs appear following the Table 2.34b.

Table 2.35b: Estimation of Dermal Relative Absorption Factors (RAFs) for Use with Oral TRVs in Brownfield Standards

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
ESTIMATES FOR INORGANICS, PETROLEUM HYDROCARBONS, PAHs, SVOCS, AND VOCs									
Inorganics without sufficient quantitative dermal absorption data.						-	-	For several inorganics, quantitative data are insufficient to determine estimates of absolute dermal absorption. A comparison approach was used, as follows: Data-derived estimates of **absolute** dermal absorption of various inorganics used or recommended by USEPA (2004), CalEPA (2000), NYS (2006), and MADEP (1992) were considered. (Estimates not based on chemical-specific data were not included.) For each inorganic, the midpoint of the range of available agency estimates was selected. The geometric mean of these midpoints was approximately 1%. As such, for inorganics without sufficient quantitative data, an estimate of 1% was selected as the **absolute** dermal absorption. (This does not necessarily mean the RAF was also 1%.)	
Polycyclic Aromatic Hydrocarbons (PAHs)						58-89%	US EPA (2004, Exhibit 4-1) estimates absolute oral absorption of 58-89% for PAHs, based on rats dosed via diet or starch solution. Also, NEPI 2000b reports studies showing that the various PAHs have similar absorption estimates.	**0.13**	US EPA (2004, Exhibit 3-4) recommends absolute dermal absorption of 13% based on Wester et al (1990). Since estimate of absolute absorption in critical study is assumed to be >50% it is assumed to be complete. Thus dermal RAF is 13%.
Petroleum Hydrocarbons (PHCs)						low - 97%	Oral absorption of PHCs ranges from low or variable absorption to very high absorption efficiencies up to 97% (ATSDR 1999a).	**0.2**	Based on the derm absorption efficiencies of several PHCs, CCME 2000 recommends 20% derm absorption for all aromatic & aliphatic PHC fractions. Since oral absorption in critical study is assumed near complete, (near 100%), estimated dermal RAF is 20%.
Semi-Volatile Organic Compounds (SVOCs)						-	-	**0.1**	US EPA (2004, Exhibit 3-4 and pg. 3-18) recommends an absolute dermal absorption of 10% for semi-volatile organic compounds (SVOCs) as a screening method for the majority of SVOCs without dermal absorption fractions. This fraction is suggested because the experimental values in Exhibit 3-4 are considered representative of the chemical class for screening evaluations.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Volatile Organic Compounds (VOCs)						-	-	**0.03**	USEPA (2004; section 3.2.2.4) explains no default values are presented for VOCs because they would tend to be volatilized from the soil on skin and should be accounted for via inhalation routes instead. USEPA Region III (1995) recommends a default of 0.05% for VOCs such as benzene, based on studies, and a default of 3% is recommended for VOCs with vapour pressures less than that of benzene. NEPI (2000b) discusses that due to rapid vaporization, liquid phase VOCs applied directly to human skin show only slight absorption, and that in a real dermal exposure scenario, the VOC bioavailability is expected to be minimal due to low adsorbed phase concentrations and slow release of the desorption resistant fraction. Selection: A default of 3% absolute dermal absorption from soil was used for all VOCs based on the analysis of USEPA Region III (1995). The low percentage default for VOCs takes into consideration that dermal absorption of VOCs in soil competes with high rates of volatilization from soil to air.
INDIVIDUAL CHEMICALS									
Acenaphthene	SVOC	ch NC	IRIS 1994	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
		sch NC	ATSDR 1995						
		C	based on B(a)P	mice	diet				
Acenaphthylene	SVOC	ch NC	IRIS 1994 (proxy)	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
		sch NC	ATSDR 1995 (proxy)						
		C	based on B(a)P	mice	diet				
Acetone	VOC	ch & sch NC	IRIS 2003	rats	drinking water	100%	default for organics USEPA RAGS (2004)	**0.03**	The low K_{OC} and moderate Henry's Law constant suggest that bioavailability of acetone from contaminated water & soil as a result of skin contact may be significant (ATSDR 1994). Default of 3% for VOCs is selected.
Aldrin	SVOC	ch NC	IRIS 1988	rats	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default absolute dermal absorption of 10% for SVOCs is selected.
		sch NC	US EPA PPRTV 2005	dogs	diet				
Anthracene	SVOC	ch & sch NC	IRIS 1993	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Antimony		ch NC	IRIS 1991	rats	Sb tartrate in water	15%	US EPA RAGS (2004) Exhibit 4-1, based on rats dosed via water.	**0.1**	1% was selected as the absolute dermal absorption. (See inorganics at top of table.) The default absolute dermal absorption of 1% is approximately an order of magnitude lower than the estimated absolute oral absorption. Rather than implying a false level of precision, an order-of-magnitude approach was used to select a dermal RAF of 10%.
Arsenic		ch NC	IRIS 1993	humans	drinking water	95%	US EPA (2004) Exhibit 4-1, based on humans assumed exposed via water.	**0.03**	US EPA RAGS (2004, Exhibit 3-4) suggests an absolute dermal absorption of 3% for As based on Wester et al (1993a).
		C	CalEPA ATH 2005						
Barium		ch NC	IRIS 2005	mice	drinking water	7%	US EPA RAGS (2004) Exhibit 4-1, based on dogs exposed to $BaCl_2$ in water.	**0.1**	1% was selected as the absolute dermal absorption. (See inorganics at top of table.) The default absolute dermal absorption of 1% is approximately an order of magnitude lower than the estimated absolute oral absorption. Rather than implying a false level of precision, an order-of-magnitude approach was used to select a dermal RAF of 10%.
Benzene	VOC	ch NC	IRIS 2003	humans	RtR from inhalation	80-97%	ATSDR 1999a for TPHs states that published absorption rates for oral doses of BTEXs in animal studies range from ~80-97%.	**0.03**	Derm absorption is <1% with unoccluded application of liquid benzene in animal studies in vivo; data indicate that soil adsorption decreases dermal bioavavailability (ATSDR 2007b). Default of 3% for VOCs is selected.
		C	HC DW (Sep 2007 draft)	rats & mice	corn oil by oral gavage	80-97%			
Benz[a]anthracene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
Benzo[a]pyrene	non-VOC	C	IRIS 1992	mice	diet	58-89%		**0.13**	
Benzo[b]fluoranthene	non-VOC	C	based on B(a)P	mice	diet	58-89%		**0.13**	
Benzo[ghi]perylene	non-VOC	C	based on B(a)P	mice	diet	58-89%		**0.13**	
Benzo[k]fluoranthene	non-VOC	C	based on B(a)P	mice	diet	58-89%		**0.13**	
Beryllium		ch NC	IRIS 1998	dogs	diet	<1%	GI absorption is probably <1% (Deubner et al 2001). USEPA RAGS 2004 Exhibit 4-1 suggests 0.7% for rats exposed via water.	**0.1**	It's unlikely that Be is absorbed through intact skin (ATSDR 2002a). For inorganics, such as Be, without sufficient quantitative data, absolute dermal absorption is assumed to be 1%. Given the very low oral absorption assumed for the critical study in the TRV for Be (<1%), the dermal RAF would be calculated as >100%. However, it is unlikely that dermal absorption of Be would equal or exceed oral absorption, even though both estimates of both types of absorption are low. Thus the order-of-magnitude approach (described below) was applied to determine a dermal RAF of 10% for Be.
Biphenyl 11'-	SVOC	ch NC	WHO CICAD 1999	rats	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
Bis(2-chloroethyl)ether	VOC	C	CalEPA ATH 2005	mice	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Bis (2-chloroisopropyl) ether	VOC	ch NC	IRIS 1990	mice	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Bis (2-ethylhexyl) phthalate	non-VOC	ch NC	ATSDR 2002	rats	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
		sch NC	ATSDR 2002	mice	diet				
Boron		ch NC	IRIS 2004	rats	diet (as boric acid)	90%	ATSDR (draft Sep 2007a) indicates oral absorption of boric acid in humans to be >90%, while oral absorption of B in animals to be 81-92%.	**0.01**	Human urinary excretion studies suggest very little absorption of B through intact skin (ATSDR draft Sep 2007a). WHO EHC (1998) states that derm absorption across intact skin is negligible in all species evaluated, that only traces of boric acid penetrated skin in infants treated with talcum powder containing boric acid, & that absorption has been demonstrated with boric acid applied to broken or damaged skin. Hostynek et al (1993) state absorption through intact skin from dilute aqueous solutions is very slight. 1% was selected as the absolute dermal absorption. (See inorganics at top of table.) A RAF of 1% is estimated using an order-of-magnitude approach.
Bromodichloromethane	VOC	ch NC	IRIS 1991	rats	corn oil by oral gavage	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	IRIS 1993	mice	corn oil by oral gavage				
Bromoform	VOC	ch NC	IRIS 1991	rats	oral gavage, vehicle not reported	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	US EPA PPRTV 2005	rats	oral gavage in corn oil				
		C	IRIS 1991						
Bromomethane	VOC	ch & sch NC	ATSDR 1992	rats	oral gavage, by solution in arachis oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Cadmium		non-C	mod from CalEPA DW 2006	humans	several human studies; urinary Cd concentrations were associated with oral intake	10%	The derivation by CalEPA DW draft 2006 is based on an absorbed fraction in women of 10%.	**0.01**	US EPA (2004, Exhibit 3-4) suggests 0.1% absolute dermal absorption for Cd. The RAF calculation is as follows: 0.1% (dermal absolute) ÷ 10% (oral absolute) = 1%. Thus a dermal RAF of 1% is selected.
Carbon Tetrachloride	VOC	ch NC	IRIS 1991	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	ATSDR 2005	rats	oral gavage in corn oil				
Chlordane	SVOC	ch NC	CalEPA chRD 2005	rats	pre- & post-natal dosing in peanut oil and peanut butter	100%	US EPA RAGS (2004) Exhibit 4-1 suggests 80% based on assumed aqueous gavage in rats. Because fats and oils enhance GI absorption of organochlorines, absorption could be higher.	**0.04**	US EPA RAGS (2004) Exhibit 3-4 suggests 4% for chlordane. Since oral absorption in critical study is assumed to be very high, dermal absorption is not adjusted for relative absorption.
		sch NC	ATSDR 1994	rats	diet				
		C	CalEPA DW 1997	mice	diet				
Chloroaniline p-	SVOC	ch NC	WHO CICAD 2003	rats	gavage in water	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
Chlorobenzene	VOC	ch & sch NC	CalEPA DW 2003	dogs	orally, by gelatin capsule	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Chloroform	VOC	ch NC	IRIS 2001	dogs	orally in a toothpaste base in gelatin capsules	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	ATSDR 1997						
		C	CalEPA ARB 1990	rats & mice	various				
Chlorophenol 2-	VOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**0.03**	In vivo & in vitro data indicate chlorophenols are readily absorbed via dermal exposure (ATSDR 1999c). Default of 3% for VOCs is selected.
		sch NC	ATSDR 1999	rats	drinking water				
Chromium Total		ch NC	IRIS 1998	rats	Cr_2O_3 in bread	1.3%	US EPA (2004) Exhibit 4-1, based on oral absorption of Cr III in rats from diet/water.	**0.1**	See Cr VI.
Chromium VI		ch NC	mod from IRIS 1998	rats	drinking water	2.5%	US EPA RAGS (2004) Exhibit 4-1 suggests 2.5% based on absorption of Cr VI in rats via water. [NEPI 2000a & ATSDR 2000a report absorption of Cr VI to be up to 10%.]	**0.1**	Cr III & VI can penetrate human skin to some extent (ATSDR 2000a). NEPI (2000a) discusses an in vivo guinea pig study reporting <1%, and an extraction study on chromite ore with human sweat reporting 0.1% for Cr VI and 0.3% for total Cr. Estimates for absolute dermal absorption are selected as 0.1% to <1%. Oral absorption in the critical study is estimated at 2.5%. In consideration of the estimates for absolute dermal absorption and absolute oral absorption, a RAF of 10% is estimated using an order-of-magnitude approach.
Chrysene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
Cobalt		ch & sch NC	ATSDR 2004	humans	$CoCl_2$ as 2% solution in either water or milk	18-97%	GI absorption of Co in humans varies considerably: 18-97% (ATSDR 2004a).	**0.01**	Data on dermal absorption are not available, but since sensitive humans demonstrate allergic reactions after derm application, dermal absorption appears to occur (RIVM 2001). Studies in humans demonstrate Co from metal dusts can be absorbed through skin (ASTDR 2004a). In in vivo studies with guinea pigs (Inaba & Suzuki-Yasumoto, 1979, as per ATSDR 2004a), absorption through intact skin was <1%. 1% was selected as the absolute dermal absorption. (See inorganics at top of table.) A RAF of 1% was estimated using an order-of-magnitude approach.
Copper		ch NC	HC DWQ 1992	humans	TRV based on dietary copper requirements	24-60%, 97%	Average absorption efficiencies ranged from 24% to 60% in presumably healthy adults (ATSDR 2004b). Early estimates of Cu absorption in humans ranged from 15-97% (Shils et al. 2006).	**0.06**	Animal studies demonstrate Cu can pass through dermal barriers (ATSDR 2004b). Wearing Cu bracelets reportedly results in loss of ~0.6% of their original weight over 50 days (Hostynek et al 1993). In vitro studies suggest Cu is poorly absorbed through intact skin, <6% of Cu deposited on ex vivo human skin samples was absorbed (ATSDR 2004b). 6% is selected as absolute absorption.
Cyanide (CN-)		ch NC	CalEPA DW 1997	rats	diet	>47 %	US EPA RAGS (2004, Exhibit 4-1) suggests >47% for cyanide in water for rats. ATSDR 2006 reports absorption of cyanide to be up to 72%.	**0.1**	Available evidence suggests dermal absorption does occur & may be quite extensive in some situations (ATSDR 2006), thus the default of 1% dermal absorption for inorganics is not appropriate. Accordingly, an order-of-magnitude approach (described below) is used to estimate a RAF of 10%.
		sch NC	ATSDR 2006	rats	drinking water				
Dibenz[a h]anthracene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Dibromochloromethane	VOC	ch NC	IRIS 1991	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	mod from IRIS 1991	rats	oral gavage in corn oil				
		C	IRIS 1992	mice	oral gavage in corn oil				
Dichlorobenzene 1 2-	VOC	ch NC	ATSDR 2006	mice	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	ATSDR 2006	rats	oral gavage in corn oil				
Dichlorobenzene 1 3-	VOC	ch & sch NC	ATSDR 2006 (proxy)	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Dichlorobenzene 1 4-	VOC	ch NC	IRIS May 2006 draft	dogs	99.9% pure chemical in gelatin capsules	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	ATSDR 2006	dogs	99.9% pure chemical in gelatin capsules				
		C	IRIS May 2006 draft	mice	>99% pure chemical in corn oil by gavage				
Dichlorobenzidine 3 3'-	non-VOC	C	CalEPA ATH 2005	rats	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Extent of absorption of 3,3'-DCB applied to shaved skin of rats at 1h, 8h, & 24h following application was 6%, 23%, & 49%, respectively (Shah & Guthrie 1983, as per ATSDR 1998). Using porcine skin flaps (in vitro), maximum absorption was ~3% over 8h, but maximum penetration was 22% over 8h, which suggests a potential for greater systemic exposure over longer time frames (Baynes et al 1996). In consideration of the range of absolute dermal absorption from 3 - 49%, an order-of-magnitude estimate of 10% was selected.
Dichlorodifluoromethane	VOC	ch NC	IRIS 1995	rats	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
DDD	SVOC	ch NC	RIVM 2001	rats	diet	70-90%	US EPA RAGS (2004) Exhibit 4-1, based on rats dosed DDT in vegetable oil.	**0.03**	US EPA RAGS (2004) Exhibit 3-4
		C	IRIS 1988	mice	diet	70-90%			
DDE	SVOC	ch NC	RIVM 2001	rats	diet	70-90%		**0.03**	US EPA RAGS (2004) Exhibit 3-4
		C	IRIS 1988	mice & hamsters	diet	70-90%			
DDT	SVOC	ch NC	RIVM 2001	rats	diet	70-90%		**0.03**	US EPA RAGS (2004) Exhibit 3-4
		C	IRIS 1991	mice & rats	diet	70-90%			
Dichloroethane 1 1-	VOC	ch & sch NC	CalEPA DW 2003	cats	inhalation, RtR to oral assuming 50% pulmonary retention & cat inhalation rate & body weight	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Dichloroethane 1 2-	VOC	ch & sch NC	ATSDR 2001	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	IRIS 1991	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004		
Dichloroethylene 1 1-	VOC	ch NC	IRIS 2002	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Dichloroethylene 1 2-cis-	VOC	ch & sch NC	mod from RIVM 2001 ; ATSDR 1996	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Dichloroethylene 1 2-trans-	VOC	ch & sch NC	IRIS 1989; ATSDR 1996	mice	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Dichlorophenol 2 4-	VOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**0.03**	In vivo & in vitro data indicate chlorophenols are readily absorbed via derm exp (ATSDR 1999c). Default of 3% for VOCs is selected.
		sch NC	ATSDR 1999	rats	drinking water				
Dichloropropane 1 2-	VOC	ch NC	ATSDR 1989	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	CalEPA DW 1999	mice	gavage in corn oil				
Dichloropropene 1 3-	VOC	ch & sch NC	IRIS 2000 & ATSDR Sep 2006 draft	rats	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	CalEPA DW 1999	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004		
Dieldrin	SVOC	ch NC	IRIS 1990 & ATSDR 2002	rats	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
		sch NC	ATSDR 2002	monkeys	dissolved in ethanol & injected into marshmallows	100%	default for organics USEPA RAGS 2004		
Diethyl Phthalate	SVOC	ch NC	WHO CICAD 2003	mice	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
		sch NC	mod from IRIS 1993	rats	diet				
Dimethylphthalate	SVOC	ch NC	WHO CICAD 2003 (proxy)	mice	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
Dimethylphenol 2 4-	VOC	ch & sch NC	IRIS 1990	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Dinitrophenol, 2,4-	SVOC	ch & sch NC	IRIS 1991	humans	ingested as drug, assume with food	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
Dinitrotoluene 2,4- and 2,6-	SVOC	ch NC	IRIS 1993	dogs	fed 98% pure 2,4-DNT in gelatin capsules	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
		sch NC	ATSDR 1998	dogs	fed DNT in gelatin capsules				
		C	IRIS 1990	rats	diet				

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		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
1,4-Dioxane	VOC	ch NC	ATSDR 2006	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	ATSDR (draft Sep 2007b) mentions *in vitro* studies with excised human skin: absolute absorption 0.3% (unoccluded) vs. 3.2% (occluded); & *in vivo* studies w/ Rhesus monkey with 1,4-dioxane dissolved in either methanol or skin lotion resulting in absolute absorption <4%. Default of 3% for VOCs is selected.
		sch NC	ATSDR 2006	rats	drinking water				
		C	IRIS 1990	rats	drinking water				
Dioxin/Furan (TEQ)	non-VOC	ch NC	WHO JECFA 2002	rats	two studies: one oral, one by sub-q injection	50-83%	US EPA RAGS (2004) Exhibit 4-1, based on multiple studies.	**0.03**	US EPA RAGS (2004) Exhibit 3-4
		sch NC	ATSDR 1998	guinea pigs	diet				
Endosulfan	SVOC	ch NC	ATSDR 2000	dogs	diet	100%	default for organics USEPA RAGS 2004	**0.1**	There is human evidence of dermal absorption in cases of acute poisonings among subjects spraying cotton & rice fields; in animals ~20% of a dermal dose may be absorbed, but the role of the administration vehicle has not been studied (ATSDR 2000c). Systemic absorption after dermal administration to monkeys in aqueous solution was 22%, but as only 50% of administered dose was recovered, it may not be accurate (JMPR 1998). Default of 10% for SVOCs is selected.
		sch NC	ATSDR 2000	rats	diet				
Endrin	SVOC	ch NC	CalEPA DW 1999	dogs	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
		sch NC	ATSDR 1996	dogs	diet				
Ethylbenzene	VOC	ch NC	IRIS 1991	rats	gavage in olive oil	80-97%	ATSDR 1999a for TPHs states that published absorption rates for oral BTEXs in animal studies range ~80-97%.	**0.03**	Dermal absorption has been measured to be approximately 3.4% of applied dose in 4 hours (Susten et al. 1990). Default of 3% for VOCs is selected.
Ethylene dibromide	VOC	ch NC	IRIS 2004	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	mod from CalEPA DW 2003	rats	inhalation, RtR to oral assuming rat body wt & inhalation rate	100%	default for organics USEPA RAGS 2004		
		C	CalEPA DW 2003	rats & mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004		
Fluoranthene	non-VOC	ch & sch NC	IRIS 1993	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
		C	based on B(a)P	mice	diet				
Fluorene	SVOC	ch & sch NC	IRIS 1990	mice	oral gavage. vehicle not reported, (assume oil or food since low water-solubility)	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
Heptachlor	SVOC	ch NC	CalEPA chRD 2005	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
		C	CalEPA DW 1999	mice	diet				

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Heptachlor Epoxide	SVOC	C	CalEPA DW 1999	mice	diet	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
Hexachlorobenzene	SVOC	ch NC & sch NC	ATSDR 2002	monkeys	in glucose in gelatin capsules	100%	default for organics USEPA RAGS 2004	**0.1**	Default of 10% for SVOCs is selected.
		C	CalEPA DW 2003	rats	diet				
Hexachlorobutadiene	VOC	ch NC	HC PSL2 2000	mice	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	IRIS 1991	rats	diet				
Hexachlorocyclohexane Gamma-	SVOC	ch NC	CalEPA DW 1999	mice	diet	99.4 %	95.8% absorption of technical grade HCH in rats, in another study with gamma-HCH in feed was 99.4% (ATSDR 2005a).	**0.04**	USEPA (2004) Exhibit 3-4 recommends 4% absolute dermal absorption for lindane. As per USEPA (2004) guidance, dermal absorption was not adjusted in calculation of dermal RAF because oral absorption in critical study was near complete.
Hexachloroethane	VOC	ch NC	IRIS 1991	rats	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	ATSDR 1997	rats	diet				
		C	IRIS 1994	mice	gavage in corn oil				
Hexane (n)	VOC	none selected							
Indeno[1 2 3-cd]pyrene	non-VOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**0.13**	US EPA RAGS (2004) Exhibit 3-4
Lead		none selected							
Mercury		ch & sch NC	IRIS 1995	rats	3 studies with $HgCl_2$: subcutaneous injection, forcible feeding (vehicle not reported), and gavage in water	7%	US EPA (2004) Exhibit 4-1 suggests 7% for $HgCl_2$ and other soluble salts based on rats dosed via water. ATSDR (1999b) states that in earlier studies absorption rate of $HgCl_2$ was reported as low, but more recent studies report absorption in 10-40% range (eg. 30-40% for male rats in DW for 8 weeks; in standard diet 1% for adult mice vs. 38% for suckling mice).	**0.1**	20-65% absorption of $HgCl_2$ among volunteers (Baranowska-Dutkiewicz 1982; cited in CalEPA 2000 & MADEP 1992) is similar to the range of oral absorption of $HgCl_2$ in water, which would support a RAF of 100%. However, NEPI (2000a) cites several *in vitro* studies measuring dissolution of Hg from soil finding average bioaccessibility <10%. Landa (1978; cited in MADEP 1992) states 10% of Hg in soil could be extracted & available for dermal absorption. A RAF of 10% is thus selected. [CalEPA 2000 considered volunteer studies with $HgCl_2$ solutions (20-65% dermal absorption) & in vitro studies (6-10%) & concluded a 1% default is too low & thus adopted a RAF of 10% using an order-of-magnitude approach.]
Methoxychlor	SVOC	ch NC	CalEPA chRD 2005	mice	fed chemical in corn oil	100%	default for organics USEPA RAGS 2004	**0.1**	Studies in goats & cows suggest derm absorption may range from 5-20% (ATSDR 2002b), but because of differences in skin, derm absorption by goats & cows may not be good models for humans; methoxychlor is strongly adsorbed to soil surfaces & this may ultimately limit its bioavailability from soils. Because of the uncertainties in using cows & goats as models, & because of high adsorption to soil which may limit bioavailability, the default of 10% for SVOCs is selected.
Methyl Ethyl Ketone	VOC	ch NC	IRIS 2003	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Methyl Isobutyl Ketone	VOC	ch NC	mod from IRIS 2003	rats & mice	RtR from inhalation studies	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Methyl Mercury		ch NC	IRIS 2001	humans	epidemiological studies - dietary intake	95%	US EPA RAGS (2004) Exhibit 4-1, based on humans exposed via water.	**0.06**	Dermal bioavailability of MeHg ranged 2.25 - 5.9% in guinea pigs (studies cited in Hrudey *et al.* 1996). Assume that the absolute dermal bioavailability of MeHg applied to GPs in water (~6%) is similar to absolute dermal bioavailability of MeHg in soil for humans.
Methyl tert-Butyl Ether (MTBE)	VOC	ch & sch NC	mod from HC 1996	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	CalEPA DW 1999	rats	3 data sets: 2 olive oil gavage & 1 inhalation	100%	default for organics USEPA RAGS 2004		
Methylene Chloride	VOC	ch NC	IRIS 1988	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	IRIS 1995	mice	2 studies: drinking water & inhalation	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
2-(1-) Methylnaphthalene	VOC	ch NC	IRIS 2003	mice	diet	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
Molybdenum		ch NC	IRIS 1993	humans	diet	up to 93%	Vyskocil & Viau (1999) state that lit shows oral absorption of Mo in humans in range of 28-77%. Turnlund et al. (1995;1999) report oral absorption in humans from diet in range of 57% to 93%.	**0.01**	1% was selected as the absolute dermal absorption. (See inorganics at top of table.)
Naphthalene	VOC	ch & sch NC	IRIS 1998	rats	corn oil by oral gavage	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
Nickel		ch NC	IRIS 1996	rats	diet	<5%	US EPA (2004, Exhibit 4-1) recommends 4%, based on humans exposed via diet/water. Human studies have found that under non-fasting conditions, bioavailability of soluble Ni salts ranged from 2-5% in the presence of food (according to studies cited in Birmingham and McLaughlin, 2006). Other studies report 1% (rats) and 1-3% (dogs) absorption of Ni administered in diet (NEPI 2000a). Absolute absorption in the critical study is assumed to be <5%.	**0.2**	Lloyd (1980, in Hostynek et al 2002) reports 0.51% of NiCl2 reached urine of guinea pigs. NYS Brownfield Cleanup Program (Sep 2006) selected 1% based on in vivo & in vitro studies of Hostynek et al (2001) & Tanojo et al (2001). Using excised human skin, Fullerton et al (1986) applied NiCl2 & reported 3.5% for occluded skin while Fullerton et al (1992) applied NiSO4 & reported 3-5% for occluded skin, forming the basis for CalEPA (2000) selection of 4%. Fullerton et al (1986) also reported 0.23% for unoccluded skin, which MOE (2002, for Port Colborne) used to develop 0.038%. [Also, Turkall et al (2003) found in vitro dermal penetration of Ni & As increase when applied with mixtures of organic substances.] Absolute absorption of Ni from skin is selected as ≤1%. As the absolute absorption of Ni from diet is assumed to be <5% (as per critical study), RAF can be calculated as follows: 1% ÷ 5% = 20%.
Pentachlorophenol	SVOC	ch NC	ATSDR 2001	minks	diet	76%	US EPA RAGS (2004) Exhibit 4-1, based on rats exposed via diet.	**0.25**	In vivo & in vitro studies indicate that chlorophenols are readily absorbed via dermal exposure (ATSDR 1999c). US EPA RAGS (2004) Exhibit 3-4 recommends 25% for pentachlorophenol [from dermal absorption of 25% in monkeys in vivo from soil]. Since oral absorption in critical study is assumed to be near complete, dermal absorption is not adjusted in determination of a dermal RAF.
		sch NC	ATSDR 2001	minks	diet	76%			
		C	IRIS 1993	mice	diet	76%			
Petroleum Hydrocarbons F1									
Aliphatic C6-C8	VOC	ch NC	TPHCWG 1997	rats & mice	RtR from inhalation studies	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
C>8-C10	VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Aromatic C>8-C10	VOC	ch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Petroleum Hydrocarbons F2									
Aliphatic C>10-C12	VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
C>12-C16	SVOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Aromatic C>10-C12	VOC	ch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
C>12-C16	SVOC	ch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Petroleum Hydrocarbons F3									
Aliphatic C>16-C21	SVOC	ch NC	TPHCWG 1997	rats	diet	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
C>21-C34	SVOC	ch NC	TPHCWG 1997	rats	diet	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Aromatic C>16-C21	SVOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
C>21-C34	Non-VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Petroleum Hydrocarbons F4									
Aliphatic C>34	non-VOC	ch NC	TPHCWG 1997	rats	diet	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Aromatic C>34	non-VOC	ch & sch NC	TPHCWG 1997	rats	orally, regimen not reported	low - 97%	See PHCs at top of table.	**0.2**	See PHCs at top of table.
Phenanthrene	SVOC	C	based on B(a)P	mice	diet	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
Phenol	VOC	ch & sch NC	IRIS 2002	rats	oral gavage, likely in water	100%	default for organics USEPA RAGS 2004	**0.13**	Approximately 13% of the dose of phenol applied directly to the forearm of volunteers was dermally absorbed in 30 min (ATSDR draft Sep 2006). Phenol generally does not adhere very strongly to soils (ATSDR draft Sep 2006). Select 13% as absolute dermal absorption.
Polychlorinated Biphenyls	SVOC	ch NC	ATSDR 2000	monkey	self-ingested capsules with chemical in a glycerol/corn oil mixture	80-96%	US EPA RAGS (2004) Exhibit 4-1, based on rats exposed via squalene, emulsion, or corn oil.	**0.14**	US EPA RAGS (2004) Exhibit 3-4
		sch NC	ATSDR 2000	monkey	by syringe into back of mouth prior to feeding				
		C	IRIS 1997	rats	diet				
Pyrene	non-VOC	ch & sch NC	IRIS 1993	mice	gavage in corn oil	58-89%	See PAHs at top of table.	**0.13**	See PAHs at top of table.
		C	based on B(a)P	mice	diet				

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Selenium		ch NC	IRIS 1991	humans	diet	30-80%	US EPA RAGS (2004) Exhibit 4-1, based on humans exposed via diet.	**0.01**	A mouse study indicates Se can be absorbed dermally (ATSDR 2003). Appropriate data to estimate dermal absorption were not located. 1% was selected as the absolute dermal absorption. (See inorganics at top of table.) A RAF of 1% is estimated using an order-of-magnitude approach.
Silver		ch NC	IRIS 1996	humans	i.v., but USEPA converted LOAEL to oral intake to derive TRV.	4%	US EPA (IRIS 1996) states that 4% was used to convert i.v. to oral intake, based on 4.4% conservative estimate of retention by a 70 kg human. Thus, absolute oral absorption of 4% is selected.	**0.25**	Snyder et al. (1985, in MADEP 1992) report <1% of dermally-applied Ag compounds are absorbed through intact skin of humans. Wahlberg (1965, in MADEP 1992) reports that guinea pigs dermally absorbed 1% of the applied dose. The absolute dermal absorption of 1% is selected based on these data and is supported by the default for inorganics with insufficient data. The dermal RAF is derived as follows 1% / 4% = 25%.
Styrene	VOC	ch NC	RIVM 2001	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Limited data indicate dermal absorption of styrene is probably low compared to absorption via other routes (ATSDR draft Sep 2007c). Percutaneous absorption of styrene vapor is ~ 0.1 to 2% of amount absorbed from the respiratory tract (ATSDR draft Sep 2007c). Default of 3% for VOCs is selected.
1,1,1,2-Tetrachloroethane	VOC	ch NC	IRIS 1996	rats	oral gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	IRIS 1991	mice	oral gavage in corn oil				
1,1,2,2-Tetrachloroethane	VOC	ch NC	US EPA HESD Sep 2006 draft	rats	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		sch NC	ATSDR Sep 2006 draft	rats	diet				
		C	IRIS 1994	mice	oral gavage in corn oil				
Tetrachloroethylene	VOC	ch & sch NC	HC 1996 & WHO DW 2003	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Thallium		ch & sch NC	CalEPA DW 1999	rats	drinking water	100%	US EPA RAGS (2004) Exhibit 4-1, based on rats dosed with aqueous Tl.	**0.01**	Tl is reported to be dermally absorbed (Hostynek et al 1993). Appropriate data to estimate dermal absorption were not located. 1% was selected as the absolute dermal absorption. (See inorganics at top of table.) A RAF of 1% is estimated using an order-of-magnitude approach.
Toluene	VOC	ch & sch NC	IRIS 2005	rats	gavage in corn oil	80-97%	ATSDR 1999 for TPHs states that published absorption rates for oral doses of BTEXs in animal studies range from ~80-97%.	**0.03**	Dermal absorption has been measured to be ~2% of applied dose in 4 hours (Susten et al. 1990). Default of 3% for VOCs is selected.
Trichlorobenzene 1 2 4-	VOC	ch & sch NC	IRIS 1996	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Trichloroethane 1 1 1-	VOC	ch & sch NC	IRIS 2007	mice	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Trichloroethane 1 1 2-	VOC	ch & sch NC	IRIS 1995	mice	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	IRIS 1994	mice	gavage in corn oil	100%	default for organics USEPA RAGS 2004		

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Trichloroethylene	VOC	ch NC	HC DWQ 2005	rats	drinking water	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	CalEPA DW 1999	mice	2 studies: oral gavage in corn oil & inhalation	100%	default for organics USEPA RAGS 2004		
Trichlorofluoromethane	VOC	ch NC	IRIS 1992	rats	gavage in corn oil	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
Trichlorophenol 2 4 5-	SVOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**0.1**	In vivo & in vitro data indicate chlorophenols are readily absorbed via dermal exposure (ATSDR 1999c). Default of 10% for SVOCs is selected.
		sch NC	ATSDR 1999	rats	drinking water				
Trichlorophenol 2 4 6-	SVOC	ch NC	RIVM 2001	rats	not reported but likely same study ATSDR 1999 used	100%	default for organics USEPA RAGS 2004	**0.1**	In vivo & in vitro data indicate chlorophenols are readily absorbed via derm exp (ATSDR 1999c). Default of 10% for SVOCs is selected.
		sch NC	ATSDR 1999	rats	drinking water				
		C	IRIS 1994	rats	diet				
Uranium		ch & sch NC	mod from HC DWQ 1999 & CalEPA DW 2001	weanling rats (likely ~3 weeks old)	uranyl nitrate [UN] hexahydrate in drinking water	0.06-2.8%, but high-end up to 34.5 %	CCME (2007) states animal studies show GI absorption ~1%. Wrenn et al (1985; cited in CalEPA DW, 2001) report <0.5% in rats. Absorption of UN in hamsters was 0.77% (Harrison & Stather, 1981). In rats gavaged with UN, 0.6% - 2.8% (La Touche et al, 1987). Tracy et al (1992) reported 0.06% in rats & rabbits administered UN hexahydrate. Frelon et al (2005) reported 0.4% for each of 5 different chemical forms of U in water ingested by rats. Absorption increases in neonatal rats & pigs vs. adults, with fasting, & with increased solubility of the U compound (ATSDR 1999d). Sullivan & Gorham (1982, as cited in CalEPA DW, 2001) report absorption of at least 34.5% in 1-day-old miniature swine given UN. An estimate of oral absorption of U by rats in the critical study is likely 0.06% - 2.8%, up to a high-end estimate of 34.5%. Note the high-end estimate from 1-day-old miniature swine is included because the rats in the critical study were weanlings.	**0.1**	Estimates of dermal absorption of U from soil for humans were not located. In vivo rat studies by de Rey et al (1983) showed more soluble U forms are more easily absorbed dermally. In vivo rat studies by Petitot et al (2007) showed that UN as powder or in solution can diffuse through intact skin, & reported 0.4%. Tymen et al (2000) reported 1.3% in rats in vivo, 2.3% in rat skin in vitro, & 0.17% in human skin in vitro. Petitot et al (2004) reported 2.3% absorption in rat skin in vitro & ~40% with pig skin in vitro. Petitot et al (2004) also showed some U applied to skin binds rapidly to viable epidermis, which then behaves as a reservoir for U, & continues to diffuse from there into the systemic circulation. Estimates for absolute dermal absorption from the in vivo studies cited here were 0.4% & 1.3%. This range is generally an order of magnitude lower than the range of estimates for absolute oral absorption in the critical study: 0.06-2.8%, up to 34.5%. Thus, a RAF of 10% is estimated using an order-of-magnitude approach.
Vanadium		ch & sch NC	CalEPA DW 2000	rats	sodium metavanadate ($NaVO_3$) in solution (probably aqueous) given intragastrically	<1% to 16.8 %	US EPA RAGS (2004) Exhibit 4-1 recommends 2.6%, based on rats dosed via gavage. Absorption of V through gastrointestinal tract of animals is low, studies reporting absolute absorption in the range of <1% to 2.6% (ATSDR 1992a) up to 16.8% (Azay et al 2001).	**0.1**	Dermal absorption is generally considered to be very low (ATSDR 1992a). Absorption of sodium metavanadate through rabbit skin has been noted (Hostynek et al 1993). 1% was selected as the absolute dermal absorption. (See inorganics at top of table.) As absolute oral absorption in the critical study is estimated to be <1% to 16.8%, a 10% RAF is estimated using an order-of-magnitude approach.

SUBSTANCE	VOC, SVOC, or non-VOC	ESTIMATE OF ABSOLUTE ORAL ABSORPTION FOR ANIMAL SPECIES USED IN CRITICAL STUDY OF TRV USED FOR BROWNFIELDS STANDARD						ESTIMATE OF DERMAL SOIL RAF (Dermal absorption of chemical from soil relative to oral absorption in critical study in TRV)	
		type of oral TRV[a]	agency & year	critical study (basis of TRV)		estimate of absolute oral absorption in critical study			
				species	dosing regimen	%	notes[b]	**dermal RAF_S**	notes[b]
Vinyl Chloride	VOC	ch NC	ATSDR 2006 & IRIS 2000	rats	diet	100%	default for organics USEPA RAGS 2004	**0.03**	Default of 3% for VOCs is selected.
		C	IRIS 2000	rats	diet				
Xylene Mixture	VOC	ch NC	IRIS 2003 & ATSDR 2007	rats	gavage in corn oil	80-97%	ATSDR 1999a for TPHs states that published absorption rates for oral doses of BTEXs in animal studies range from ~80-97%.	**0.03**	m-Xylene adsorbed on sandy soil or clay soils showed lower peak absorption than for m-xylene alone, & clay soil significantly prolonged absorption half-life, but the total amount absorbed was unchanged (ATSDR 2007c). Default of 3% for VOCs is selected.
		sch NC	ATSDR 2007	mice	gavage in corn oil	80-97%			
Zinc		ch NC	IRIS 2005	humans	diet + zinc supplements	8-81%	USEPA RAGS Exhibit 4-1 (2004) states that Zn absorption in humans from diet is highly variable & they suggest no value for absolute oral absorption. ATSDR 2005b states that oral absorption of Zn in humans ranges from 8 to 81% (variable but ranges up to a high percentage). Dietary protein facilitates oral Zn absorption (ATSDR 2005b) & dietary phytate reduces oral Zn absorption (ATSDR 2005b).	**0.1**	Dermal absorption of Zn is considered as a method of Zn supplementation when oral feeding is not possible, and dermal absorption has been shown to occur in animals (Keen & Hurley 1977). 1% was selected as the absolute dermal absorption. (See inorganics at top of table.) However, dermal absorption of zinc is shown to occur, and since oral absorption of zinc can be low, an order-of-magnitude approach has been applied to select a dermal RAF of 10%. (This implies that dermal absorption is ~10% as effective as oral absorption in the critical study.)

a) ch NC = chronic non-cancer; C = cancer; sch NC = sub-chronic non-cancer.
b) References for Table 2.34 appear directly below.

References for Table 2.34

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3 DEVELOPMENT OF VALUES PROTECTIVE OF AQUATIC BIOTA

Section 3 describes the process used to derive the updated Aquatic Protection Values, which are, as described in Section 1, part of the array of component values used to determine the updated Site Condition Standards (SCS).

3.1 Introduction

3.1.1 Surface Water Quality

Surface water resources may be affected by Brownfield properties as a result of discharges of contaminated groundwater to surface water or from migration of contaminants by overland flow. Under O.Reg. 153/04, the Ministry has developed Aquatic Protection Values (APVs) to protect aquatic biota exposed to contaminants from migration of contaminated groundwater to surface water. Protection of aquatic biota from migration of contaminants by overland flow is provided by a site being designated an environmentally sensitive area if the property includes or is adjacent to a water body or includes land that is within 30 metres of a water body[3].

Aquatic Protection Values are used to establish the GW-3 component of the Tables of Site Condition Standards. These GW-3 values address the potential for environmental impacts to aquatic biota when contaminated groundwater discharges into surface water bodies. They are derived by back calculating a groundwater value from an APV through the modelling process described in Section 7.8 of this document. Aquatic Protection Values are not the same as the Ministry's Provincial Water Quality Objectives (PWQOs) developed for the protection of aquatic life and recreational uses (MOEE 1994). PWQOs are numerical and narrative ambient surface water quality criteria that represent a desirable level of water quality that the Ministry strives to maintain in the surface waters of the Province. PWQOs for the protection of aquatic life are conservative values that, when met, are protective of all forms of aquatic life and all aspects of the aquatic life cycle during indefinite exposure to the water. PWQOs are not used as the basis for the Tables of Site Condition Standards because some of the assumptions made in the development of PWQOs are not considered appropriate for the assessment and potential remediation of contaminated brownfield sites. Instead, APVs are designed to provide a scientifically defensible and reasonably conservative level of protection for most aquatic organisms from the migration of contaminated groundwater to surface water resources.

[3] Full depth generic or stratified site condition standards are not applicable to environmentally sensitive areas as set out in Section 41 of this Regulation.

3.1.2 Sediment Quality

The Ministry has developed Provincial Sediment Quality Guidelines (PSQG) for the protection of sediment dwelling organisms (MOE 2008). These sediment guidelines are established for up to three levels of effect:

- The No Effect Level (NEL) - a concentration of a chemical in the sediment that does not affect fish or sediment-dwelling organisms or result in transfer of chemicals through the food chain.
- The Lowest Effect Level (LEL) - a level of contamination that can be tolerated by the majority of sediment-dwelling organisms, and
- The Severe Effect Level (SEL) - a level of contamination that is expected to be detrimental to the majority of sediment-dwelling organisms.

Under O.Reg. 153/04, the Ministry uses the LEL as the site condition standards for sediment quality. The LEL is determined for each contaminant using a screening level concentration approach based on the relationship between sediment concentrations and co-occurrence (i.e., presence) of benthic invertebrates. However, LEL's are not effects-based guidelines and only provide an indication of the level of contamination that can be tolerated by the majority of sediment-dwelling organisms. Under the Regulation, exceeding an LEL will trigger a risk assessment including an investigation of the source of contamination, and proposed property specific standards. If the source of the contamination were on-site, a remediation plan may be appropriate, depending on the outcome of the risk assessment.

The Ministry recently updated the guidelines for identifying, assessing and managing contaminated sediments in Ontario (MOE 2008) by incorporating the recent Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (COA framework available at http://www.on.ec.gc.ca/greatlakes/default.asp?lang=En&n=FE582241) with existing Ministry guidance on assessing and managing contaminated sediments (MOE 1993 and MOE 1996a). However, no changes were made to the PSQGs or to the process used to develop them. The site condition standards for sediment have not been changed from the previous 1996 guidelines (MOE 1996b). No review of the sediment quality numbers was conducted under the current Brownfield's standards revisions.

Exceeding an LEL should not be used as the only determinative factor regarding the need for sediment remediation. As described in the assessment component of MOE 2008, additional evidence from an assessment of the benthic community, laboratory toxicity testing, and/or the potential for biomagnification should be collected to determine if sediment remediation is necessary or if additional, more detailed studies, are required. If required, the process outlined in MOE 2008 should be followed to guide the development of a strategy for managing contaminated sediment.

3.2 Approach Used for Updating APVs

3.2.1 Description of Approach

This section describes the procedures used to conduct a review of current aquatic toxicity information to update the APVs established to protect aquatic biota from contaminated groundwater. APVs were updated following a similar process as used by the Massachusetts Department of Environmental Protection (MADEP) and that was used to develop the previous APVs in the 1996 rationale document (MOE 1996b). This approach was to select an APV based on the following hierarchy:

1) The freshwater chronic ambient water quality criterion (AWQC) developed by the USEPA. The chronic AWQC is referred to by the USEPA as the continuous chronic criteria (CCC); an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The most current freshwater CCC was accessed online on July 24, 2008 (http://www.epa.gov/waterscience/criteria/wqctable/index.html).
2) If no CCC value was available, then the acute AQWC was selected and divided by 10 to provide an estimate of chronic toxicity. This only occurred for aldrin and gamma-hexachlorocyclohexane. The acute AWQC is referred to by the USEPA as the continuous maximum criteria (CMC); an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The most current freshwater CMC was accessed online on July 24, 2008.
3) Next, the lowest toxicity effects-based value for freshwater organisms from published journal articles as found in available databases (e.g., USEPA's Ecotoxicology (ECOTOX) database, etc.) were selected and evaluated. The toxicity data collection and screening process is described in more detail below.
4) Lastly, the lowest ecologically based criteria from the Massachusetts Department of Environmental Protection (MADEP 2008).

In addition to the above, some APVs were developed by using information from CCME documents (e.g PHCs) or from criteria developed by consultants through work conducted for purposes relating to MOE needs or requirements

For the hardness-dependent criteria for the metals cadmium, chromium, copper, lead, nickel, and zinc, APVs were based on total metal concentrations in groundwater using the most current USEPA CCC hardness equation assuming a hardness of 70 mg/L (as $CaCO_3$). This hardness value represents the 5th percentile of the hardness data for groundwater collected since 2000 by the Provincial Groundwater Monitoring Network (PGMN) for up to 423 instrumented monitoring wells in Ontario. This hardness value is expected to provide a reasonably conservative estimate of the APV for metals since metal toxicity is lower at higher hardness values.

For the pH-dependent criterion for pentachlorophenol, the APV was based on the most current USEPA CCC pH equation assuming a pH of 6.7. This pH value represents the 5th percentile of the pH data from 206 wells across the Province representing groundwater from overburden and bedrock conditions. This pH value is expected to provide a reasonably conservative estimate of the APV for pentachlorophenol since pentachlorophenol toxicity is lower at higher pH values.

In some cases, the lowest toxicity value was an acute endpoint. In these situations, the APV was determined by dividing the acute toxicity value by 10 to provide an estimate of chronic toxicity.

This hierarchical approach was used for all chemicals except for boron, chloride, 1-4-dioxane, petroleum hydrocarbons and uranium. Aquatic values from the CCME Canada Wide Standards for Petroleum Hydrocarbons (CCME 2008) were used for the F1 and F2 petroleum hydrocarbon fractions[4], the lowest effects-based toxicity values published in the literature as determined from recent evaluations of aquatic toxicity data were used for boron, chloride, and 1-4-dioxane (Cantox Environmental Inc., 2007a, b, and c), and the lowest effects-based toxicity value based on recent toxicity testing of uranium to aquatic organisms (Vizon SciTec Inc., 2004).

3.2.2 Aquatic Toxicity Data Collection and Screening

A tiered approach was used to obtain toxicity data to update APVs for aquatic biota. This toxicity information was collected and compiled in a series of spreadsheets by Barenco Inc. (Barenco, 2002). All of the APVs were assessed for new toxicity information since 1995 to evaluate if they needed to be updated. However, for 19 chemicals, toxicity information was assessed as far back as the 1950s. The existing APV for these 19 chemicals (from MOE 1996b) was based on acutely lethal toxicity values; values representing a test concentration or test time where 50% of the exposed test organisms died over a short term exposure period. In order to ensure the most appropriate chronic freshwater toxicity data were used (if available) a more complete search of the toxicological literature was conducted for these 19 chemicals.

These 19 chemicals were: benzo(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, boron, bromodichloromethane, bromoform, chrysene, cobalt, copper, dibenzo(a,h)anthracene, 3,3'-dichlorobenzidine, 1,1-dichloroethane, methyl isobutyl ketone, methylene chloride, 2-methylnaphthalene, molybdenum, pyrene, vinyl chloride, and nitrite.

[4] No APVs were determined for the F3 and F4 petroleum hydrocarbon fractions because these fractions are sufficiently insoluble that movement via dissolution in groundwater in not likely to be an operable exposure pathway to aquatic receptors (CCME 2000).

Aquatic Toxicity Data Collection

In general, the following approach was used by Barenco Inc. to compile aquatic toxicity data for each compound (Barenco, 2002). A literature search of scientific journals was conducted for aquatic toxicity studies that characterize a dose-response relationship from either laboratory and/or field experiments. Information on the experiment and toxicity results were summarized in an Excel spreadsheet (e.g., response of the test species at the effect concentration, exposure duration, whether it was a field or laboratory experiment, etc.). The following tiered process was used to identify the aquatic toxicity studies.

In Tier 1, toxicity data for each compound were searched for using existing, peer reviewed dose-response effects databases; primarily from the USEPA's Ecotoxicology database (ECOTOX) as well as the Hazardous Substances Database (HSDB) and the Registry of Toxic Effects of Chemical Substances database (RTECS). ECOTOX is a comprehensive computer-based database system maintained by the USEPA that provides single toxic chemical effects data for aquatic life, terrestrial plants, and terrestrial wildlife. ECOTOX integrates three previously independent databases - AQUIRE, PHYTOTOX, and TERRETOX - into a unique system which includes toxicity data derived predominately from the peer-reviewed literature. HSDB is a toxicology data file on the National Library of Medicine's Toxicology Data Network which focuses on the toxicity of potentially hazardous chemicals. RTECS is a database that contains toxicity data and references for commercially important substances such as drugs and agrochemicals.

In Tier 2, a search of scientific publications published after the date the Tier 1 databases were last updated was conducted for all the chemicals. This search was conducted using the following bibliographic databases of scientific publications: Biological Abstracts, Agricola, Biological Sciences, MEDLINE and Plant Science Abstracts. All papers identified in this search were entered into the spreadsheets and source coded accordingly. Where dose-response was not evident from the abstracts, a copy of the papers was ordered and the relevant information entered into the database.

In Tier 3, if little or no toxicity data were available for the 19 chemicals stated above after the Tier 1 and Tier 2 search, then a manual search of Biological Abstracts dating back to the 1950's was performed.

Finally, in Tier 4, objectives, guidelines, criteria and standards published by any of the following organizations were compiled (if available):

- Ontario Ministry of the Environment
- Environment Canada
- Provincial Ministries of the Environment
- Canadian Council of Ministers of the Environment (CCME)
- USEPA
- State Departments of the Environment
- World Health Organization

Aquatic Toxicity Data Screening

Once compiled, the aquatic toxicity data were screened to evaluate the new aquatic toxicity endpoints for APVs. The following steps were used in the screening process:

1. Toxicity data for aquatic biota were sorted and filtered by toxic endpoints. Data values for aquatic organisms reporting population relevant effects on survival (mortality), growth, or reproduction were included and those reporting accumulation or cellular, physiological, and behavioural effects were screened out. For aquatic plants, population and individual effects were also included in addition to growth, reproduction and mortality.

2. The remaining data were again sorted by effect levels (e.g., acute LC_{50}, $EC_{50,}$ chronic values), and the lowest observable effects level (LOEL) from all of the pertinent studies was identified.

3. All the toxicity endpoints (including those screened out in Step 1) were then scanned for reported concentration levels cited in the publications that were close to or below the current APVs reported in the MOE 1996b (Appendix B.4). In most cases, only those studies that were at, or less than, the 1996 APV were considered as candidate studies to revise the APV.

Once the lowest toxicity effects-based value for freshwater organisms was selected, the original journal article was evaluated. Information on the APV, the toxicological basis and the citation is provided in Table 3-1. APV values that have been updated are shown in bold.

3.3 Final Aquatic Protection Values, Bases and Sources

Table 3.1 Aquatic Protection Values (APV) to Protect Aquatic Biota Exposed to Contaminants from Migration of Contaminated Groundwater to Surface Water.

Chemical Name	Aquatic Protection Value (ug/L)	Basis	Source
Acenaphthene	520	Final Chronic Criterion.	USEPA 1986
Acenaphthylene	**0.14**	Median PAH phototoxicity.	MADEP 2008
Acetone	10000	LOEL. 3.2d-reduced growth in *Chlorella pyrenoidosa*.	Pollard and Adams, 1988; LOEL from ECOTOX database.

Chemical Name	**Aquatic Protection Value (ug/L)**	**Basis**	**Source**
Aldrin	**0.3**	Criterion Maximum Concentration of 3 ug/L divided by 10.	USEPA 2008
Anthracene	**0.1**	LOEL divided by 10. 24h-LC_{50} of 1.0 ug/L in mosquito *Aedes aegypti.*	Borovsky et al., 1987; LC50 from ECOTOX database.
Antimony	1,600	Final Chronic Criterion.	USEPA 1986
Arsenic	**150**	Criterion Continuous Concentration.	USEPA 2008
Barium	2,300	LOEL. 91.3d-reduced growth in *Chlorella vulgaris.*	De Jong 1985; LOEL from ECOTOX database.
Benzene	**460**	LOEL divided by 10. 96-h LC50 of 4,600 ug/L in pink salmon.	Moles et al., 1979 from MADEP 2008
Benzo[a]anthracene	**0.18**	LOEL divided by 10. 66h-LT50 of 1.8 ug/L for fathead minnow and 12.5h LT50 of 1.8 ug/L for *Daphnia magna (UV induced)*.	Oris and Giesy 1987 and Newsted and Giesy 1987; LT50's from ECOTOX database.
Benzo[a]pyrene	0.21	Failure of rainbow trout eggs to hatch.	Hannah et al., 1982; LOEL from ECOTOX database.
Benzo[b]fluoranthene	**0.42**	LOEL divided by 10. Photo-induced toxicity, 24h-EC50 of 4.2 ug/L in *Daphnia magna*.	Wernersson and Dave 1997; EC50 from ECOTOX database.
Benzo[ghi]perylene	**0.02**	LOEL divided by 10. 13.8h-LT50 (UV induced) of 0.2 ug/L in *Daphnia magna*.	Newstead and Giesy 1987; LT50 from ECOTOX database.
Benzo[k]fluoranthene	**0.14**	LOEL divided by 10. 13h-LT50 (UV induced) of 1.4 ug/L in *Daphnia magna*.	Newstead and Giesy 1987; LT50 from ECOTOX database.
Beryllium	5.3	Final Chronic Criterion.	USEPA 1986
Biphenyl, 1,1'-	170	LOEL. 21d-reduced growth in *Daphnia magna*.	Gersich et al., 1989; LOEL from ECOTOX database
Bis(2-chloroethyl)ether	**24,000**	LOEL divided by 10. 48h-LC50 of 240,000 ug/L in *Daphnia magna*.	LeBlanc 1980 from MADEP 2008
Bis(2-chloroisopropyl)ether	**24,000**	Used value for Bis(2-chloroethyl)ether.	LeBlanc 1980 from MADEP 2008
Bis(2-ethylhexyl)phthalate	3	Final Chronic Criterion based on water quality criterion for all phthalate esters.	USEPA 1986
Boron	**3,550**	LOEL. 10d- frond production in duckweed, *Spirodela polyrrhiza*.	Davis et al., 2002 from Cantox Environmental Inc., 2007a
Bromodichloromethane	**6,700**	LOEL divided by 10. 5d LC50 of 67,000 ug/L in carp.	Mattice et al., 1981; LC50 from ECOTOX

Chemical Name	**Aquatic Protection Value (ug/L)**	**Basis**	**Source**
			database.
Bromoform	**2,900**	LOEL divided by 10. 96h LC50 of 29,000 ug/L in bluegill.	Buccafusco et al., 1981; LC50 from ECOTOX database.
Bromomethane	320	LOEL. 90d-growth impairment in guppies.	Weston et al., 1988; LOEL from ECOTOX database.
Cadmium	**0.21**	Criterion Continuous Concentration (hardness @ 70 mg/L as $CaCO_3$).	Hardness-based equation from USEPA 2008.
Carbon Tetrachloride	**200**	LOEL divided by 10. 48h-LC50 of 2,000 ug/L in medaka, red killifish	Yoshioka et al., 1986 from MADEP 2008
Chlordane	**0.0043**	Criterion Continuous Concentration.	USEPA 2008
Chloroaniline, p-	32	LOEL. 21d-reduced growth in *Daphnia magna*.	Kuhn et al., 1989. LOEL from ECOTOX database.
Chlorobenzene	50	Final Chronic Criterion.	USEPA 1986
Chloroform	1,240	Final Chronic Criterion.	USEPA 1986
Chlorophenol, 2-	**260**	LOEL divided by 10. 48h-LC50 of 2,600 ug/L in *Daphnia magna*.	LeBlanc, 1980 from MADEP 2008
Chromium (Total)	**64**	Criterion Continuous Concentration (hardness @ 70 mg/L as $CaCO_3$).	Hardness-based equation for chromium III from USEPA 2008.
Chromium VI	11	Criterion Continuous Concentration.	USEPA 2008
Chrysene	**0.07**	LOEL divided by 10. 24h-LC50 (UV induced) of 0.7 ug/L in *Daphnia magna*.	Newstead and Giesy 1987; LC50 from ECOTOX database.
Cobalt	**5.2**	LOEL. 28d in *Daphnia magna*.	Kimball 1978; LOEL from ECOTOX database.
Copper	**6.9**	Criterion Continuous Concentration (hardness @ 70 mg/L as $CaCO_3$).	USEPA 2008
Cyanide (CN-)	5.2	Criterion Continuous Concentration.	USEPA 2008
Dibenzo[a h]anthracene	**0.04**	LOEL divided by 10. 3h-LT50 (UV induced) of 0.4 ug/L in *Daphnia magna*.	Newstead and Giesy 1987; LT50 from ECOTOX database.
Dibromochloromethane	**6,500**	LOEL divided by 10. 24h-EC50 of 65,000 ug/L reduced growth in the ciliated protozoan, *Tetrahymena pyriformis*.	Yoshioka et al., 1985. EC50 from ECOTOX database.
Dichlorobenzene, 1, 2-	763	Final Chronic Criterion based on	USEPA 1986

Chemical Name	**Aquatic Protection Value (ug/L)**	**Basis**	**Source**
		water quality criterion for all dichlorobenzenes.	
Dichlorobenzene, 1, 3-	763	Final Chronic Criterion based on water quality criterion for all dichlorobenzenes.	USEPA 1986
Dichlorobenzene, 1, 4-	763	Final Chronic Criterion based on water quality criterion for all dichlorobenzenes.	USEPA 1986
Dichlorobenzidine 3 3'-	**50**	LOEL divided by 10. 5d-LC50 of 500 ug/L in bluegill.	Sikka et al., 1978. LC50 from ECOTOX database.
Dichlorodifluoromethane	**350**	Developed using Quantitative Structure Activity Relationships.	MOE 2000
DDD	**0.18**	LOEL. 10d-LC50 in midge, *Chironomus tentans*.	Phipps et al., 1995; LC50 from ECOTOX database.
DDE	**1.66**	LOEL. 10d-LC50 in amphipod, *Hyalella azteca*.	Phipps et al., 1995; LC50 from ECOTOX database.
DDT	0.001	Criterion Continuous Concentration.	USEPA 2008
Dichloroethane, 1, 1-	**202,000**	LOEL. 7d-LD50 in guppies.	Konemann, 1981. LD50 from ECOTOX database.
Dichloroethane, 1, 2-	20,000	Final Chronic Criterion.	USEPA 1986
Dichloroethylene, 1,1-	**1,200**	LOEL divided by 10. 48-h LC50 of 11,600 ug/L in *Daphnia magna*.	Dill et al., 1980 from MADEP 2008
Dichloroethylene, cis-1,2-	**14,000**	LOEL divided by 10. 96h-LC50 of 140,000 ug/L in bluegill sunfish (*Lepomis macrochirus*).	Buccafusco et al., 1981 from MADEP 2008
Dichloroethylene, trans-1,2-	**22,000**	LOEL divided by 10. 48h-LC50 of 220,000 ug/L in *Daphnia magna*.	LeBlanc, 1980 from MADEP 2008
Dichlorophenol, 2,4-	365	Final Chronic Criterion.	USEPA 1986
Dichloropropane, 1,2-	5,700	Final Chronic Criterion.	USEPA 1986
Dichloropropene, 1,3-	244	Final Chronic Criterion.	USEPA 1986
Dieldrin	**0.056**	Criterion Continuous Concentration.	USEPA 2008
Diethyl Phthalate	3	Final Chronic Criterion based on water quality criterion for all phthalate esters.	USEPA 1986
Dimethyl Phthalate	3	Final Chronic Criterion based on water quality criterion for all phthalate esters.	USEPA 1986
Dimethylphenol, 2, 4-	**3,100**	LOEL. 32d reduced growth in fathead minnows.	Holcombe et al., 1982 from MADEP 2008

Chemical Name	**Aquatic Protection Value (ug/L)**	**Basis**	**Source**
Dinitrophenol, 2,4-	**900**	LOEL. 60d reduced growth in rainbow trout.	Howe et al., 1994, from MADEP 2008
Dinitrotoluene, 2,4-	230	Final Chronic Criterion.	USEPA 1986
Dioxane - 1,4	**575,000**	Lowest reported effect concentrations for blue green algae (8-d toxicity threshold)	Bringmann and Kuhn 1978 from Cantox Environmental Inc., 2007c.
Dioxin/Furan (ng TEQ/g soil)	0.00001	Final Chronic Criterion.	USEPA 1986
Endosulfan	0.056	Criterion Continuous Concentration.	USEPA 2008
Endrin	**0.036**	Criterion Continuous Concentration.	USEPA 2008
Ethylbenzene	**181**	LOEL divided by 10. 48h-EC50 for reproduction of 1,810 ug/L in *Daphnia magna*.	Vigano, 1993 from MADEP 2008
Ethylene dibromide	**9,600**	LOEL. 28d reduced growth in Japanese Medaka.	Holcombe et al., 1995, from MADEP 2008.
Fluoranthene	**7.3**	LOEL. 10d-LC50 (UV induced) in amphipod *Hyalella azteca*.	Hatch and Burton, 1999. LC50 from ECOTOX database.
Fluorene	29	LOEL. 30d-LOEC emergence *Chironomus reparius*.	Finger et al., 1985. LOEL from ECOTOX database.
Heptachlor	0.0038	Criterion Continuous Concentration.	USEPA 2008
Heptachlor Epoxide	**0.0038**	Criterion Continuous Concentration.	USEPA 2008
Hexachlorobenzene	**23**	LOEL. 14d reproduction in *Daphnia magna*.	Calamari et al., 1983 from MADEP 2008
Hexachlorobutadiene	9.3	Final Chronic Criterion.	USEPA 1986
Hexachlorocyclohexane, gamma-	**0.095**	Criterion Maximum Concentration of 0.95 ug/L divided by 10.	USEPA 2008
Hexachloroethane	540	Final Chronic Criterion.	USEPA 1986
Hexane (n)	**250**	LOEL divided by 10. 4d-LC50 of 2500 ug/L in fathead minnows.	Geiger et al., 1990. LC50 from ECOTOX database.
Indeno[1 2 3-cd]pyrene	**0.14**	Median PAH phototoxicity	MADEP 2008
Lead	**2.0**	Criterion Continuous Concentration (hardness @ 70 mg/L as $CaCO_3$).	Hardness-based equation from USEPA 2008.
Mercury	**0.77**	Criterion Continuous Concentration.	USEPA 2008.
Methoxychlor	0.03	Final Chronic Criterion.	USEPA 1986

Chemical Name	**Aquatic Protection Value (ug/L)**	**Basis**	**Source**
Methyl Ethyl Ketone	120,000	LOEL. 8d-reduced growth in *Anacystis aeruginosa*.	Bringmann and Kuhn, 1978. LOEL from ECOTOX database.
Methyl Isobutyl Ketone	**46,000**	LOEL divided by 10. 24h-LC50 of 460,000 ug/L in goldfish (*Carassius auratus*).	Birdie et al., 1979. LC50 from ECOTOX database.
Methyl Mercury	0.012	Final Chronic Criterion.	USEPA 1986
Methyl tert-Butyl Ether	100,000	LOEL. 43d-reduced growth in frog tadpoles *Rana temporaria*.	Paulov, 1987. LOEL from ECOTOX database.
Methylene Chloride	**1,320**	LOEL divided by 10. Acute LC50 of 13,200 ug/L in rainbow trout.	Black et al., 1982. LC50 from ECOTOX database.
Methlynaphthalene, 2-	**146**	LOEL divided by 10. 96h-LC50 of 1,456 ug/L in rainbow trout.	Kennedy, 1990. LC50 from ECOTOX database.
Molybdenum	730	LOEL. 28d-LC50 rainbow trout eggs.	Birge, 1978. LC50 from ECOTOX database.
Naphthalene	620	Final Chronic Criterion.	USEPA 1986
Nickel	**39**	Criterion Continuous Concentration (hardness @ 70 mg/L as $CaCO_3$).	Hardness-based equation from USEPA 2008.
Pentachlorophenol	**4.95**	Criterion Continuous Concentration (pH @ 6.7).	pH-based equation from USEPA 2008
Petroleum Hydrocarbons F1			
Aliphatic C6-C8	**46.5**	Critical Body Residue approach assuming narcosis-type endpoint.	CCME 2008
C>8-C10	**7.6**	Critical Body Residue approach assuming narcosis-type endpoint.	CCME 2008
Aromatic C>8-C10	**140**	Critical Body Residue approach assuming narcosis-type endpoint.	CCME 2008
Petroleum Hydrocarbons F2			
Aliphatic C>10-C12	**1.18**	Critical Body Residue approach assuming narcosis-type endpoint.	CCME 2008
C>12-C16	**0.074**	Critical Body Residue approach assuming narcosis-type endpoint.	CCME 2008
Aromatic C>10-C12	**96**	Critical Body Residue approach assuming narcosis-type endpoint.	CCME 2008
C>12-C16	**55.4**	Critical Body Residue approach assuming narcosis-type endpoint.	CCME 2008
Petroleum Hydrocarbons F3			
Aliphatic C>16-C21	No Value		CCME 2008

Chemical Name	**Aquatic Protection Value (ug/L)**	**Basis**	**Source**
C>21-C34	No Value		CCME 2008
Aromatic C>16-C21	No Value		CCME 2008
C>21-C34	No Value		CCME 2008
Petroleum Hydrocarbons F4			
Aliphatic C>34	No Value		CCME 2008
Aromatic C>34	No Value		CCME 2008
Phenanthrene	**38**	LOEL. 27d mortality in rainbow trout	Black et al., 1983 from MADEP 2008.
Phenol	**961**	LOEL. 12-d EC50 in freshwater invertebrate *Macrobrachium reosenbergii.*	Law and Yeo, 1997. EC50 from ECOTOX database.
Polychlorinated Biphenyls	0.014	Criterion Continuous Concentration.	USEPA 2008
Pyrene	**0.57**	LOEL divided by 10. 24h-LC50 of 5.7 ug/L following 2h UV irradiation in *Daphnia magna.*	Wernersson and Dave 1997. LC50 from ECOTOX database.
Selenium	5	Criterion Continuous Concentration.	USEPA 2008
Silver	0.12	Final Chronic Criterion.	USEPA 1986
Styrene	**720**	LOEL. 96h-EC50 for green algae *Selanastrum capricornutum*.	Cushman et al., 1997. EC50 from ECOTOX database.
Tetrachloroethane, 1,1,1,2-	**2,000**	LOEL divided by 10. 96h-LC50 of 20,000 ug/L in bluegill sunfish.	Buccafusco, et al. 1981 from MADEP 2008
Tetrachloroethane, 1,1,2,2-	2,400	Final Chronic Criterion.	USEPA 1986
Tetrachloroethylene	840	Final Chronic Criterion.	USEPA 1986
Thallium	40	Final Chronic Criterion.	USEPA 1986
Toluene	**1,400**	LOEL. 1h avoidance (not divided by 10 since behavioural endpoint) in coho salmon (*Oncorhinchus kisutch*).	Maynard and Weber,1981 from MADEP 2008
Trichlorobenzene, 1,2,4-	**340**	LOEL. 14d reduced growth in *daphnia magna*.	Calamari et al., 1983 from MADEP 2008
Trichloroethane 1,1,1-	**900**	Acute EC10 divided by 10. Behavioural changes in fathead minnows (*Pimephales promelas*).	Alexander et al, 1978, from MADEP, 2008.
Trichloroethane, 1,1,2-	9,400	Final Chronic Criterion	USEPA 1986
Trichloroethylene	21,900	Final Chronic Criterion	USEPA 1986
Trichlorofluoromethane	**200**	Developed using Quantitative Structure Activity Relationships.	MOE 2000

Chemical Name	**Aquatic Protection Value (ug/L)**	**Basis**	**Source**
Trichlorophenol, 2,4,5-	**130**	LOEL. 12d reduced growth in rainbow trout.	Neville, 1995 from MADEP 2008.
Trichlorophenol, 2,4,6-	**18**	LOEL divided by 10. 48h LC50 in medaka, red killifish.	Yoshioka, et al., 1986 from MADEP 2008.
Uranium	**33**	LOEL. IC25 for reproduction in *Ceriodaphnia dubia*.	Vizon SciTec Inc., 2004
Vanadium	20	LOEL. 3d-cell division in *Chlorella pyrenoidosa*.	Meisch and Benzschawell, 1978. LOEL from ECOTOX database.
Vinyl Chloride	**35,600**	LOEL divided by 10. 48h-LC50 of 356,000 ug/L in golden orfe Leuciscus idus.	Juhnke and Ludemann, 1978. LC50 from ECOTOX database.
Xylene Mixture	**330**	LOEL divided by 10. 96h-LC50 of 3,300 ug/L in rainbow trout.	Mayer and Ellersieck, 1986. LC50 from ECOTOX database.
Zinc	**89**	Criterion Continuous Concentration (hardness @ 70 mg/L as $CaCO_3$).	Hardness-based equation from USEPA 2008.
Electrical Conductivity (mS/cm)	No Value		
Chloride	**180,000**	LOEL. 7-d IC50 of 180,000 ug/L for reduced reproduction in Ceriodaphnia dubia.	Degreave et al., 1992 from Cantox Environmental Inc., 2007b
Sodium Adsorption Ratio	No Value		
Sodium	**180,000**	Substitute chloride value as chloride is less toxic than Na	Mount et al. 1997
APVs in bold indicate value updated from MOE 1996b. ECOTOX database integrates three previously independent databases - AQUIRE, PHYTOTOX, and TERRETOX (see text for details).			

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4 DEVELOPMENT OF PLANT AND SOIL INVERTEBRATE PROTECTION COMPONENT

Section 4 describes the process and calculations used to derive the updated plant and soil invertebrate component values, which are, as described in Section 1, part of the array of component values used to determine the updated Site Condition Standards (SCS).

4.1 Principles and Approach

4.1.1 Standards Development

The process the MOE is following to develop ecological standards includes the determination of direct contact soil values for soil organisms and vegetation as well as ecological values based on exposure models of ingestion of soil contaminants by birds and mammals. Ultimately, the direct contact and ingestion values are compared and the lower value becomes the ecological soil standard.

The MOE development of soil standards for vegetation and soil organisms is based on CCME protocols (CCME, 1996). The following are the Guiding Principles for the development of ecological standards:

- Soil at the standards levels will provide a healthy functioning ecosystem capable of sustaining the current and likely future uses of the site by ecological receptors and humans (CCME, 1996).

- Soil standards are for the cleanup of contaminated sites and must not be used for the contamination of clean sites. They represent clean down to levels at contaminated sites and not pollute up to levels for less contaminated sites (CCME, 1996).

- The relevant endpoints selected are direct effects on growth, reproduction and mortality. An exception to this is for plants, where effects on appearance can be important for aesthetic reasons in residential areas, and critical to the economics of growing horticultural crops. This is compatible with the CCME (1996) protocol that states “In developing generic environmental soil quality guidelines, only the endpoints related to “direct effects” of chemical stressors to receptors can be examined, and these do not account for the “indirect effects” (e.g., avoidance of polluted food items) that may occur from sublethal exposures. The CCME document goes on to say that indirect effects and interactions can be examined at a site-specific level.

4.1.2 Process for Developing Component Value Using Standards from Other Jurisdictions

In addition to developing new plant and soil invertebrate protection components from the available scientific literature, MOE conducted a thorough literature review of existing ecological criteria in other jurisdictions (Stantec, 2004). MOE determined that both the currently available CCME ecological protection numbers and the numbers that have been developed by the Netherlands would provide suitable levels of protection for Ontario should the Ontario process not be able to provide a standard for a parameter. Although British Colombia. (B.C.) values may also be appropriate, they did not add any additional parameters to what Ontario and CCME have developed. Thus, the sequence of acceptance for the plant and soil organism protection component was determined to be the following;

1) Criteria developed by MOE using the process detailed below, or, if not able to determine a new number, the 1996 guideline value for ecological protection.
2) CCME Soil Quality criteria for direct soil contact by plants and soil organisms
3) Netherlands Intervention Values described as Serious Risk Concentration for the Ecosystem (SRC_{eco}), as revised in Lijzen, et al., 2001, and corrected to 2% organic matter.

The Netherlands SRC_{eco} criteria were derived using the 50th percentile of the "No Observed Effect Distribution" (NOEC) of the data used by the Netherlands. The Netherlands documents provide these criteria for soils at 10% organic matter and 25% clay content and give methods for converting to other soil clay and organic matter contents. In Ontario, contaminated sites tend to be at much lower organic carbon concentrations. Since the Ontario and CCME criteria cover all the inorganic parameters that the Netherlands covered, there was no need to convert back for the inorganic numbers. The conversion for organic parameters involves only organic matter content, and since contaminated sites in Ontario rarely have soils that contain 10% organic matter, the SRCeco values were adjusted by a factor of 2/10 as per the Dutch documentation, to bring them to the equivalent of 2% or less organic matter.

The Netherlands used NOEC values to determine their Environmental Quality Standards. Within a given study, the NOEC represents the highest specific experimental concentration at which no statistically significant effects were seen. Thus, a criterion set at the 50th percentile of the NOEC values does not give a good indication of the degree of effect that that concentration could be expected to produce, although it does give a reasonable indication of the concentration below which one would not expect to observe effects on most species. A comparison of the SRC_{eco} values (adjusted for organic matter content) to the Ontario and CCME derived values for organic constituents for which there were values in both sets of data, indicates that the SRC_{eco} values tend toward being more stringent than the CCME and Ontario numbers. These numbers would, therefore, be as or more protective of the environment as are Ontario and CCME derived values, and it was determined that they would be acceptable substitute criteria in cases where the other procedures could not generate a number. An examination of the numbers in comparison with our current understanding of toxicity in Ontario conditions indicates that such numbers would be unlikely to result in any ecological functions of the soil being seriously affected.

There is inherently some error in the determination of standards using the protocol. In order to estimate this error SDB conducted a bootstrapping exercise where values from the same distribution as the SSD were added to the distribution. The exercise indicated that the resulting component value could vary within about 25% by the altering of one or two values, which would be the equivalent of adding another study to the distribution. As a result, it was decided to not change an old (1996) component value unless the new value was different from the old by more than 25%. This recognizes that there is some value to stability of a component value from a proponent's perspective, and that a change needs to be effected only when there is a reasonable degree of certainty that the change is real and not a result of randomness in the distribution.

In addition to the above methods, MOE has been open to considering using terrestrial ecological component values that have been developed specifically as generic criteria within risk assessments, where such MOE criteria are lacking for a contaminant, if they are felt to be appropriate. The only case where this method was used for the current standards was for trichlorofluoromethane (Freon11) and dichlorodifluoromethane (Freon 12), for which terrestrial ecological numbers were accepted by MOE for a risk assessment (EA547.99). The terrestrial ecological numbers for these two substances were drawn from work by USEPA Region 5 on Ecological Data Quality Levels (EDQLs) and were felt to be protective of small mammals, plants and soil invertebrates. They are as follows:

Dichlorofluoromethane	39.5 mg/kg
Trichlorofluoromethane	16.4 mg/kg

4.1.3. Standards for Agricultural/Other, Residential/Parkland/Institutional and Industrial/Commercial/Community Land Use Categories

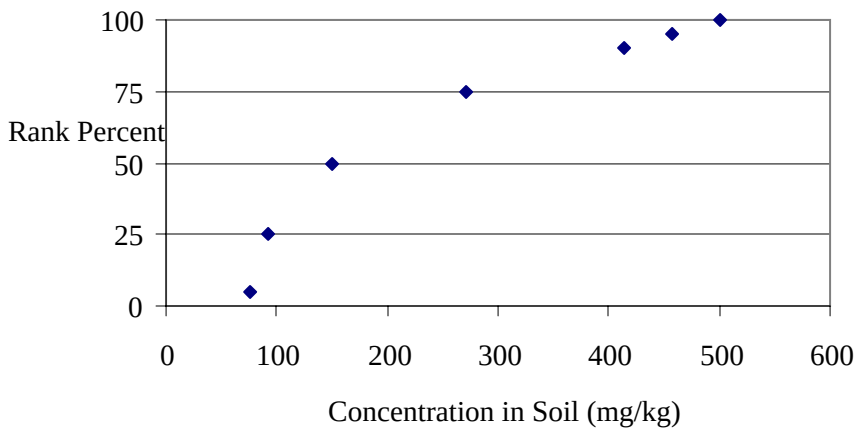
The derivation procedure detailed below for plant and soil invertebrate protection results in standards for three land use categories (Agricultural/Other; Residential/Parkland/Institutional and Industrial/Commercial/Community) only when the weight of evidence procedure can be used. This occurs when there are sufficient data such that the resulting concentrations are ranked, and rank percentiles determined for each data point as demonstrated in the example (Figure 4.1) below. In other cases only one number, which is suitable for the Agricultural/Other and Residential/Parkland/Instutional categories, is generated. In addition, the Netherlands SRC_{ECO} criteria are not specified for land use categories. In previous MOE guidelines, a factor of two was normally used to generate an industrial/commercial direct contact ecological protection number from the residential number, although for some parameters, no adjustment was made. Using the CCME Protocol procedures with current data, MOE was able to generate criteria for both agricultural/other and residential/parkland/instutional and industrial/commercial/community land use categories for 10 parameters; that is, the weight of evidence method was able to be used for 10 parameters. The ratio of the industrial/commercial/community numbers to the agricultural/residential/parkland/institutional numbers varied from 1.0 to 3.6. (Mean of 1.6). Since it is commonly acknowledged that for brownfield sites the level of protection for plants and for soil organisms can be less stringent for commercial and industrial use than for agricultural, residential and parkland use, and since the purpose of the CCME method for Industrial/Commercial was to reflect the need for a

numerically higher criterion for Industrial/Commercial, it is evident that something in the method was failing given the type of data that currently exists. An assumption required for the CCME method for Ind/Com to work properly is that for every LOEC there is a NOEC that has a lower value, and that for every NOEC there is a LOEC at a higher value.

After following the CCME (1996) methods and calculating Industrial/Commercial values wherever possible, MOE determined that the 1996 CCME method for calculating Industrial/Commercial values for NOEC/LOEC data was problematic in that situations arise in the data where the basic concept of an Ind/Com number is not borne out. The shift within the 1996 CCME protocol from the use of the combined NOEC/LOEC database for residential numbers to only the LOEC data for industrial numbers creates some significant inconsistencies. Within the current available data, there were experiments for which the highest experimental concentration did not produce an effect. The CCME method for Industrial/Commercial throws out this very useful information, thereby driving the Industrial/Commercial number down, and in some cases resulting in the two numbers being equal. To solve this problem, it was decided to utilize an alternate method that is similar to the CCME method that is used when there is sufficient EC_{20} data. Utilizing the entire NOEC/LOEC data and increasing the percentile at which the Ind/Com criterion is chosen from the 25th to the 50th percentile avoids this major problem and is more appropriate given the available data. This method still incorporates a check to be sure that the database is not dominated by LC_{50} s and/or EC_{50} s and that important LC_{50}s and EC_{50}s are not exceeded; that is, the final number chosen should not exceeed LC_{50} s or EC_{50} s where the effect is one that is meaningful to populations relevant to Ind/Com settings. It is noted that the latest version of the CCME protocol reflects this finding and includes the altered method of derivation.

In situations where a plant and soil organism protection component for Industrial/Commercial land use could not be developed using the above method, it was decided that for the new criteria, it would be appropriate to use 2.0 as a multiplier to move from the Agr/Other/Res/Park/Inst category to the Ind/Com category. Since the LOEC and Median Effects Methods use a factor of a minimum of 5 (CCME 1996) to account for uncertainty in the use of the lowest effects number used, the use of a factor of 2 for the Industrial/Commercial land use cannot result in the final number being above any meaningful effect value from the available literature. This multiplier was used in previous MOE guidelines, and an examination of the results of the current derivation method bears out that it is an appropriate factor for these situations.

Figure 4.1. Example of a Ranked Bioassay Data



4.1.4 Adjustments for Effect of Soil Texture

The bioavailability of contaminants is greatly influenced by their interactions with specific soil physical and geochemical binding mechanisms that vary among contaminants and soil types. Contaminants interact with the surface of particulate materials in soils (adsorption) or penetrate the particulate surfaces and become associated with the internal material (absorption or portioning). Also, some contaminants, especially metals, can associate with inorganic ligands and precipitate. The affinity of a contaminant to be associated with soil particulates, thus being removed from solution, irrespective of mechanism is generally referred to as “sorption”. Therefore, contaminants are generally considered bioavailable when they are released from interactions with soil and soil constituents (solid phase) and released into the soil pore-water (solution phase). Soil parameters such as pH, available charged sites on soil surfaces (mainly cation exchange capacity), texture and amount of organic matter significantly affect the potential bioavailability of contaminants in the environment.

With respect to soil texture (sand, silt and clay), the finer fractions have been shown to have higher concentrations of metals due to increased surface areas, higher clay minerals (less than 2 microns in size), and higher organic matter content. For example, clay has an estimated surface area of about 8 million cm^2/g of soil compared to about only 11 cm^2/g for coarse sand. For non-ionic organic contaminants such as pesticides and PCBs, the primary sorption domain is organic matter. Much of the cation exchange capacity (CEC) of a soil also comes from the negatively charged sites on clay surfaces. Therefore, high clay soils will have a higher affinity to sorb cationic species whether organic or inorganic due to CEC, and to sorb non-ionic organic contaminants due to high surface areas, thus making contaminants less biovailable relative to sandy soils. Metals can also form precipitates with inorganic soil constituents, such as carbonate and phosphate minerals under certain soil conditions, thus decreasing their bioavailability.

MOE reviewed the literature on the quantitative relationships between the bioavailability and toxicity of contaminants (especially heavy metals) and the main soil parameters. Most

toxicity studies don't report the CEC and clay content of the soils investigated. In the absence of this important information, it is very difficult to quantify toxicity of contaminants based on soil texture. Of the few studies that compared the bioavailability of certain contaminants in different soils, the findings for the same contaminants are often quite different. This is not surprising since different investigators don't always use same extractants or soils with similar parameters. For example, Bjerre and Schierup (1985) reported that bioavailable Cd in sandy soils was twice that of sandy loam, while Eriksson (1989) reported that the extractable Cd in sandy soils was 3-6 times higher than that of clay soils. Nadia et al. (2004) also reported significantly higher median inhibiting concentrations (IC_{50}) for Cu (23 times higher) and Cr^{6+} (9 times higher) in loamy sand soil when compared to sandy soil.

Coarse-textured soils have higher bioavailability of contaminants (especially trace metals) than fine-textured soils. From the above-mentioned examples, it is clear that quantifying this relationship is not simple, as it depends on contaminant type and other soil factors not always reported by authors. Until standardized bioassay studies are done for this purpose, quantification of the relationship will be problematic and the use of a factor based on professional judgement will be necessary, as was the case for previous Ontario criteria and for the Canada Wide Standard for Petroleum Hydrocarbons in Soil. The professional judgement of MOE experts is that utilizing an increase of 25% above the coarse soil criterion for use for medium and fine-textured soils, which has been used in Ontario for previous soil quality criteria (1996 and 1991), is very conservative and that there is room for increasing it. However, since there is no strong basis on which to determine an actual specific numeric value for the increase, it is appropriate to utilize the 25% increase until a specified higher multiplier can be fully justified.

4.2 Screening Procedures

The process outlined below is the screening process and the steps used to select appropriate data for vegetation and soil invertebrates leading to the development of ecological standards from databases compiled by Barenco (MOE Project SSB-023656, July 2002).

4.2.1 Ecological Toxicity Database

Four databases (New Terrestrial Ecological Data for both Vegetation and Soil Organisms and Updated Ecological Data for both Vegetation and Soil Organisms) were developed by the consulting firm Barneco (Barenco, 2002) by carrying out the following activities. Throughout this section, these databases are referred to as the Ecological Toxicity Database (ETD).

a) Scientific Literature Search

The scientific literature was searched for data on agricultural crops, native plant species and soil dwelling organisms (micro-organisms, earthworms, insect larvae, etc.) resulting from air and/or soil-borne exposure under controlled, dose-response studies undertaken in field, greenhouse and environmental chamber studies. This literature search followed a four tier approach.

In Tier 1 the ECOTOX database system, which provides single chemical toxic effect data for aquatic life, terrestrial plants, and terrestrial wildlife, was searched. These data provided the foundation for the ETD. The HSDB toxicology database on the National Library of Medicine's (NLM) Toxicology Data Network (TOXNET ®) that focuses on the toxicology of potentially hazardous chemicals and the RTECS (Registry of Toxic Effects of Chemical Substances) database that contains toxicity data and references for commercially important substances, including drugs and agrochemicals as well as the U.S. EPAs Health Effects Assessment Summary Tables (HEAST) and the Integrated Risk Information System (IRIS) wee searched; however, these databases were not found to be as comprehensive as the ECOTOX database.

In Tier 2, the BIOLOGICAL ABSTRACTS were searched. Where dose: response information was not evident from the abstracts, a copy of the papers was ordered and the relevant information entered into the database.

In Tier 3, chemicals were identified where data generated from Tier 1 and 2 searches had resulted in no or little data in any of the exposure routes/pathways. For these chemicals, the search for effects information that may have escaped detection in the peer reviewed EPA and other databases identified in Tiers 1 and 2 was undertaken via the Tier 2 search strategy with the limit on the date covered being determined by the date each electronic database was commenced.

Tier 4 consisted of a review of published objectives, guidelines, criteria and standards published by any of the following organizations if available:

a) Ontario Ministry of the Environment
b) Environment Canada
c) Provincial Ministries of the Environment
d) Canadian Council of Ministers of the Environment (CCME)
e) EPA
f) various State Departments of the Environment
g) World Health Organization

4.2.2 Acceptability Criteria for Vegetation Data

Using the ETD, the following acceptability criteria were used as a basis for screening the data.

- Effects must be quantified.
- Data from laboratory or field studies are acceptable.
- Studies must involve whole plants and not excised tissues.
- Effects measurements must be directly related to mortality, growth or reproduction. Data involving photosynthesis, plant pigments, enzyme systems, plant injury, histology, physiology, biochemistry or accumulation are not acceptable.

- Studies may involve any plant species in the world whether or not the species can survive in the Canadian climate.
- The ETD is primarily based on the U.S. EPA Ecotox database, which only includes single chemical exposures and excludes chemical mixtures.
- Studies where the main effects are on non-pathogenic mycorrhiza or bacterial root nodules are acceptable.

4.2.3 Vegetation Data

The following 7 steps were used to screen out unacceptable data from the ETD. Although the resulting filtered data provided the core data used to develop terrestrial standards based on direct contact, additional data that were screened for acceptability, but which were not in the ETD, were included in the databases used to develop the standards.

Step 1
Select all studies which report endpoints (author reported or calculated) including NOEC, LOEC, EC and LC.

Step 2
Select the appropriate media type. Table 4.1 shows the media types included in the database.

Table 4.1. Acceptable media for studies in the database

Media type acronym	Description
AGR	agricultural soil
ART	artificial soil
HUM	Humus
LIT	soil litter
MAN	cattle manure
MIN	mineral soil
MIX	mixture of media or soil and manure
NAT	natural soil
UKS	unknown soil type or soil and aged manure

Step 3
Select the appropriate effects (endpoints) to be included in the database. Effects that are considered suitable for the development of standards are given in part A of Table 4.2 while unsuitable effects are given in part B.

Table 4.2. Recommendations of effects to be included and excluded from vegetation databases used to develop standards

Part A. Effects that should be included in the development of standards		
Effect acronym	**Effect name**	**Reason for inclusion**
GRO	Growth	Includes measures of growth of whole plants such as height, weight and size. However there are effects measurements under the Effect growth, such as "abnormal", body burden and condition index, that probably should not be included.
DVP	Development	This category includes many effects measurements that are not applicable, but it also includes measures of emergence and weight that are relevant to the establishment of vegetation on a site.
POP	Population	This category includes the effects measurement of biomass and weight that are used in crop yields. However, it also includes effects measurements of chlorophyll concentration that are not applicable.
REP	reproduction	Although this category includes numerous effects measurements that are not applicable, the measures of germination, vegetative reproduction and fecundity should not be ignored.
MPH	Morphology	In general this category applies to animals not plants, but the effect measurement "organ weight in relation to body weight" is used in some plant studies.
INJ	Injury	This category includes measures such as desiccation, curvature, vascular disruption and lesions. These measures are difficult to quantify, but perhaps they should be included as they do measure damage caused to the plant, presumably by the contaminant.
MOR	Mortality	This category is in some of the databases but is not listed in the Glossary of Codes and Explanations. Although mortality of plants is important, the mortality may apply to ectomycorrhiza on the roots.
PHY	Physiology	This category includes measures as diverse as mycorrhizal colonization, photosynthesis and cold hardiness. Mycorrhiza should be included since the fungi can be an extension of the root and critical to the plant's survival. Photosynthetic measurements are often conducted on plants in the field. However, field photosynthetic measurements are usually only conducted on time periods of less than a minute and unless many factors such as historesis of the plant, water relations of the plant, leaf temperature and photon flux density are properly taken into consideration, the results are meaningless. Even with properly conducted experiments, the link between more or less instantaneous photosynthetic rates and long term growth is tenuous at best, as

		plant recovery and/or adaption to photosynthetic and other physiological effects is typically not evaluated.
Part B. Effects that should not be included in the development of standards		
ACC	accumulation	This category applies primarily to chemical uptake into the plants or chemical residues in the plants, with no direct measure of adverse effect on the plant.
BCM	biochemistry	This category deals primarily with enzyme systems. A link between the enzyme concentration and actual growth effects would have to be established before this category could be used as a measure of adverse effects. Plant recovery is also a factor in this end-point.
CEL	Cells	Most cellular experiments are conducted in a laboratory setting and may involve tissue cultures. It is not yet possible to relate these types of experiments to a real world situation.
ENZ	Enzymes	This category includes the activity of many enzymes. As with the biochemistry category, there is not necessarily a connection between the activity of a certain enzyme and the growth and reproduction of plants on a site.
GEN	Genetics	This category includes measurements such as mitotic and meiotic abnormalities, pigment concentrations, RNA synthesis rates and mutations. Although these measures will theoretically affect the fecundity of plants and their growth, the practical aspect of these measurements is usually unknown.
HIS	Histology	This category includes changes in cell type, degeneration, lesions, necrosis and other measures of cellular change or damage. However, these cellular changes may not affect the overall health or growth of plants on a site. Often common pathogens affect these type of measurement much more than contaminants.

Step 4
Select the appropriate effects measurements within each effect. The acceptable effects measurements are given in Table 4.3.

Table 4.3. Effect measurements to be included in the database

Effect acronym	Effect measurement	Description
GRO (growth)	AREA	Area
	BMAS	Biomass
	COND	condition index
	DMTR	Diameter
	DWGT	dry weight
	GGRO	growth, general
	GGRT	general growth rate

	HGHT	Height
	LGHT	Length
	NODE	# nodules per nodulated root
	RADI	Radius
	RLGR	relative growth rate
	SIZE	Size
	SPGR	specific growth rate
	STNT	Stunting
	VOLU	Volume
	WDTH	Width
	WGHT	Weight
	WWGT	wet weight
DVP (development)	EMRG	Emergence
	FORM	organ/tissue formation
	MATR	Maturity
	TEMR	time to first emergence
	THED	time to heading
	WGHT	Weight
INJ (injury)	DAMG	Damage
	GINJ	injury, general
	VASC	vascular disruption
MOR (mortality)		Mortality
	HTCH	Hatch
MPH (morphology)	LGHT	Length
	SMIX	organ weight in relationship to body weight
	WGHT	Weight
PHY (physiology)	ABSC	abscission
	MYCO	mycorrhizal colonization
	PGRT	population growth rate
POP (population) Includes crops	BMAS	Biomass
	CVER	cover, canopy
	GPOP	population changes, general
	PBMS	biomass or weight for total population
	PGRT	population growth rate
	SURF	surface area
	WGHT	Weight
REP (reproduction)	BMAS	Biomass
	FCND	Fecundity
	GERM	Germination
	GREP	reproduction, general
	NPOD	pod, number of pods
	PROG	Progeny
	RSUC	reproductive success

	SEED	seed number
	TRPD	total production
	VIAB	viability
	VEGR	Vegetative reproduction
PRS (ecosystem)	DCMP	decomposition
	PPRO	primary productivity
	GPPR	gross primary productivity/respiration

Step 5
Convert all concentration/dose units to mg/kg soil using the conversion factors in Table 4.4.

Table 4.4. Conversion factors of concentration/dose units to mg/kg soil.

Database unit	**Conversion**
% (percent)	check that this applies to soils and if it does multiply by 10,000
g/ha (gram per hectare)	divide by 2000 (assuming approx. 2,000,000 kg soil per ha)
g/L (grams per litre)	don't select this value
g/eu (grams per experimental unit)	don't select this value since the amount in the experimental unit is unknown
kg/ha (kilograms per hectare)	divide by 2 (assuming approx. 2,000,000 kg soil per ha)
kg/mu (kilogram per ?)	don't select this value
M (molar)	don't select this value
mg/g (milligram per gram)	multiply by 1000
mg/3kg (milligram per 3 kilograms)	divide by 3
mg/kg (milligram per kilogram)	no conversion is necessary
ng/g (nanograms per gram)	divide by 1000
ppm (parts per million)	If it applies to soils no conversion is necessary. If it applies to liquids delete the row.
μg/g (micrograms per gram)	no conversion is necessary
μg/500g (micrograms per 500 grams)	divide by 500
μg/eu (micrograms per experimental unit)	don't select this value since the amount in the experimental unit is unknown

μg/L (micrograms per litre)	don't select this value
μM (micro molar)	don't select this value

Step 6
Remove all values where a lowest-observed-effect concentration (LOEC) was a beneficial effect on the plants and the values that represent the accompanying no-observed-effect-concentration (NOEC). This is done since the distributions required are only for adverse effects of an excess of the substance of concern. After this step, the LOEC values are regarded as lowest-observed-adverse-effect levels (LOAECs).

Step 7
The three methods (Weight of Evidence Method, Lowest Observed Effect Concentration Method and the Median Effects Method) outlined in the CCME protocl (CCME, 1996) were followed for the derivation of direct soil contact ecological values. See details in section 4.3.

4.2.4 Soil Invertebrate Data

For soil invertebrate data, the follow 7 steps were used to screen out unacceptable data from the ETD.

Step 1
Select all studies which report endpoints (author reported or Barenco-calculated) including NOEC, LOEC, EC and LC.

Step 2
Select the appropriate media type. The following media types are the only ones included in the database.

Table 4.5. Acceptable media for studies in the database

Media type acronym	**Description**
ART	artificial soil
HUM	Humus
MIN	mineral soil
MIX	mixture of media
NAT	natural soil
UKS	unknown soil type

Step 3
Select the appropriate effects (endpoints) to be included in the database. Effects that are considered suitable for the development of standards are given in Table 4.6 (part A) while unsuitable effects are given in (part B).

Table 4.6. Recommendations of effects to be included and excluded from soil organism databases used to develop standards

Part A. Effects that should be included in the development of standards		
Effect acronym	**Effect name**	**Reason for inclusion**
GRO	growth	Includes measures of length, weight and size that are very important.
DVP	development	This category includes many effects measurements that are not applicable, but it also includes measures of developmental changes, sexual development and weight that are relevant for soil organisms.
MOR	mortality	This category is in some of the databases but is not listed in the Glossary of Codes and Explanations. This is a very important effect.
POP	population	This category includes the effects measurement of biomass and weight as well as population changes that are important in determining toxic effects to communities of soil organisms.
PRS	ecosystem process	This effect includes system respiration, which can be a good measure of the health of soil organisms.
REP	reproduction	Although this category includes numerous effects measurements that are not applicable, the measures of fertile cocoons, biomass and fecundity are very important.
MPH	morphology	Changes in the size, shape, weight of soil organisms can be adverse effects.
INJ	injury	This effect includes tumor induction and general damage, which may be important.
PHY	physiology	This category includes measures such as absorption efficiency, blood volume, nutrient uptake, lipid content that, like biochemistry, do not necessarily affect the growth, reproduction or mortality of the organisms. However, respiration may be an important measure of the health of communities of soil organisms.
Part B. Effects that should not be included in the development of standards		
ACC	accumulation	This category applies primarily to chemical uptake/body burden into soil organisms. It does not directly measure adverse effects to soil organisms.
AVO	avoidance	The CCME does not consider avoidance an acceptable effect upon which to base a standard. This is somewhat controversial, but at this time avoidance will not be included.

BCM	biochemistry	This category deals primarily with enzyme systems. A link between the enzyme concentration and actual growth effects or mortality would have to be established before this category could be used as a measure of adverse effects.
BEH	behavior	This effect includes effects measures such as burrowing behavior, general activity, predator vulnerability, temperature tolerance. These effect measures are often difficult to interpret and do not necessarily adversely affect the growth, reproduction or survival of the organisms.
CEL	cells	Most cellular experiments are conducted in a laboratory setting and may involve tissue cultures. To relate these type of experiments to a real world situation is difficult.
ENZ	enzymes	This category includes the activity of many enzymes. As with the biochemistry category, there is not necessarily a connection between the activity of a certain enzyme and the growth, reproduction or mortality of soil organisms.
FDB	feeding behaviour	Changes in feeding behaviour can lead to adverse effects on growth, reproduction and survival but since there is not necessarily a connection they are included.
GEN	genetics	This category includes measurements such as mitotic and meiotic abnormalities, pigment concentrations, RNA synthesis rates and mutations. Although these measures will theoretically affect the growth, reproduction and mortality of soil organisms, the practical aspect of these measurements is usually unknown.
HIS	histology	This category includes changes in cell type, degeneration, lesions, hemorrhage and other measures of cellular change or damage. It is difficult to determine whether these changes are indicative of an adverse, within the normal range of cellular changes or due to pathogens.
HRM	hormone	Changes in hormone levels are rarely measured in soil organisms and the interpretation of changes is likely to be very difficult. Hormonal changes do not necessarily indicate an adverse effect.
IMM	immunological	Measurements of antibodies or general immunity are unlikely to be taken in soil organisms and even if this type of data were available it is likely to be very difficult to interpret.
ITX	Intoxication	Measurement of intoxication in soil organisms is difficult. Immobility or paralysis in earthworms will likely lead to death and so more direct measures of toxicity such as mortality are more likely to be measured and have are more applicable to the development of standards.

Step 4
Select the appropriate effects measurements within each effect. The acceptable effects measurements are given in Table 4.7.

Table 4.7. Effect measurements to be included in the database

Effect acronym	Effect measurement	Description
GRO (growth)	BMAS	biomass
	DMTR	diameter
	DWGT	dry weight
	GGRO	growth, general
	GGRT	general growth rate
	LGHT	length
	RLGR	relative growth rate
	SIZE	size
	SPGR	specific growth rate
	WDTH	width
	WGHT	weight
	WWGT	wet weight
DVP (development)	DVLP	development, general
	GDVP	development changes, general
	MMPH	metamorphosis
	SXDP	sexual development
	WGHT	weight
INJ (injury)	DAMG	damage
	GINJ	injury, general
	TUMR	tumor induction
MOR (mortality)		mortality
MPH (morphology)	LGHT	length
	WGHT	weight
PHY (physiology)	OXYG	oxygen consumption
	RESP	respiration
	RPRT	respiration rate
POP (population)	ABND	abundance
	BMAS	biomass
	DVRS	diversity
	GENT	generation time
	GPOP	population changes, general
	PBMS	biomass or weight for total population
	PBRA	population biomass turnover ratio
	PCCP	population carrying capacity
	PGRT	population growth rate
	RCLN	colonization rate
	WGHT	weight
REP (reproduction)	ABNM	abnormal
	FCND	fecundity
	FERT	fertility
	FTCC	fertile cocoons

	GREP	reproduction, general
	INFT	infertile
	NDAY	number of days between egg laying
	PRFM	pregnant females in a population
	RPRD	reproductive capacity
	RSUC	reproductive success
	VIAB	viability
PRS (ecosystem)	CO2P	CO2 evolution
	DCMP	decomposition
	SRES	system respiration

Step 5
Convert all Concentration/Dose units to mg/kg soil using the conversion factors provided in Table 4.4.

Step 6
Remove all values where a lowest-observed-effect concentration (LOEC) was a beneficial effect on the plants and the values that represent the accompanying no-observed-effect-concentration (NOEC). This is done since the distributions required are only for adverse effects of an excess of the substance of concern. After this step, the LOEC values are regarded as lowest-observed-adverse-effect levels (LOAECs).

Step 7
This step of combining the vegetation and soil invertebrate data is the same as the vegetation studies step 7.

4.3 Rationale for Individual Parameters

This section outlines the methods and the rationale used to derive direct soil contact values for vegetation and soil invertebrates.

Direct soil contact values were derived following the CCME protocols (CCME, 1996), which include three methods. The first method is called the weight of evidence method which requires at least ten data points from at least three studies including a minimum of two soil invertebrate and two crop/plant data points. If there is insufficient information to use this method, the second method is termed the “Lowest observed effect concentration method” (LOEC). This method requires a minimum of three studies reporting LOEC and NOEC endpoints including at least one terrestrial plant and one soil invertebrate study. If there is insufficient information to use this method, the final method is the “Median effects method”. This method requires a minimum of three studies with EC_{50} or LC_{50} endpoints including one terrestrial plant and one soil invertebrate study. If there are insufficient data to meet the minimum requirements of this final method, then a standard can not be developed.

Vegetation and soil invertebrate data from the ETD were initially sorted using the above-mentioned acceptability criteria for vegetation and soil invertebrate studies. If there were no studies in either category it was determined that there were insufficient data to develop a standard for that chemical. If there was at least one vegetation and one soil organism study but not three studies in total, again no standard was developed due to insufficient data. Standards were developed only for chemicals where there were at least three studies, including one vegetation and one soil invertebrate study. The studies that met the acceptability criteria for the selected chemicals and that could be obtained were checked thoroughly for proper extractants and concentrations. Hard copies of these studies were kept in files for each chemical.

Data for plants and soil invertebrates were combined into a single data set since suffiecient data were not availabe to evaluate them separately while still maintaining statistically valid data distributions. Redundant toxicity data points were combined into a single response concentration calaculated as the geometric mean of the individual values. Data points were considered redundant if they represent same species with same type of response under the same or highly similar exposure conditions. When toxicity data were available for the same species with the same type of response but based on different exposure periods, the data for the longer exposure period were used.

Rationales for all the chemicals for which there was sufficient information to develop a soil contact value follow.

4.3.1 Arsenic

For arsenic (As), there were thirty-three studies, consisting of twenty-six vegetation studies and seven soil invertebrate studies. Six soil invertebrate studies were all eliminated because they didn't report an endpoint. Eighteen vegetation studies were eliminated for either not reporting an endpoint or measuring only biochemical effects such accumulation or biochemical concentration of As in test plants which can't be correlated directly to adverse effects on plants.

Eight vegetation studies and one soil invertebrate study met the criteria set for the derivation of direct soil contact value. Therefore, there is sufficient information to develop an ecological standard for As. The Weight of Evidence Method, which uses the distribution of effects/no-effects data were chosen to derive a soil contact value for As. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 22 µg/g, and the 50th percentile was 34 µg/g.

The derived direct soil contact value is 22 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 34 µg/g for Industrial/Commercial/Community land use.

Table 4.8. Studies of Arsenic toxicity on terrestrial plants and soil invertebrates

Arsenic compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
Arsenic	Alfalfa *(Medicago sativa)*	Biomass (30% reduction)	Natural soil	7	2 months	Root	30	LOEC	Biro et al. 1998
Arsenic pentoxide	Apple *(Malus domestica)*	Biomass (no reduction)	Natural soil	6.7	142 days	Shoot	200	NOEC	Covey et al.1981
Arsenic acid, Disodium salt	Bean *(Phaseolus vulgaris)*	Biomass (11% reduction)	Natural soil	5.5	Grown to maturity	Whole organism	10	NOEC	Woolson, 1973
Arsenic acid, Disodium salt	*Bean (Phaseolus vulgaris)*	Biomass (94% reduction)	Natural soil	6.2	Grown to maturity	Whole organism	22	LOEC	Woolson, 1973
Arsenic oxide	Bermuda grass *(Cynodon dactylon)*	Biomass	Natural soil	7.6	6 weeks	Shoot	21 64	NOEC LOEC	Weaver et al. 1984
Arsenic acid, Disodium salt	Cabbage *(Brassica oleracea)*	Biomass	Natural soil	6.2	Grown to maturity	Whole organism	71 224	NOEC LOEC	Woolson, 1973
Arsenic pentoxide	Corn *(Zea mays)*	Biomass (12% reduction)	Natural soil	6.7	55 days	Shoot	141	NOEC	Covey et al. 1981
Arsenic acid, Disodium salt	Corn *(Zea mays)*	Biomass (67% reduction)	Natural soil	Not reported	4 weeks	Unspecified	500	LOEC	Woolson, 1972
Arsenic oxide	Cotton *(Gossypium hirsutum)*	Biomass	Natural soil	7.6	6 weeks	Aboveground portion	40	NOEC	Deuel and Swoboda, 1972
Arsenic oxide	Cotton *(Gossypium hirsutum)*	Biomass	Natural soil	6.1	7 weeks	Aboveground portion	63	LOEC	Deuel and Swoboda, 1972
Arsenic acid, Disodium salt	Lima bean *(Phaseolus lunatus)*	Biomass (99% reduction)	Natural soil	6.2	Grown to maturity	Whole organism	22 71	NOEC LOEC	Woolson, 1973
Arsenic acid, Disodium salt	*Mustard (Brassica sp.)*	Biomass (no reduction)	Natural soil	5.2	14 days	Root	10	NOEC	Cox et al. 1996
Arsenic acid, Disodium salt	Radish *(Raphanus sativus)*	Biomass (3% reduction)	Natural soil	5.5	Grown to maturity	Whole organism	10	NOEC	Woolson, 1973
Arsenic acid, Disodium salt	Radish *(Raphanus sativus)*	Biomass (23% reduction)	Natural soil	6.2	Grown to maturity	Whole organism	22	LOEC	Woolson, 1973
Arsenic	Red clover *(Trifolium pratense)*	Biomass (57% reduction)	Natural soil	7	2 months	Root	30	LOEC	Biro et al. 1998
Arsenic acid, Sodium salt	Rice *(Oryza sativa L.)*	Biomass (42% As5+ or 52% As3+ 33%reduction)	Natural soil	7.25	60 days	Aboveground portion	25	LOEC	Onken and Hossner, 1995

Arsenic compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
Arsenic oxide	Soybean *(Glycine max)*	Biomass	Natural soil	7.6	6 weeks	Aboveground portion	56	NOEC	Deuel and Swoboda, 1972
Arsenic oxide	*Glycine max*	Biomass	Natural soil	6.1	6 weeks	Aboveground portion	34	LOEC	Deuel and Swoboda, 1972
Arsenic acid, Disodium salt	Spinach *(Spinacia oleracea)*	Biomass (4% reduction)	Natural soil	5.5	Grown to maturity	Whole organism	10	NOEC	Woolson, 1973
Arsenic acid, Disodium salt	Spinach *(Spinacia oleracea)*	Biomass (41% reduction)	Natural soil	6.2	Grown to maturity	Whole organism	22	LOEC	Woolson, 1973
Arsenic acid, Disodium salt	*Tomato (Lycopersicon esculentum)*	Biomass (96% reduction)	Natural soil	6.2	Grown to maturity	Whole organism	32 158	NOEC LOEC	Woolson, 1973
Arsenic acid, Monopotassium salt	Earthworm *(Eisenia foetida)*	Mortality	Natural soil	7.6	8 weeks	Not reported	50 100	NOEC LC50	Fischer and Koszorus, 1992

4.3.2 Cadmium

For cadmium (Cd), there were one hundred sixty-nine studies, consisting of 65 soil invertebrate studies and 104 vegetation studies. Fifty-six soil invertebrate studies were eliminated because they either didn't report an endpoint or the test organisms were exposed to Cd on filter paper, which is not an acceptable medium. In several cases, reported Cd toxicity was complicated by its use in mixture with other chemicals. Eighty vegetation studies were also eliminated for not reporting an endpoint or only measuring Cd uptake and accumulation in test plants, as well as other biochemical or physiological effects which can't be correlated to direct adverse effects of cadmium on terrestrial plants.

Nine soil invertebrate studies and twenty-four vegetation studies were acceptable and met the criteria set for deriving ecological toxicity value. Therefore, there is sufficient information to set a standard for Cd. The Weight of Evidence Method, which uses the distribution of effects/no-effects data was chosen to derive a direct soil contact value for cadmium. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 10µg/g, and the 50th percentile was 24 µg/g. The 25th percentile value of 10µg/g is identical to the value reported by Sheppard et al. (2005). For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the "effects only" data was 10 µg/g.

The derived direct soil contact value for Cd is 10 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 24 µg/g for Industrial/Commercial/Community land use.

Table 4.9. Studies on the Toxicity of Cadmium on Terrestrial Plants and Soil Invertebrates

Cadmium compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Cadmium sulphate	Common onion *(Allium cepa)*	Biomass	Natural	8.3	Grown to maturity	Unspecified	24	EC10	Dang et al. 1990
Cadmium sulphate	Common onion *(Allium cepa)*	Biomass (20% reduction)	Natural	8.3	Grown to maturity	Unspecified	50	LOEC	Dang et al. 1990
Cadmium sulfate	Garlic *(Allium sativum)*	Biomass (40 % reduction)	Natural	6.8	11 weeks	Bulb	100	LOEC	Lehoczky et al. 1996
Cadmium sulfate	Alyssum *(Alyssum pintodasilvae)*	Weight (19% reduction)	Natural	6.7	2 months	Unspecified	5	LOEC	De Varennes et al. 1996
Cadmium sulfate	*Worm (Aporrectodea caliginosa)*	Weight	Natural	7.05	6 weeks	Whole organism	68.4	EC50	Khalil et al. 1996
Cadmium sulfate	Common oat *(Avena sativa)*	Biomass (29% reduction)	Natural	8.1	45 days	Plant tops	2.5	LOEC	Singh and Nayyar, 1994
Cadmium sulfate	Chard *(Beta vulgaris cicla)*	Biomass (3% reduction)	Natural	Not Reported	5 weeks	Whole organism	10	NOEC	Mahler et al. 1987
Cadmium chloride	Clusterbean *(Cyamopsis tetragonoloba)*	Biomass (23% reduction)	Natural	8.3	50 days	Unspecified	2.5	LOEC	Gupta and Dixit, 1992
Cadmium chloride	Earthworm *(Eisenia andrei)*	Sexual development	ArificialArtificial	6.7	12 weeks	Not reported	108	EC50	Van Gestel et al. 1991
Cadmium chloride	Earthworm *(Eisenia andrei)*	Weight	ArificialArtificial	6.7	12 weeks	Not reported	96	EC50	Van Gestel et al. 1992
Cadmium chloride	Earthworm *(Eisenia andrei)*	Mortality	Arificial	6.7	12 weeks	Whole organism	303	LC50	Van Gestel et al. 1991
Cadmium chloride	Earthworm *(Eisenia andrei)*	Sexual development	Arificial	6.7	12 weeks	Not reported	10 56	NOEC LOEC	Van Gestel et al. 1991
Cadmium chloride	Earthworm *(Eisenia andrei)*	Weight	Arificial	6.7	12 weeks	Not reported	32	NOEC	Van Gestel et al. 1991
Cadmium nitrate	Earthworm *(Eisenia andrei)*	Weight	Arificial	6.1	21days	Whole organism	215	EC50	Spurgeon and Hopkin, 1995
Cadmium	Earthworm	Mortality	Arificial	6	2 weeks	Not reported	1843	LC50	Neuhauser et al. 1985c

Cadmium compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
nitrate	*(Eisenia andrei)*								
Cadmium sulfate	Earthworm *(Eisenia Fetida)*	Mortality	Arificial	6.2	14 days	Whole organism	3000	LOEC	Reinecke et al. 1999
Cadmium chloride	Springtail *(Folsomia candida)*	Weight	Arificial	6.09	6 weeks	Whole organism	84	EC10	Van Gestel and Hensbergen, 1997
Cadmium chloride	Springtail *(Folsomia candida)*	Weight	Arificial	6	63 days	Whole organism	376	EC50	Crommentuijn et al. 1993
Cadmium chloride	Springtail *(Folsomia candida)*	Weight	Arificial	5.52	6 weeks	Whole organism	427	EC50	Van Gestel and Van Diepen, 1997
Cadmium chloride	Springtail *(Folsomia candida)*	Population growth	Arificial	5.52	6 weeks	Not reported	71	EC50	Van Gestel and Van Diepen, 1997
Cadmium chloride	Springtail *(Folsomia candida)*	Mortality	Arificial	6	63 days	Whole organism	778	LC50	Crommentuijn, et al. 1993
Cadmium chloride	Springtail *(Folsomia candida)*	Weight	ArificialArtificial	6	63 days	Whole organism	326	LOEC	Crommentuijn, et al. 1993
Cadmium chloride	Springtail *(Folsomia candida)*	Weight	ArificialArtificial	5.52	6 weeks	Not reported	247	NOEC	Van Gestel and Van Diepen, 1997
Cadmium sulfate	American-Egyptian cotton *(Gossypium barbadense)*	Biomass (60% reduction)	Natural	6.8	5 weeks	Leaf	300	LOEC	Rehab and Wallace, 1978
Cadmium sulfate	Cotton *(Gossypium hirsutum)*	Biomass (77% reduction)	Natural	6.8	5 weeks	Stem	300	LOEC	Rehab and Wallace, 1978
Cadmium sulfate	Common annual sunflower *(Helianthus annuus)*	Biomass (1% reduction)	Natural	7.3	35 days	Root	10	NOEC	Simon, 1998
Cadmium sulfate	Barley *(Hordeum vulgare)*	Biomass (18% reduction)	Natural	7.8	45 days	Root	10	LOEC	Aery and Jagetiya, 1997
Cadmium sulfate	Barley *(Hordeum vulgare)*	Biomass (no reduction)	Natural	5.7	110 days	Aboveground	25	NOEC	Piotrowska and Dudka, 1994
Cadmium sulfate	Lettuce *(Lactuca sativa)*	Biomass (9% reduction)	Natural	6.8	4 weeks	Unspecified	10	NOEC	Lehoczky et al. 1998
Cadmium chloride	Ryegrass *(Lolium sp.)*	Biomass (42% reduction)	Natural	5.6	11 years	Unspecified	50	LOEC	Singh and Jeng, 1993
Cadmium sulfate	Corn *(Zea mays)*	Biomass (40%	Natural	8.1	45 days	Unspecified	40	LOEC	Singh and Nayyar, 1989

Cadmium compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
		reduction)							
Cadmium chloride	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	7.3	12 weeks	Unspecified	150	LOEC	Ma, 1982
Cadmium sulfate	Alfalfa *(Medicago sativa)*	Biomass (25% reduction)	Natural	7	2 months	Shoot	30	LOEC	Biro et al. 1998
Cadmium sulfate	Alfalfa *(Medicago sativa)*	Biomass (40% reduction)	Natural	8.1	45 days	Plant tops	2.5	LOEC	Singh and Nayyar, 1994
Cadmium sulfate	Indian-Sweet Clover *(Melilotus indica)*	Biomass (16% reduction)	Natural	8.1	45 days	Plant tops	2.5	LOEC	Singh and Nayyar, 1994
Cadmium chloride	*Wild bergamot (Monarda fistulosa)*	Weight	Natural	Not Reported	6 weeks	Whole organism	11.26	EC25	Miles and Parker, 1980
Cadmium chloride	Wild bergamot *(Monarda fistulosa)*	Biomass (74% reduction)	Natural	Not Reported	6 weeks	Whole organism	20	LOEC	Miles and Parker, 1980
Cadmium	Rice *(Oryza sativa)*	Biomass (25% reduction)	Natural	5.4	Grown to maturity	Grain	5 25	NOEC LOEC	Sarkunan et al. 1996
Cadmium chloride	Pearl millet *(Pennisetum glaucum)*	Biomass (14% reduction)	Natural	8.3	50 days	Unspecified	2.5	LOEC	Gupta and Dixit, 1992
Cadmium chloride	Bean *(Phaseolus vulgaris)*	Length (47% reduction)	Natural	Not Reported	14 days	Shoot	20	LOEC	Vangronsveld et al. 1995
Cadmium chloride	Northern red oak *(Quercus rubra)*	Biomass	Natural	6	16 weeks	Whole organism	10	LOEC	Dixon, 1988
Cadmium chloride	Northern red oak *(Quercus rubra)*	Area	Natural	6	16 weeks	Leaf	10	NOEC	Dixon, 1988
Cadmium chloride	Blackeyed Susan *(Rudbeckia hirta)*	Weight	Natural	Not Reported	6 weeks	Whole organism	17	EC25	Miles and Parker, 1980
Cadmium chloride	Blackeyed Susan *(Rudbeckia hirta)*	Biomass (48% reduction)	Natural	Not Reported	6 weeks	Whole organism	20	LOEC	Miles and Parker, 1980
Cadmium chloride	Little bluestem *(Schizachyrium scoparium)*	Weight	Natural	Not Reported	6 weeks	Whole organism	25.42	EC25	Miles and Parker, 1980
Cadmium	Little bluestem	Biomass	Natural	Not	6 weeks	Whole	20	LOEC	Miles and Parker,

Cadmium compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
chloride	*(Schizachyrium scoparium)*	(21% reduction)		Reported		organism			1980
Cadmium chloride	Broomcorn *(Sorghum bicolor)*	Biomass (15% reduction)	Natural	8.3	50 days	Unspecified	2.5	LOEC	Gupta and Dixit, 1992
Cadmium	Spinach *(Spinacia oleracea)*	Biomass (23% reduction)	Natural	8.3	70 days	Unspecified	2 4	NOEC LOEC	Sadana and Singh, 1987
Cadmium acetate	Spinach *(Spinacia oleracea)*	Biomass (12% reduction)	Natural	7.2	Grown to maturity	Not reported	4	NOEC	Smilde et al. 1992
Cadmium sulfate	Red clover *(Trifolium pratense)*	Biomass (56% reduction)	Natural	7	2 months	Shoot	30	LOEC	Biro et al. 1998
Cadmium sulfate	Fenugreek *(Trigonella foenum-graecum)*	Biomass	Natural	8.3	8 weeks	Unspecified	10 50	EC10 LOEC	Dang et al. 1990
Cadmium acetate	Bread wheat *(Triticum aestivum)*	Biomass	Natural	6.9	4 weeks	Shoot	5.6	LOEC	Reber, 1989
Cadmium sulfate	Bread wheat *(Triticum aestivum)*	Biomass	Natural	8.1	45 days	Grain	12.5	LOEC	Singh et al. 1989
Cadmium sulfate	Bread wheat *(Triticum aestivum)*	Biomass	Natural	8.1	Grown to maturity	Straw	25	NOEC	Singh et al. 1989
Cadmium chloride	Mungbean *(Vigna radiata)*	Biomass (33% reduction)	Natural	8.3	50 days	Unspecified	2.5	LOEC	Gupta and Dixit, 1992
Cadmium chloride	*Vigna unguiculata*	Biomass (57% reduction)	Natural	8.3	50 days	Unspecified	2.5	LOEC	Gupta and Dixit, 1992
Cadmium chloride	Corn *(Zea mays)*	Biomass	Natural	6	31 days	Shoot	13.56	LOEC	Miller et al. 1976
Cadmium chloride	Corn *(Zea mays)*	Biomas	Natural	8.3	50 days	Unspecified	6.3	LOEC	Gupta and Dixit, 1992
Cadmium sulfate	Corn *(Zea mays)*	Biomass	Natural	6.8	4 weeks	Unspecified	100	NOEC	Lehoczky et al. 1996

4.3.3 Chromium (total)

For Chromium (Cr total), there were 15 studies consisting of six soil invertebrate studies and nine vegetation studies. Four soil invertebrate studies were eliminated because they either didn't report an endpoint or reported endpoints such as accumulation, bioconcentration or bioaccumulation factors, which can't be directly related to adverse effects. Five plant studies were also eliminated for not reporting endpoints or only measuring biochemical accumulation effects, which can't be directly correlated to adverse effects of Cr on plants.

The remaining six studies (two soil invertebrate and four vegetation) were acceptable. Therefore, there is sufficient information to create a standard for total Cr. The Weight of Evidence Method, which uses the distribution of effects/no-effects data were chosen to derive a direct soil contact value. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 312 µg/g , and the 50th percentile was 500 µg/g . For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the "effects only" data was 725 µg/g.

The derived direct soil contact value for total Cr is 310 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 500 µg/g for Industrial/Commercial/Community land use category.

Table 4.10. Studies of Chromium (total) toxicity on terrestrial plants and soil invertebrates

Chromium compound	Organism	Effect measurement	Media Type	Soil PH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Acetic acid, Chromium(3+) salt	*Oat (Avena sp.)*	Biomass	Natural	5.6	200 days	Whole organism	283	NOEC	De Haan, 1985
Nitric acid, Chromium(3+) salt	Earthworm *(Eisenia andrei)*	Weight	Artificial	6	3 weeks	Whole organism	287	NOEC	Van Gestel et al. 1989
Nitric acid, Chromium(3+) salt	Earthworm *(Eisenia andrei)*	Weight	Artificial	6.7	6 weeks	Whole organism	320	NOEC	Van Gestel et al. 1992
Nitric acid, Chromium(3+) salt	Earthworm *(Eisenia andrei)*	Weight	Artificial	6	6 weeks	Whole organism	973	LOEC	Van Gestel et al. 1989
Nitric acid, Chromium(3+) salt	Earthworm *(Eisenia andrei)*	Weight	Artificial	6.7	6 weeks	Whole organism	1000	LOEC	Van Gestel et al. 1992
Nitric acid, Chromium(3+) salt	Earthworm *(Eisenia andrei)*	Mortality	Artificial	6	2 weeks	Whole organism	800	LC50	Van Gestel et al. 1989
Chromium oxide	Prennial ryegrass *(Lolium perenne)*	Biomass	Natural	5.2	35 days	Whole organism	500	NOEC	Otabbong, 1989
Chromium oxide	Prennial ryegrass *(Lolium perenne)*	Biomass	Natural	6.9	35 days	Whole organism	500	LOEC	Otabbong, 1989

4.3.4 Cobalt

For cobalt (Co), there were 12 studies consisting of eight vegetation studies and four soil invertebrate studies. Three soil invertebrate studies were eliminated because they didn't report any endpoint. Four plant studies were also eliminated for not reporting an endpoint or only measuring biochemical effects such accumulation or biochemical concentration of Co in test plants, which can't be directly related to adverse effects on plants.

Four vegetation studies and two soil invertebrate studies met the criteria set for ecological standard development. Therefore, there is sufficient information to create a direct soil contact value. The Weight of Evidence Method, which uses the distribution of effects/no-effects data was chosen to develop a standard for cobalt. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 33 µg/g, and the 50th percentile was 72 µg/g. For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the "effects only" data was 43 µg/g.

The derived direct soil contact value for Co is 33 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 72 µg/g for Industrial/Commercial/Community land use.

Table 4.11. Studies of Cobalt toxicity on terrestrial plants and soil invertebrates

Cobalt compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Cobalt chloride	Barley *(Hordeum vulgare)*	Weight	Natural	6.32	18 weeks	Whole organism	68	EC20	TN&Associates Inc. 2000
Cobalt chloride	Alfafa *(Medicago sativa)*	Weight	Natural	6.32	22 days	Whole organism	10	EC20	TN&Associates Inc. 2000
Cobalt chloride	*Raphanus sativus*	Biomass	Natural	6.32	18 days	Whole organism	35	EC20	TN&Associates Inc. 2000
Cobalt chloride	Radish *Earthworm (Eisenia fetida)*	Weight	Natural	Not reported	24 weeks	Whole organism	91.9	LOEC	Neuhauser et al. 1984
Cobalt chloride	Tomato *(Lycopersicon esculentum)*	Biomass (no reduction)	Natural	8.24	Grown to maturity	Whole organism	200	NOEC	Perez-Espinosa et al. 1999
Cobalt chloride	Earthworm *(Eisenia fetida)*	Weight	Natural	Not reported	24 weeks	Whole organism	25.9	NOEC	Neuhauser et al. 1984
Cobalt sulfate	Cotton *Gossypium barbadense*	Biomass	Natural	6	35 days	Stem	100	LOEC	Rehab and Wallace, 1978
Cobalt sulfate	Corn *(Zea mays)*	Biomass (52% reduction)	Natural	6	21 days	Shoot	75	LOEC	Wallace, 1989

4.3.5 Copper

For copper (Cu), there were 97 studies consisting of 42 soil invertebrate studies and 55 vegetation studies. Thirty-six soil invertebrate studies were eliminated because they either didn't report an endpoint or the test organisms were exposed to Cu on filter paper, which is not an acceptable medium. Forty-three vegetation studies were also eliminated because they either didn't report an endpoint or only measured Cu uptake and accumulation in test plants, as well as other biochemical or physiological effects, which can't be correlated directly to adverse effects of Cu on plants.

Six soil invertebrate studies and 12 vegetation studies were acceptable and met the criteria for standard development. Therefore, there is sufficient information to set a standard for Cu in plants. The Weight of Evidence Method, which uses the distribution of effects/no-effects data was used to derive a direct soil contact value for copper. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 141 µg/g, and the 50th percentile was 232 µg/g. For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the "effects only" data was 200 µg/g.

The derived direct soil contact value for Cu is 140 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 230 µg/g for Industrial/Commercial/Community land use.

Table 4.12. Studies of Copper toxicity on terrestrial plants and soil invertebrates

Copper compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Resp site	Concentration (µg/g)	Endpoint	Reference
Sulfuric acid, Copper(2+) salt(1:1)	Worm *(Aporrectodea caliginosa)*	Weight	Natural	7.05	6 weeks	Whole Organism	81.8	EC50	Khalil et al. 1996
Copper sulfate, Tribasic	Common oat *(Avena sativa)*	Biomass (6% reduction)	Natural	6.4	31 days	Plant tops	4791	NOEC	Roth et al. 1971
Sulfuric acid, Copper(2+) salt(1:1)	Nematode *(Cephalobus sp.)*	Population Growth	Natural	6.1	10 years	Not reported	125	LOEC	Korthals et al. 1996b
Sulfuric acid, Copper(2+) salt(1:1)	Roundworm *(Cervidellus sp.)*	Population Growth	Natural	5.4	10 years	Not reported	250	LOEC	Korthals et al. 1996b
Sulfuric acid, Copper(2+) salt(1:1)	Citrus hybrid	Biomass (7% reduction)	Natural	7	106 days	Root	100	NOEC	Mozaffari et al. 1996
Sulfuric acid, Copper(2+) salt(1:1)	Citrus hybrid	Biomass (17% reduction)	Natural	7	106 days	Root	200	LOEC	Mozaffari et al. 1996
Sulfuric acid, Copper(2+) salt(1:1)	Earthworm *(Eisenia foetida)*	Mortality	Artificial	6.5	14 days	Whole Organism	1460	LC50	Edwards and Bater, 1992
Sulfuric acid, Copper(2+) salt(1:1)	Springtail *(Folsomia candida)*	General Reproduction	Natural	6.7	4 weeks	Whole Organism	519	EC50	Pedersen et al. 2000
Sulfuric acid, Copper(2+) salt(1:1)	Springtail *(Folsomia candida)*	General Reproduction	Natural	6.7	4 weeks	Whole Organism	50	EC10	Pedersen et al. 2000
Sulfuric acid, Copper(2+) salt(1:1)	Springtail *Folsomia fimetaria*	General Reproduction	Natural	6.7	3 weeks	Whole Organism	657	EC50	Pedersen et al. 2000
Sulfuric acid, Copper(2+) salt(1:1)	Springtail *Folsomia fimetaria*	General Reproduction	Natural	6.7	3 weeks	Whole Organism	141	EC10	Pedersen et al. 2000
Copper sulfate, Tribasic	Soybean *(Glycine max)*	Biomass (15% reduction)	Natural	6.4	46 days	Plant tops	2032	NOEC	Roth et al., 1971
Copper sulfate,	Soybean	Biomass	Natural	6.4	46 days	Plant tops	4791	LOEC	Roth et al.,

Copper compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Resp site	Concentration (µg/g)	Endpoint	Reference
Tribasic	*(Glycine max)*	(38% reduction)							1971
Copper sulfate, Tribasic	American-Egyptian cotton *(Gossypium barbadense)*	Biomass (35% reduction)	Natural	6.6	5 weeks	Leaf	400	LOEC	Rehab and Wallace, 1978
Copper sulfate, Tribasic	American-Egyptian cotton *(Gossypium barbadense)*	Biomass (5% reduction)	Natural	6.6	5 weeks	Leaf	200	NOEC	Rehab and Wallace, 1978
Copper sulfate, Tribasic	Cotton *(Gossypium hirsutum)*	Biomass (10% reduction)	Natural	6.6	5 weeks	Stem	200	NOEC	Rehab and Wallace, 1978
Copper sulfate, Tribasic	Cotton *(Gossypium hirsutum)*	Biomass (49% reduction)	Natural	6.6	5 weeks	Leaf	400	LOEC	Rehab and Wallace, 1978
Sulfuric acid, Copper(2+) salt(1:1)	Earthworm *(Lumbricus rubellus)*	Weight	Natural	7.1	2.5 weeks	Whole Organism	148	NOEC	Ma, 1984
Sulfuric acid, Copper(2+) salt(1:1)	Earthworm *(Lumbricus rubellus)*	Weight	Natural	7.1	2.5 weeks	Whole Organism	278	LOEC	Ma, 1984
Sulfuric acid, Copper(2+) salt(1:1)	*Alfalfa (Medicago sativa)*	Biomass (30% reduction)	Natural	7	2 months	Shoot	113	LOEC	Biro et al. 1998
Sulfuric acid, Copper(2+) salt(1:1)	*Alfalfa (Medicago sativa)*	Biomass	Natural	7.5	Grown to maturity	Above ground	257	EC10	Gonzalez, 1991
Sulfuric acid, Copper(2+) salt(1:1)	*Mesorhabditis sp.*	General population growth	Natural	5.4	10 years	Not reported	375	NOEC	Korthals et al. 1996b
Sulfuric acid, Copper(2+) salt(1:1)	*Nemata*	Abundance	Natural	5.4	10 years	Not reported	217	LOEC	Korthals et al. 1996b
Sulfuric acid, Copper(2+) salt(1:1)	*Nothotylenchus sp.*	General population growth	Natural	5.4	10 years	Not reported	250	NOEC	Korthals et al. 1996b
Sulfuric acid, Copper(2+) salt(1:1)	Nematode *(Panagrolaimus sp.)*	General population growth	Natural	6.1	10 years	Not reported	375	NOEC	Korthals et al. 1996b
Copper hydroxide (Cu(OH)2)	Bean *(Phaseolus vulgaris)*	Biomass (2% reduction)	Natural	6.7	Grown to maturity	Pods	74	NOEC	Walsh et al. 1972
Sulfuric acid,	Bean	Biomass	Natural	6.7	Grown to	Pods	222	LOEC	Walsh et al.

Copper compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Resp site	Concentration (µg/g)	Endpoint	Reference
Copper(2+) salt(1:1)	*(Phaseolus vulgaris)*	(97% reduction)			maturity				1972
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Polygonum convolvulus L.)*	Biomass (8% reduction)	Natural	6.4	34 days	Plant above ground	200	NOEC	Kjaer and Elmegaard, 1996
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Polygonum convolvulus L.)*	Mortality	Natural	6.4	105 days	Whole Organism	125	NOEC	Kjaer and Elmegaard, 1996
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Polygonum convolvulus L.)*	Biomass (62% reduction)	Natural	6.4	34 days	Plant above ground	315	LOEC	Kjaer and Elmegaard, 1996
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Polygonum convolvulus L.)*	Mortality	Natural	6.4	105 days	Whole Organism	200	LOEC	Kjaer and Elmegaard, 1996
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Fallopia convolvulus)*	Germination	Natural	6.6	2 months	Seed	391	NOEC	Kjaer et al. 1998
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Fallopia convolvulus)*	Mortality	Natural	6.6	2 months	Seedlings	232	NOEC	Kjaer et al. 1998
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Fallopia convolvulus)*	Germination	Natural	6.6	2 months	Seed	704	LOEC	Kjaer et al. 1998
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Fallopia convolvulus)*	Mortality	Natural	6.6	2 months	Seedlings	391	LOEC	Kjaer et al. 1998
Sulfuric acid, Copper(2+) salt(1:1)	Bindweed *(Fallopia convolvulus)*	Biomass	Natural	6.7	12 weeks	Root	275	EC50	Pedersen et al. 2000
Sulfuric acid, Copper(2+) salt(1:1)	Red clover *(Trifolium pratense)*	Biomass (37% reduction)	Natural	7	2 months	Shoot	113	LOEC	Biro et al. 1998
Copper	Bread wheat *(Triticum aestivum)*	Biomass (no reduction)	Natural	7.8	Grown to maturity	Whole Organism	20	NOEC	Chhibba et al. 1994
Copper	Bread wheat *(Triticum aestivum)*	Biomass (13% reduction)	Natural	7.8	Grown to maturity	Whole Organism	40	LOEC	Chhibba et al. 1994
Sulfuric acid,	Corn	Biomass	Natural	6.5	Grown to	Grain	180	NOEC	Reed et al.

Copper compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Resp site	Concentration (µg/g)	Endpoint	Reference
Copper(2+) salt(1:1)	*(Zea mays)*	(no reduction)			maturity				1993
Sulfuric acid, Copper(2+) salt(1:1)	Corn *(Zea mays)*	Biomass (17% reduction)	Natural	6.1	10 weeks	Above ground	375	LOEC	Boon et al. 1998

4.3.6 Lead

For lead (Pb), there were 78 studies consisting of 39 soil invertebrate studies and 39 vegetation studies. Thirty-three soil invertebrate studies were eliminated because they either didn't report an endpoint or the tests were conducted on filter paper which is not an acceptable medium. Thirty vegetation studies were also eliminated because they either didn't report an endpoint or only measured Pb uptake and accumulation in test plants, as well as other biochemical or physiological effects, which can't be correlated to direct adverse effects of Pb on plants.

Six soil invertebrate studies and nine vegetation studies were acceptable and met the criteria for standard development. Therefore, there is sufficient information to set a standard for Pb in terrestrial plants. The Weight of Evidence Method, which uses the distribution of effects/no-effects data was used to derive a direct soil contact value for Pb. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. . All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 246µg/g, and the 50th percentile was 1100 µg/g. For purpose of comparing the latter value with that which would be derived using the CCME method for Ind/Com land use, the 25th percentile of the "effects only" data was 559µg/g.

The derived direct soil contact value for Pb is 250µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 1100 µg/g for Industrial/Commercial/Community land use.

Table 4.13. Studies of Lead toxicity on terrestrial plants and soil invertebrates

Lead compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Acetic acid, Lead(2+) salt	Alyssum *(Alyssum pintodasilvae)*	Growth (9% reduction)	Natural	6.7	2 months	Unspecified	100	LOEC	De Varennes et al. 1996
Nitric acid, Lead (2+) salt	Nematode *(Caenorhabditis elegans)*	Mortality	Arfticial	5	24 hours	Whole organism	2293	LC50	Peredney and Williams, 2000
Nitric acid, Lead (2+) salt	Earthworm *(Eisenia fetida)*	Mortality	Arfticial	6.1	14 days	Whole organism	3240	NOEC	Spurgeon and Hopkin, 1995
Nitric acid, Lead (2+) salt	Earthworm *(Eisenia fetida)*	Weight	Arfticial	6.1	21 days	Whole organism	1886	NOEC	Spurgeon and Hopkin, 1995
Nitric acid, Lead (2+) salt	Earthworm *(Eisenia fetida)*	Mortality	Arfticial	6.1	14 days	Whole organism	10000	LOEC	Spurgeon and Hopkin, 1995
Nitric acid, Lead (2+) salt	Earthworm *(Eisenia fetida)*	Cocoon production	Arfticial	6.3	56 days	Whole organism	1940	EC50	Spurgeon et al. 1994
Nitric acid, Lead (2+) salt	Earthworm *(Eisenia fetida)*	Mortality	Arfticial	6	2 weeks	Whole organism	4726	LC50	Neuhauser et al. 1985b
Nitric acid, Lead (2+) salt	Earthworm *(Eisenia fetida)*	Weight	Arfticial	6.1	21 days	Whole organism	2249	EC50	Spurgeon and Hopkin, 1995
Nitric acid, Lead (2+) salt	Barley *(Hordeum vulgare)*	Biomass	Natural	7.8	45 days	Shoot	232	NOEC	Aery and Jagetiya, 1997
Nitric acid, Lead (2+) salt	Barley *(Hordeum vulgare)*	Length	Natural	7.8	45 days	Shoot	559	LOEC	Aery and Jagetiya, 1997
Lead chloride	Ryegrass *(Lolium sp.)*	Biomass (no reduction)	Natural	5.6	3 years	Whole organism	50	NOEC	Singh and Jeng, 1993
Lead chloride	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	7.3	12 weeks	Whole organism	1000	NOEC	Ma, 1982
Lead chloride	Earthworm *(Lumbricus rubellus)*	Weight	Natural	7.3	12 weeks	Whole organism	1000	NOEC	Ma, 1982
Lead chloride	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	7.3	12 weeks	Whole organism	3000	LOEC	Ma, 1982
Lead chloride	Earthworm *(Lumbricus rubellus)*	Weight	Natural	7.3	12 weeks	Whole organism	3000	LOEC	Ma, 1982
Lead chloride	Loblolly pine *(Pinus taeda)*	Biomass (25% reduction)	Natural	5.48	19 weeks	Root	600	NOEC	Seiler and Paganelli, 1987
Lead chloride	Loblolly pine *(Pinus taeda)*	Biomass (60% reduction)	Natural	5.25	19 weeks	Root	1200	LOEC	Seiler and Paganelli, 1987
Lead chloride	Northern red oak *(Quercus rubra)*	Biomass	Natural	6	16 weeks	Whole organism	100	NOEC	Dixon, 1988

Lead compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Acetic acid, Lead(2+) salt	Annual sow thistle *(Sonchus oleraceus)*	Biomass (16% reduction)	Natural	7.23	45 days	Whole organism	1600	NOEC	Xiong, 1997
Acetic acid, Lead(2+) salt	Annual sow thistle *(Sonchus oleraceus)*	Biomass (32% reduction)	Natural	7.23	45 days	Whole organism	3200	LOEC	Xiong, 1997
Nitric acid, Lead (2+) salt	Fenugreek *(Trigonella foenum-graecum)*	Biomass (10% reduction)	Natural	8.3	8 weeks	Unspecified	200	NOEC	Dang et al. 1990
Nitric acid, Lead (2+) salt	Fenugreek *(Trigonella foenum-graecum)*	Biomass (20% reduction)	Natural	8.3	8 weeks	Unspecified	400	LOEC	Dang et al. 1990
Lead chloride	Corn *(Zea mays)*	Length	Natural	6	5 days	Root	125	NOEC	Miller et al. 1976
Lead chloride	Corn *(Zea mays)*	Length	Natural	6	5 days	Root	250	LOEC	Miller et al. 1976

4.3.7 Nickel

For nickel (Ni), there were 49 studies consisting of 15 soil invertebrate studies and 34 vegetation studies. Nine soil invertebrate studies were eliminated, mainly because they either didn't report an endpoint or the tests were conducted on filter paper, which is not an acceptable medium. Twenty-four vegetation studies were also eliminated because they either didn't report an endpoint or measured Ni uptake and accumulation in test plants, as well as other biochemical or physiological effects which can't be correlated to direct adverse effects of nickel on vegetation.

Six soil invertebrate studies and 10 vegetation studies were acceptable and met the criteria set for standard development. Therefore, there is sufficient information to develop a direct soil contact value for Ni. The Weight of Evidence Method, which uses the distribution of effects/no-effects data was used to create a standard for nickel. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 100 µg/g, and the 50th percentile was 270 µg/g. For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the "effects only" data was 110 µg/g.

The derived direct soil contact value for Ni is 100 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 270 µg/g for Industrial/Commercial/Community land use..

Table 4.14. Studies of Nickel toxicity on terrestrial plants and soil invertebrates

Nickel compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Sulfuric acid, Nickel(2+)salt (1:1)	Common onion *(Allium cepa)*	Biomass (21% reduction)	Natural	8.3	8 weeks	Unspecified	50	LOEC	Dang et al. 1990
Sulfuric acid, Nickel(2+)salt (1:1)	Common oat *(Avena sativa)*	Biomass (2% reduction)	Natural	6.1	31 days	Plant tops	3840	NOEC	Roth et al. 1971
Sulfuric acid, Nickel(2+)salt (1:1)	Common oat *(Avena sativa)*	Biomass (75% reduction)	Natural	6.1	31 days	Plant tops	7269	LOEC	Roth et al. 1971
Nickel	Mustard *(Brassica sp.)*	Biomass	Natural	8	Grown to maturity	Grain	115	NOEC	Gupta et al. 1996
Nickelous nitrate	Nematode *(Caenorhabditis elegans)*	Mortality	Artificial	7.21	24 hours	Whole organism	2490	LC50	Peredney and Williams, 2000
Nickelous nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6	2 weeks	Whole organism	757	LC50	Neuhauser et al. 1985b
Nickelous chloride	Earthworm *(Eisenia veneta)*	Fertile cocoons	Natural	5.5	4 weeks	Whole organism	100	NOEC	Scott-Fordsmand et al. 1998
Nickelous chloride	Earthworm *(Eisenia veneta)*	Mortality	Natural	5.5	4 weeks	Whole organism	700	NOEC	Scott-Fordsmand et al. 1998
Nickelous chloride	Earthworm *(Eisenia veneta)*	Fertile cocoons	Natural	5.5	4 weeks	Whole organism	300	LOEC	Scott-Fordsmand et al. 1998
Nickelous chloride	Earthworm *(Eisenia veneta)*	Mortality	Natural	5.5	4 weeks	Whole organism	1000	LOEC	Scott-Fordsmand et al. 1998
Nickelous chloride	Earthworm *(Eisenia veneta)*	Fertile cocoons	Natural	5.5	4 weeks	Whole organism	300	EC50	Scott-Fordsmand et al. 1998
Nickelous chloride	Earthworm *(Eisenia veneta)*	Fertile cocoons	Natural	5.5	4 weeks	Whole organism	85	EC10	Scott-Fordsmand et al. 1998
Nickelous chloride	Springtail *Folsomia fimetaria*	Fertile cocoons	Natural	5.5	21 days	Whole organism	300	NOEC	Scott-Fordsmand et al. 1999

Nickel compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Nickelous chloride	Springtail *Folsomia fimetaria*	Mortality	Natural	5.5	21 days	Whole organism	700	NOEC	Scott-Fordsmand et al. 1999
Nickelous chloride	Springtail *Folsomia fimetaria*	Fertile cocoons	Natural	5.5	21 days	Whole organism	500	LOEC	Scott-Fordsmand et al. 1999
Nickelous chloride	Springtail *Folsomia fimetaria*	Mortality	Natural	5.5	21 days	Whole organism	1000	LOEC	Scott-Fordsmand et al. 1999
Nickelous chloride	Springtail *Folsomia fimetaria*	Mortality	Natural	5.5	21 days	Whole organism	856	LC50	Scott-Fordsmand et al. 1999
Nickelous chloride	Springtail *Folsomia fimetaria*	Mortality	Natural	5.5	21 days	Whole organism	536	LC10	Scott-Fordsmand et al. 1999
Nickelous chloride	Springtail *Folsomia fimetaria*	Fertile cocoons	Natural	5.5	21 days	Whole organism	450	EC50	Scott-Fordsmand et al. 1999
Nickelous chloride	Springtail *Folsomia fimetaria*	Fertile cocoons	Natural	5.5	21 days	Whole organism	173	EC10	Scott-Fordsmand et al. 1999
Sulfuric acid, Nickel(2+)salt (1:1)	Soybean *(Glycine max)*	Biomass (no reduction)	Natural	6.1	46 days	Plant tops	1099	NOEC	Roth et al. 1971
Sulfuric acid, Nickel(2+)salt (1:1)	Soybean *(Glycine max)*	Biomass (44% reduction)	Natural	6.1	46 days	Plant tops	1356	LOEC	Roth et al. 1971
Sulfuric acid, Nickel(2+)salt (1:1)	American- Egyptian cotton *(Gossypium barbadense)*	Biomass (45% reduction)	Natural	6.8	5 weeks	Leaf	100	LOEC	Rehab and Wallace, 1978
Sulfuric acid, Nickel(2+)salt (1:1)	Cotton *(Gossypium hirsutum)*	Biomass (44% reduction	Natural	6.8	5 weeks	Leaf	100	LOEC	Rehab and Wallace, 1978
Sulfuric acid, Nickel(2+)salt (1:1)	Barley *(Hordeum vulgare)*	Biomass (75% reduction)	Natural	6.5	28 days	Unspecified	25	LOEC	Wallace et al. 1977
Nickelous chloride	Ryegrass *(Lollum sp.)*	Biomass	Natural	5.6	3 weeks	Unspecified	50	NOEC	Singh and Jeng, 1993
Nickelous	Earthworm	Weight	Natural	7.3	12 weeks	Whole	1000	NOEC	Ma, 1982

Nickel compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
chloride	*(Lumbricus rubellus)*					organism			
Nickelous chloride	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	7.3	12 weeks	Whole organism	2000	LC50	Ma, 1982
Sulfuric acid, Nickel(2+)salt (1:1)	Alfalfa *(Medicago sativa)*	Biomass (23% reduction)	Natural	7	2 months	Shoot	270	NOEC	Biro et al., 1998
Sulfuric acid, Nickel(2+)salt (1:1)	Bean *(Phaseolus vulgaris)*	Biomass (no reduction)	Natural	7.5	16 days	Leaf	100	NOEC	Wallace et al. 1977
Sulfuric acid, Nickel(2+)salt (1:1)	Bean *(Phaseolus vulgaris)*	Biomass (36% reduction)	Natural	7.5	16 days	Leaf	250	LOEC	Wallace et al. 1977
Nickelous chloride	Northern red oak *(Quercus rubra)*	Biomass	Natural	6	16 weeks	Whole organism	100	NOEC	Dixon, 1988
Acetic acid, Nickel(2+)salt	Red clover *(Trifolium pratense)*	Biomass	Natural	8.1	35 days	Plant tops	100	NOEC	Elmosly and Abdel-Sabour, 1997
Sulfuric acid, Nickel(2+)salt (1:1)	Red clover *(Trifolium pratense)*	Biomass (33% reduction)	Natural	7	2 months	Shoot	35	LOEC	Biro et al. 1998
Sulfuric acid, Nickel(2+)salt (1:1)	Fenugreek *(Trigonella foenum-graecum)*	Biomass (21% reduction)	Natural	8.3	8 weeks	Unspecified	50	LOEC	Dang et al. 1990
Sulfuric acid, Nickel(2+)salt (1:1)	Corn *(Zea mays)*	Biomass (no reduction)	Natural	5.6	14 days	Shoot	100	NOEC	Wallace et al. 1977
Nickelous chloride	Corn *(Zea mays)*	Biomass (5% reduction)	Natural	8.02	40 days	Unspecified	71	NOEC	Narwal et al. 1996
Sulfuric acid, Nickel(2+)salt (1:1)	Corn *(Zea mays)*	Biomass (80% reduction)	Natural	5.6	14 days	Shoot	250	LOEC	Wallace et al. 1977
Nickelous chloride	Corn *(Zea mays)*	Biomass (72% reduction)	Natural	8.02	40 days	Unspecified	141	LOEC	Narwal et al. 1996

4.3.8 Zinc

For zinc (Zn), there were 161 studies consisting of 50 soil invertebrate studies and 111 vegetation studies. Thirty-five soil invertebrate studies were eliminated because they either didn't report an endpoint or the tests were conducted on filter paper, which is not an acceptable medium. One hundred-three vegetation studies were also eliminated for not reporting an endpoint or in several cases reporting Zn toxicity in mixture with other chemicals, or only measuring biochemical effects, which can't be correlated to direct adverse effects on plants.

Fifteen soil invertebrate studies and eight vegetation studies were acceptable and met the criteria set for standard development. Therefore, there is sufficient information to derive a direct soil contact value. The Weight of Evidence Method, which uses the distribution of effects/no-effects data was chosen to develop a standard for Zn. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 400 µg/g, and the 50th percentile was 666 µg/g. For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the "effects only" data was 577 µg/g.

Zinc poses an additional problem in that the derived value for the Industrial/Commercial land use category is above a number of EC_{50} and LC_{50} values. Most of these values are for springtails (a soil microarthropod) in artificial soils with highly available forms of zinc added, and it can be argued that they should not be used to lower the 666 value for an Industrial/Commercial/Community standard. However, there are five LC50s for earthworms that are below the 666 value, and it is normally viewed that the generic criterion for Industrial/Commercial/Community should be protective of earthworms. As such the number should be lowered such that there would be a higher degree of confidence that the number is protective of earthworms. In lowering a number, an uncertainty factor is normally recommended; however in the case of Zn, it was felt that the currently available data clearly indicates that the existing (1996) criterion of 600 µg/g for Zn in an Industrial/Commercial scenario is still the most appropriate value. Both the CCME protocol method and the modified MOE method, used with current data, place the calculated value in that range, and the 600 µg/g value is within the uncertainty of our understanding of where such a value should lie. Given the highly available forms of Zn used in the studies, it is highly likely that 600 µg/g is at the conservative end of that range and is sufficiently protective of plants and soil organisms at industrial and commercial sites being remediated. There is therefore, no scientific justification to change the standard from the existing 600 µg/g, and the current scientific review adds support to the appropriateness of that number.

The derived direct soil contact value is therefore 400 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 600 µg/g for the Industrial/Commercial/Community land use category.

Table 4.15. Studies of Zinc toxicity on terrestrial plants and soil invertebrates

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
Sulfuric acid, Zinc salt (1:1)	Common onion *(Allium cepa)*	Biomass (7% reduction)	Natural	8.3	Grown to maturity	Unspecified	100	NOEC	Dang et al. 1990
Sulfuric acid, Zinc salt (1:1)	Common onion *(Allium cepa)*	Biomass (12% reduction)	Natural	8.3	Grown to maturity	Unspecified	200	LOEC	Dang et al. 1990
Zinc nitrate	Worm *(Aporrectodea caliginosa)*	Mortality	Natural	6.35	14 days	Whole Organism	1695	LC50	Spurgeon et al. 2000
Zinc nitrate	Worm *(Aporrectodea caliginosa)*	Mortality	Natural	6.35	48 days	Whole Organism	1619	LC50	Spurgeon et al. 2000
Zinc nitrate	Worm *(Aporrectodea caliginosa)*	Mortality	Natural	6.35	14 days	Whole Organism	1417	LC10	Spurgeon et al. 2000
Zinc nitrate	Worm *(Aporrectodea caliginosa)*	Mortality	Natural	6.35	48 days	Whole Organism	1402	LC10	Spurgeon et al. 2000
Sulfuric acid, Zinc salt (1:1) sulphate	Worm *(Aporrectodea caliginosa)*	Weight	Natural	7.05	6 weeks	Whole Organism	461	EC50	Khalil et al. 1996
Zinc nitrate	Worm *(Aporrectodea caliginosa)*	Weight	Natural	6.35	48 days	Whole Organism	868	EC50	Spurgeon et al. 2000
Zinc nitrate	Worm *(Aporrectodea caliginosa)*	Weight	Natural	6.35	14 days	Whole Organism	417	EC10	Spurgeon et al. 2000
Zinc nitrate	Worm *(Aporrectodea rosea)*	Mortality	Artificial	Not reported	14 days	Whole Organism	561	LC50	Spurgeon and Hopkin, 1996b
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Emergence	Artificial	6.3	Grown to maturity	Seed	50	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Emergence	Natural	7.3	Grown to maturity	Seed	600	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Emergence	Natural	7.9	Grown to maturity	Seed	600	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Biomass	Artificial	6.3	Grown to maturity	Stem	50	NOEC	Sheppard et al. 1993

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Biomass	Natural	7.3	Grown to maturity	Stem	600	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Biomass	Natural	7.9	Grown to maturity	Stem	600	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Height	Natural	7.3	Grown to maturity	Stem	600	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Height	Natural	7.9	Grown to maturity	Stem	600	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Emergence	Artificial	6.3	Grown to maturity	Seed	100	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Emergence	Natural	7.3	Grown to maturity	Seed	1000	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Emergence	Natural	7.9	Grown to maturity	Seed	1000	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Biomass	Artificial	6.3	Grown to maturity	Stem	100	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Biomass	Natural	7.3	Grown to maturity	Stem	1000	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Biomass	Natural	7.9	Grown to maturity	Stem	1000	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Height	Artificial	6.3	Grown to maturity	Stem	50	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Height	Natural	7.3	Grown to maturity	Stem	1000	LOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	*(Brassica rapa)*	Height	Natural	7.9	Grown to maturity	Stem	1000	LOEC	Sheppard et al. 1993
Zinc chloride	Nematode *(Caenorhabditis elegans)*	Mortality	Artificial	7.14	24 hours	Whole Organism	1643	LC50	Peredney and Williams, 2000
Zinc nitrate	Nematode *(Caenorhabditis elegans)*	Mortality	Artificial	7.14	24 hours	Whole Organism	1915	LC50	Peredney and Williams, 2000
Zinc chloride	Field earthworm *(Drawida willsi)*	Mortality (juvenile)	Natural	6.8	14 days	Whole Organism	762.87	LC50	Panda et al. 1999
Zinc chloride	Field earthworm *(Drawida willsi)*	Mortality (immature)	Natural	6.8	14 days	Whole Organism	840.69	LC50	Panda et al. 1999
Zinc chloride	Field earthworm *(Drawida willsi)*	Mortality (adult)	Natural	6.8	14 days	Whole Organism	907.82	LC50	Panda et al. 1999
Zinc nitrate	Earthworm	Weight	Artificial	6.1	21 days	Whole	400	NOEC	Spurgeon and

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
	(Eisenia fetida)					Organism			Hopkin, 1995
Zinc nitrate	Earthworm *(Eisenia fetida)*	Weight	Artificial	Not reported	21 days	Whole Organism	620	NOEC	Spurgeon and Hopkin, 1996b
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6.1	21 days	Whole Organism	442	NOEC	Spurgeon and Hopkin, 1995
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6	21 days	Whole Organism	1048	NOEC	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	5	21 days	Whole Organism	368	NOEC	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6	21 days	Whole Organism	702	NOEC	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	5	21 days	Whole Organism	256	NOEC	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6	21 days	Whole Organism	274	NOEC	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	5	21 days	Whole Organism	366	NOEC	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6.3	56 days	Whole Organism	289	NOEC	Spurgeon et al. 1994
Zinc nitrate	Earthworm *(Eisenia fetida)*	Weight	Artificial	Not reported	21 days	Whole Organism	1200	LOEC	Spurgeon and Hopkin, 1996b
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6	2 weeks	Whole Organism	662	LC50	Neuhauser et al. 1985
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6	21 days	Whole Organism	1613	LC50	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	5	21 days	Whole Organism	992	LC50	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6	21 days	Whole Organism	791	LC50	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	5	21 days	Whole Organism	601	LC50	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia foetida)*	Mortality	Artificial	6	21 days	Whole Organism	620	LC50	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	5	21 days	Whole Organism	591	LC50	Spurgeon and Hopkin, 1996a
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	Not reported	21 days	Whole Organism	1106	LC50	Spurgeon and Hopkin, 1996b
Zinc nitrate	Earthworm	Mortality	Natural	6.35	14 days	Whole	3172	LC50	Spurgeon et al. 2000

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
	(Eisenia fetida)					Organism			
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Natural	6.35	48 days	Whole Organism	3150	LC50	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6.3	14 days	Whole Organism	1010	LC50	Spurgeon et al. 1994
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6.3	56 days	Whole Organism	745	LC50	Spurgeon et al. 1994
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Natural	6.35	14 days	Whole Organism	2511	LC10	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Natural	6.35	48 days	Whole Organism	2740	LC10	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Eisenia fetida)*	Weight	Artificial	6.1	21 days	Whole Organism	400	EC50	Spurgeon and Hopkin, 1995
Zinc nitrate	Earthworm *(Eisenia fetida)*	Weight	Artificial	Not reported	21 days	Whole Organism	693	EC50	Spurgeon and Hopkin, 1996b
Zinc nitrate	Earthworm *(Eisenia fetida)*	Mortality	Artificial	6.1	21 days	Whole Organism	1078	EC50	Spurgeon and Hopkin, 1995
Zinc chloride	Springtail *(Folsomia candida)*	Weight	Natural	Not reported	4 weeks	Whole Organism	1198	NOEC	Smit and Van Gestel, 1998
Zinc chloride	Springtail *(Folsomia candida)*	Weight	Natural	Not reported	4 weeks	Whole Organism	457	NOEC	Smit and Van Gestel, 1998
Zinc chloride	Springtail *(Folsomia candida)*	Weight	Natural	Not reported	4 weeks	Whole Organism	256	NOEC	Smit et al. 1998
Zinc chloride	Springtail *(Folsomia candida)*	Weight	Natural	Not reported	4 weeks	Whole Organism	410	NOEC	Smit et al. 1998
Zinc chloride	Springtail *(Folsomia candida)*	Weight	Artificial	6	4 weeks	Whole Organism	567	NOEC	Smit and Van Gestel, 1998
Zinc chloride	Springtail *(Folsomia candida)*	Weight	Natural	Not reported	4 weeks	Whole Organism	410	LOEC	Smit et al. 1998
Zinc chloride	Springtail *(Folsomia candida)*	Weight	Natural	Not reported	4 weeks	Whole Organism	655	LOEC	Smit et al. 1998
Zinc chloride	Springtail *(Folsomia candida)*	Mortality	Natural	Not reported	4 weeks	Whole Organism	796	LC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail *(Folsomia candida)*	Mortality	Natural	Not reported	4 weeks	Whole Organism	727	LC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail *(Folsomia candida)*	Mortality	Natural	Not reported	6 weeks	Whole Organism	864	LC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail	Mortality	Natural	Not	6 weeks	Whole	821	LC50	Smit and Van

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
	(*Folsomia candida*)			reported		Organism			Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	42 days	Whole Organism	741	LC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	35 days	Whole Organism	650	LC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	28 days	Whole Organism	699	LC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	23 days	Whole Organism	580	LC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	4 weeks	Whole Organism	625	LC50	Smit et al. 1998
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	10 weeks	Whole Organism	476	LC50	Smit et al. 1998
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	4 weeks	Whole Organism	670	LC50	Smit et al. 1998
Zinc chloride	Springtail (*Folsomia candida*)	Mortality	Natural	Not reported	10 weeks	Whole Organism	1085	LC50	Smit et al. 1998
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	6 weeks	Whole Organism	462	EC50	Smit and Van Gestel, 1996
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	42 days	Whole Organism	443	EC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	35 days	Whole Organism	458	EC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	28 days	Whole Organism	526	EC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	23 days	Whole Organism	567	EC50	Smit and Van Gestel, 1997
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Artificial	6	4 weeks	Whole Organism	1228	EC50	Smit and Van Gestel, 1998
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	3200	EC50	Smit and Van Gestel, 1998
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	584	EC50	Smit and Van Gestel, 1998
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	476	EC50	Smit et al. 1998
Zinc chloride	Springtail (*Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	152	EC50	Smit et al. 1998
Zinc chloride	Springtail	Weight	Artificial	Not	2 weeks	Whole	1160	EC50	Van Gestel and

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
	(Folsomia candida)			reported		Organism			Hensbergen, 1997
Zinc chloride	Springtail *(Folsomia candida*)	Weight	Artificial	Not reported	4 weeks	Whole Organism	1202	EC50	Van Gestel and Hensbergen, 1997
Zinc chloride	Springtail *(Folsomia candida*)	Weight	Artificial	Not reported	6 weeks	Whole Organism	1444	EC50	Van Gestel and Hensbergen, 1997
Zinc chloride	Springtail *(Folsomia candida*)	Weight	Artificial	6	4 weeks	Whole Organism	738	EC10	Smit and Van Gestel, 1998
Zinc chloride	Springtail *(Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	800	EC10	Smit and Van Gestel, 1998
Zinc chloride	Springtail *(Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	305	EC10	Smit and Van Gestel, 1998
Zinc chloride	Springtail *(Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	307	EC10	Smit et al. 1998
Zinc chloride	Springtail *(Folsomia candida*)	Weight	Natural	Not reported	4 weeks	Whole Organism	416	EC10	Smit et al. 1998
Sulfuric acid, Zinc salt (1:1)	American-Egyption cotton *(Gossypium barbadense)*	Biomass (2% reduction)	Natural	6.6	5 weeks	Leaf	200	NOEC	Rehab and Wallace, 1978
Sulfuric acid, Zinc salt (1:1)	American-Egyption cotton *(Gossypium barbadense)*	Biomass (51% reduction)	Natural	6.6	5 weeks	Stem	400	LOEC	Rehab and Wallace, 1978
Sulfuric acid, Zinc salt (1:1)	Cotton *(Gossypium hirsutum)*	Biomass (5% reduction)	Natural	6.6	5 weeks	Stem	200	NOEC	Rehab and Wallace, 1978
Sulfuric acid, Zinc salt (1:1)	Cotton *(Gossypium hirsutum)*	Biomass (25% reduction)	Natural	6.6	5 weeks	Leaf	400	LOEC	Rehab and Wallace, 1978
Sulfuric acid, Zinc salt (1:1)	Barley *(Hordeum vulgare)*	Biomass (no reduction)	Natural	7.8	45 days	Root	50	NOEC	Aery and Jagetiya, 1997
Zinc	Barley *(Hordeum vulgare)*	Biomass (no reduction)	Natural	5.4	93 days	Above - ground	33.9	NOEC	Chlopeck and Adriano, 1996
Zinc	Barley *(Hordeum vulgare)*	Biomass (15% reduction)	Natural	5.4	93 days	Above - ground	225	NOEC	Chlopeck and Adriano, 1996
Sulfuric acid, Zinc salt (1:1)	Barley *(Hordeum vulgare)*	Biomass (15% reduction)	Natural	7.8	45 days	Shoot	250	LOEC	Aery and Jagetiya, 1997
Zinc chloride	Barley	Biomass	Natural	5.56	48 days	Shoot	100	LOEC	Luo and Rimmer,

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
	(Hordeum vulgare)	(22% reduction)							1995
Sulfuric acid, Zinc salt (1:1)	Lettuce *(Lactuca sativa)*	Emergence	Artificial	6.3	Emergence	Not repoted	100	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	Lettuce *(Lactuca sativa)*	Emergence	Natural	7.3	Emergence	Not reported	1000	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	Lettuce *(Lactuca sativa)*	Emergence	Natural	7.9	Emergence	Not reported	1000	NOEC	Sheppard et al. 1993
Sulfuric acid, Zinc salt (1:1)	Lettuce *(Lactuca sativa)*	Emergence	Artificial	6.3	Emergence	Not reported	300	LOEC	Sheppard et al. 1993
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Artificial	Not reported	21 days	Whole Organism	728	LC50	Spurgeon and Hopkin, 1999
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	Not reported	42 days	Whole Organism	1424	LC50	Spurgeon and Hopkin, 1999
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	Not reported	42 days	Whole Organism	1264	LC50	Spurgeon and Hopkin, 1999
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	Not reported	42 days	Whole Organism	1450	LC50	Spurgeon and Hopkin, 1999
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	6.35	14 days	Whole Organism	1734	LC50	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	6.35	48 days	Whole Organism	1709	LC50	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	6.35	14 days	Whole Organism	1234	LC10	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Mortality	Natural	6.35	48 days	Whole Organism	1232	LC10	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Weight	Natural	Not reported	42 days	Whole Organism	1520	EC50	Spurgeon and Hopkin, 1999
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Weight	Natural	Not reported	42 days	Whole Organism	1308	EC50	Spurgeon and Hopkin, 1999

Zinc compound	Organism	Effect Measurement	Media Type	Soil pH	Exposure Duration	Response Site	Concentration (µg/g)	Endpoint	Reference
Zinc nitrate	Earthworm *(Lumbricus rubellus)*	Weight	Natural	Not reported	42 days	Whole Organism	1301	EC50	Spurgeon and Hopkin, 1999
Zinc nitrate	Earthworm *(Lumbricus terrestris*)	Mortality	Natural	6.35	14 days	Whole Organism	2378	LC50	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Lumbricus terrestris*)	Mortality	Natural	6.35	48 days	Whole Organism	2217	LC50	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Lumbricus terrestris*)	Mortality	Natural	6.35	14 days	Whole Organism	1870	LC10	Spurgeon et al. 2000
Zinc nitrate	Earthworm *(Lumbricus terrestris*)	Mortality	Natural	6.35	48 days	Whole Organism	1857	LC10	Spurgeon et al. 2000
Zinc	Common rye *(Secale cereale)*	Biomass (no reduction)	Natural	5.4	6 weeks	Unspecified	24.9	NOEC	Chlopecka and Adriano, 1997
Zinc	Common rye *(Secale cereale)*	Biomass (57% reduction)	Natural	5.4	6 weeks	Unspecified	965	LOEC	Chlopecka and Adriano, 1997
Sulfuric acid, Zinc salt (1:1)	Fenugreek *(Trigonella foenum-graecum)*	Biomass (15% reduction)	Natural	8.3	8 weeks	Unspecified	100	NOEC	Dang et al. 1990
Sulfuric acid, Zinc salt (1:1)	Fenugreek *(Trigonella foenum-graecum)*	Biomass (21% reduction)	Natural	8.3	8 weeks	Unspecified	200	LOEC	Dang et al. 1990
Zinc	Corn *(Zea mays)*	Biomass (no reduction)	Natural	5.4	12 weeks	Unspecified	24.9	NOEC	Chlopecka and Adriano, 1997
Zinc	Corn *(Zea mays)*	Biomass	Natural	5.4	3 months	Above ground	33.9	NOEC	Chlopecka and Adriano, 1996
Zinc	Corn *(Zea mays)*	Biomass (14% reduction)	Natural	5.4	12 weeks	Unspecified	965	LOEC	Chlopecka and Adriano, 1997
Zinc	Corn *(Zea mays)*	Biomass (13% reduction)	Natural	Not reported	3 months	Above ground	225	LOEC	Chlopecka and Adriano, 1996

4.3.9 Benzene

For benzene, there were 17 studies consisting of six soil invertebrate studies and 11 vegetation studies. Five soil invertebrate studies didn't meet the criteria set for standard development and were consequently eliminated. These studies either didn't report an endpoint or used an exposure type or a media type that is not acceptable. Nine vegetation studies were also eliminated for the same reasons as the soil invertebrate studies. The remaining three studies (one soil invertebrate and two vegetation) are acceptable; therefore there is sufficient information to develop a direct soil contact value for Benzene.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for benzene for agricultural/other and residential/parkland/institutional land use categories. The lowest datum selected was an LC_{50} value; therefore an initial uncertainty factor of 10 was applied. An additional uncertainty factor of 5 was applied since there were only three studies available and only three taxonomic groups represented. The Median Effects Method is not recommended for setting a standard for industrial/commercial land uses; therefore, a direct soil contact value was not derived for these categories.

The derived direct soil contact value using the CCME protocol on available data from published scientific journals for Agricultural/Other and Residential/Parkland/Institutional land use is 20 µg/g. However, the CCME recently commissioned studies to determine soil concentrations of benzene at which adverse effects occur on plants and soil organisms. These studies were of high quality and appropriately accounted for the loss of volatilized benzene during the experiment. Although these studies have not yet been published in scientific journals, it was reasoned that the resulting data would be equal to or superior to that available from the literature search, and as such, it was determined that Ontario would not use the number developed above, but would resort to the CCME ecological direct contact values (CCME, 2004) for the Ontario terrestrial ecological component value. Therefore, the direct soil contact values to be used for benzene for coarse textured soils are 31 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 180 µg/g for Industrial/Commercial/Community land use category, and for fine/medium textured soils are 60 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 310µg/g for Industrial/Commercial/Community land use category .

Table 4.15. Studies of Benzene toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect Measurement	Media type	Exposure Duration	Endpoint	Concentration (µg/g)	Reference
Benzene	*Common oat (Avena sativa)*	General growth	Artificial	14 days	EC50	1000	Ballhorn et al. 1984
Benzene	*Common oat (Avena sativa)*	General growth	Artificial	14 days	EC50	1000	Kordel et al. 1984
Benzene	Bird rape *(Brassica rapa)*	General growth	Artificial	14 days	EC50	1000	Ballhorn et al. 1984
Benzene	Bird rape *(Brassica rapa)*	General growth	Artificial	14 days	EC50	1000	Kordel et al. 1984
Benzene	Earthworm *(Eisenia foetida)*	Mortality	Artificial	28 days	LC50	1000	Ballhorn et al. 1984

4.3.10 Trichlorobenzene,1,2,4-

For trichlorobenzene,1,2,4-, there were eight studies consisting of four soil invertebrate studies and four vegetation studies. Two soil invertebrate studies were eliminated because the test organisms were exposed to trichlorobenzene,1,2,4- on filter paper, which is not an acceptable medium. The remaining two soil invertebrate studies and the four vegetation studies are acceptable, therefore, there is sufficient information to develop a standard for trichlorobenzene,1,2,4.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for trichlorobenzene,1,2,4- for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an LC_{50} value; therefore an initial uncertainty factor of 10 was applied. There was no need to apply an additional uncertainty factor. The Median Effects Method is not recommended for developing a standard for commercial/industrial scenarios, therefore direct soil contact values were not developed for these land use categories.

The derived direct soil contact value for Agricultural/Other and Residential/Parkland/Institutional land use is 12.7 µg/g.

Table 4-17. Studies of 1,2,4-Trichlorobenzene toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
1,2,4-Trichlorobenzene	Earthworm *(Allolobophora tuberculata)*	Mortality	LC50	251	Neuhauser et al. 1986
1,2,4-Trichlorobenzene	Common oat *(Avena sativa)*	General growth	EC50	294	Ballhorn et al.1984
1,2,4-Trichlorobenzene	Common oat *(Avena sativa)*	General growth	EC50	240	Broeker et al. 1984
1,2,4-Trichlorobenzene	Common oat *(Avena sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Pak-choi *(Brassica chinensis)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Rape *(Brassica napus-napus)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Bird rape *(Brassica rapa)*	General growth	EC50	110	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Turnip *(Brassica rapa - rapa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Earthworm *(Eisenia fetida)*	Mortality	LC50	197	Neuhauser et al. 1986
1,2,4-Trichlorobenzene	Earthworm *(Eisenia fetida)*	Mortality	LC100	500	Broeker et al. 1984
1,2,4-Trichlorobenzene	African earthworm *(Eudrilus eugeniae)*	Mortality	LC50	127	Neuhauser et al. 1986
1,2,4-Trichlorobenzene	Lettuce *(Lactuca sativa)*	General growth	NOEC	10	Adema and Henzen, 2001
1,2,4-Trichlorobenzene	Lettuce *(Lactuca sativa)*	Mortality	NOEC	100	Adema and Henzen, 2001

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
1,2,4-Trichlorobenzene	Lettuce *(Lactuca sativa)*	General growth	EC50	56	Adema and Henzen, 2001
1,2,4-Trichlorobenzene	Lettuce *(Lactuca sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Garden cress *(Lepidium sativum)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Prennial ryegrass *(Lolium perenne)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	India blue earthworm *(Perionyx excavatus)*	Mortality	LC50	180	Neuhauser et al. 1986
1,2,4-Trichlorobenzene	*Raphanus sativus*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	White mustard *(Sinapis alba)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Grain sorghum *(Sorghum bicolor bicolor)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Red clover *(Trifolium pratense)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Bread wheat *(Triticum aestivum)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	*Vicia sativa*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,2,4-Trichlorobenzene	Golden gram *(Vigna radiata radiata)*	General growth	EC50	1000	Pestemer and Auspurg, 1989

4.3.11 Hexachlorobenzene

For hexachlorobenzene, there were six studies consisting of two soil invertebrate studies and four vegetation studies. One soil invertebrate study was eliminated for using filter paper as a medium of exposure. All four vegetation studies and the remaining soil invertebrate study met the criteria set for standard development and were accepted. Therefore, there is sufficient information to derive a direct soil contact value for hexachlorobenzene.

Since the data available are predominantly EC_{50}/LC_{50} (15 data points) with the exception of two NOEC data points, the Median Effects Method was used to derive a direct soil contact value for hexachlorobenzene for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an LC_{50} value, therefore an initial uncertainty factor of 10 was applied and there was no need to use an additional uncertainty factor. The Median Effects Method is not recommended for deriving direct soil contact values for commercial/industrial scenarios; therefore, a standard was not developed for these land categories.

The derived direct soil contact value for Agricultural/Residential land use is 100 µg/g.

Table 4.18. Studies of Hexachlorobenzene toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
Hexachlorobenzene	Common oat *(Avena sativa)*	General growth	EC50	1000	Ballhorn et al. 1984
Hexachlorobenzene	Common oat *(Avena sativa)*	General growth	EC50	1000	Kordel et al. 1984
Hexachlorobenzene	Common oat *(Avena sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Pak-choi *(Brassica chinensis)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Colza *(Brassica napus)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Bird rape *(Brassica rapa)*	General growth	EC50	1000	Ballhorn et al. 1984
Hexachlorobenzene	Bird rape *(Brassica rapa)*	General growth	EC50	1000	Kordel et al. 1984
Hexachlorobenzene	Bird rape *(Brassica rapa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Earthworm *(Eisenia foetida)*	Mortality	LC50	1000	Ballhorn et al. 1984
Hexachlorobenzene	Lettuce *(Lactuca sativa)*	General growth	NOEC	10	Adema and Henzen, 2001
Hexachlorobenzene	Lettuce *(Lactuca sativa)*	General growth	NOEC	100	Adema and Henzen, 2001
Hexachlorobenzene	Lettuce *(Lactuca sativa)*	Mortality	NOEC	1000	Adema and Henzen, 2001
Hexachlorobenzene	Lettuce *(Lactuca sativa)*	General growth	EC50	2170	Adema and Henzen, 2001
Hexachlorobenzene	Lettuce *(Lactuca sativa)*	General growth	EC50	1000	Adema and Henzen, 2001
Hexachlorobenzene	Lettuce *(Lactuca sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
Hexachlorobenzene	Garden cress (*Lepidium sativum*)	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Prennial ryegrass (*Lolium perenne*)	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	*Raphanus sativus*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	White mustrard *(Sinapis alba)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Grain sorghum *(Sorghum bicolor bicolor)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	*Red clover* (Trifolium pratense)	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Bread wheat (*Triticum aestivum)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Common Vetch *Vicia sativa*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorobenzene	Golder gram *(Vigna radiata radiata)*	General growth	EC50	1000	Pestemer and Auspurg, 1989

4.3.12 Chloroaniline,p-

For chloroaniline,p-, there were five studies consisting of two soil invertebrate studies and three vegetation studies. The two soil invertebrate studies were both earthworm mortality studies conducted in artificial soil and were accepted. The three vegetation studies were all 14-day toxicity tests conducted in an unknown soil type where plant growth was measured. All three studies met the criteria set for standard development and were all accepted. Therefore, there is sufficient information to derive a direct soil contact value for chloroaniline,p-.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for chloroaniline,p- for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an EC_{50} value, therefore, an initial uncertainty factor of 5 was applied and there was no need to apply an additional uncertainty factor. The Median Effects Method is not recommended for developing a standard for commercial/industrial scenarios; therefore, a direct soil contact value was not derived for these land use categories.

The derived direct soil contact value for chloroaniline,p- in Agricultural/Other and Residential/Parkland/Institutional land use is 20 µg/g.

Table 4.19. Studies of Chloroaniline,p- toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Media type	Endpoint	Concentration (µg/g)	Reference
4-Chloroaniline	*Common oat (Avena sativa)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	*Common oat (Avena sativa)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Pak-choi *(Brassica chinensis)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Bird rape *(Brassica rapa)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Bird rape *(Brassica rapa)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Turnip *(Brassica rapa - rapa)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Earthworm *(Eisenia foetida)*	Mortality	Artificial	LC50	180	Adolphi et al. 1984
4-Chloroaniline	Earthworm *(Eisenia foetida)*	Mortality	Artificial	LC50	540	Ballhorn et al. 1984
4-Chloroaniline	Earthworm *(Eisenia foetida)*	Mortality	Artificial	LC100	800	Adolphi et al. 1984
4-Chloroaniline	Lettuce *(Lactuca sativa)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Garden cress *(Lepidium sativum)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Prennial ryegrass *(Lolium perenne)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	*Raphanus sativus*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	White mustard	General growth	Artificial	EC50	140	Ballhorn et al.

Compound	Organism	Effect measurement	Media type	Endpoint	Concentration (µg/g)	Reference
	(Sinapis alba)					1984
4-Chloroaniline	*Grain sorghum (Sorghum bicolor bicolor)*	General growth	Artificial	EC50	200	Adolphi et al. 1984
4-Chloroaniline	*Red clover (Trifolium pratense)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	Bread wheat *(Triticum aestivum)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989
4-Chloroaniline	*Vicia sativa*	General growth	Artificial	EC50	100	Pestemer and Auspurg, 1989
4-Chloroaniline	Golden gram *(Vigna radiata radiata)*	General growth	Artificial	EC50	1000	Pestemer and Auspurg, 1989

4.3.13 Dichloroethylene,1,1-

For dichloroethylene,1,1-, there were five studies (one soil invertebrate and four vegetation studies). The soil invertebrate study is an earthworm mortality study conducted for 28 days in artificial soil and was accepted. Two vegetation studies were eliminated for not reporting endpoints or using unacceptable exposure types. The remaining two vegetation studies are 14-day toxicity tests conducted in an unknown soil type and were accepted. Based on the one earthworm study and the two vegetation studies, there is sufficient information to derive a direct soil contact value for dichloroethylene,1,1-.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for dichloroethylene,1,1- for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an LC_{50} value; therefore, an initial uncertainty factor of 10 was applied. An additional uncertainty factor of 2 was applied since there were only three studies (the minimum number) available. The Median Effects Method is not recommended for deriving a direct soil contact value for commercial/industrial scenarios, therefore, a standard was not developed for these land use categories.

The derived direct soil contact value for dichloroethylene, 1,1- in Agricultural/Other and Residential/Parkland/Institutional land use is 50 µg/g.

Table 4.20. Studies of Dichloroethylene,1,1- toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
1,1-Dichloroethylene	Common oat *(Avena sativa)*	General growth	EC50	1000	Ballhorn et al. 1984
1,1-Dichloroethylene	Common oat *(Avena sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Pak-choi *(Brassica chinensis)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Colza *(Brassica napus)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Bird rape *(Brassica rapa)*	General growth	EC50	1000	Ballhorn et al. 1984
1,1-Dichloroethylene	Bird rape *(Brassica rapa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Earthworm *(Eisenia foetida)*	Mortality	LC50	1000	Ballhorn et al. 1984
1,1-Dichloroethylene	Lettuce *(Lactuca sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Garden cress *(Lepidium sativum)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Prennial ryegrass *(Lolium perenne)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	*Raphanus sativus*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	White mustard *(Sinapis alba)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Grain sorghum *(Sorghum bicolor bicolor)*	General growth	EC50	1000	Pestemer and Auspurg, 1989

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
1,1-Dichloroethylene	Red clover (*Trifolium pratense)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Bread wheat *(Triticum aestivum)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	*Vicia sativa*	General growth	EC50	1000	Pestemer and Auspurg, 1989
1,1-Dichloroethylene	Goldern gram *(Vigna radiata radiata)*	General growth	EC50	1000	Pestemer and Auspurg, 1989

4.3.14 Trichloroethylene

For trichloroethylene, there were 10 studies consisting of three soil invertebrate studies and seven vegetation studies. Two soil invertebrate studies were eliminated because the test organisms were exposed to trichloroethylene on filter paper which is not an acceptable medium. Four vegetation studies were also eliminated because they either didn't report an endpoint or the plants were grown hydroponically in an aqueous solution, which is not an acceptable medium of exposure. The remaining soil invertebrate study and three vegetation studies met the criteria set for standards development; therefore there is sufficient information to create a standard for trichloroethylene.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for trichloroethylene for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an LC_{50} value; therefore, an initial uncertainty factor of 10 was applied and there was no need to use an additional uncertainty factor. The Median Effects Method is not recommended for deriving a direct soil contact value for commercial/industrial scenarios, therefore, a standard was not developed for these land use categories.

The derived direct soil contact value for trichloroethylene in Agricultural/Other and Residential/Parkland/Institutional land use is 100 µg/g.

Table 4.21. Studies of Trichloroethylene toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
Trichloroethylene	Common oat *(Avena sativa)*	General growth	EC50	1000	Ballhorn et al. 1984
Trichloroethylene	Common oat *(Avena sativa)*	General growth	EC50	1000	Kordel et al. 1984
Trichloroethylene	Common oat *(Avena sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Pak-choi *(Brassica chinensis)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Rape *(Brassica napus-napus)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Bird rape *(Brassica rapa)*	General growth	EC50	1000	Ballhorn et al. 1984
Trichloroethylene	Bird rape *(Brassica rapa)*	General growth	EC50	1000	Kordel et al. 1984
Trichloroethylene	Turnip *(Brassica rapa - rapa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethene	Earthworm *(Eisenia foetida)*	Mortality	LC50	1000	Ballhorn et al. 1984
Trichloroethylene	Lettuce *(Lactuca sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Garden cress *(Lepidium sativum)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Prennial ryegrass *(Lolium perenne)*	General growth	EC50	1000	Pestemer and Auspurg, 1991

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
Trichloroethylene	*Raphanus sativus*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	White mustard *(Sinapis alba)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Grain sorghum *(Sorghum bicolor bicolor)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Red clover *(Trifolium pratense)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Bread wheat *(Triticum aestivum)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	*Vicia sativa*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Trichloroethylene	Golden gram *(Vigna radiata radiata)*	General growth	EC50	1000	Pestemer and Auspurg, 1989

4.3.15 Phenol

For phenol, there were 11 studies consisting of four soil invertebrate studies and seven vegetation studies. Two soil invertebrate studies were eliminated for using filter paper as an exposure medium. Five vegetation studies were also eliminated for either not reporting an endpoint or using an exposure medium which is not acceptable. The remaining four studies (two vegetation studies and two soil invertebrate studies) met the selection criteria and were accepted. Therefore, there is sufficient information to derive a direct soil contact value for phenol.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct contact value for phenol for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an EC_{50} value; therefore an initial uncertainty factor of 5 was applied. There was no need to use an additional uncertainty factor. The Median Effects Method is not recommended for deriving a direct soil contact value for commercial/industrial scenarios, therefore a standard was not developed for these land use categories.

The derived direct soil contact value for phenol in Agricultural/Other and Residential/Parkland/Institutional land use is 17.4 µg/g.

Table 4.22. Studies of Phenol toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Phenol	Earthworm *(Allolobophora tuberculata)*	Mortality	Artificial	6	2 weeks	Whole organism	450	LC50	Neuhauser et al. 1986
Phenol	Earthworm *(Eisenia foetida)*	Mortality	Artificial	6	2 weeks	Whole organism	401	LC50	Neuhauser et al. 1985
Phenol	African earthworm *(Eudrilus eugeniae)*	Mortality	Artificial	6	2 weeks	Whole organism	188	LC50	Neuhauser et al. 1986
Phenol	Lettuce *(Lactuca sativa)*	General growth	Unknown soil	Not reported	7 days	Not reported	32	NOEC	Adema and Henzen, 2001
Phenol	Lettuce *(Lactuca sativa)*	Mortality	Unknown soil	Not reported	7 days	Not reported	320	NOEC	Adema and Henzen, 2001
Phenol	Lettuce *(Lactuca sativa)*	General growth	Unknown soil	Not reported	7 days	Not reported	157	EC50	Adema and Henzen, 2001
Phenol	Lettuce *(Lactuca sativa)*	Germination	Unknown soil	7	14 days	Seed	87	EC50	Hulzebos et al. 1989
Phenol	India blue earthworm *(Perionyx excavatus)*	Mortality	Artificial	6	2 weeks	Whole organism	258	LC50	Neuhauser et al. 1986

4.3.16 Trichlorophenol,2,4,6-

For trichlorophenol,2,4,6-, there were 12 studies consisting of six soil invertebrate studies and six vegetation studies. One soil invertebrate study was eliminated because the test organisms were exposed to trichlorophenol,2,4,6- on filter paper which is not an acceptable medium. One vegetation study was also eliminated because the plants were exposed to trichlorophenol,2,4,6- in aqueous solution, which is not an acceptable medium of exposure. The remaining five soil invertebrate studies and five vegetation studies met the criteria set for standard development; therefore there is sufficient information to create a standard for Trichlorophenol,2,4,6-.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for trichlorophenol, 2,4,6- for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an LC_{50} value; therefore an initial uncertainty factor of 10 was applied. There was no need to use an additional uncertainty factor. The Median Effects Method is not recommended for deriving a direct soil contact value for commercial/industrial scenarios, therefore a standard was not developed for these land use categories.

The derived direct soil contact value for trichlorophenol,2,4,6- is 4.4 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use.

Table 4.23. Studies of 2,4,6-Trichlorophenol toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
2,4,6-Trichlorophenol	Earthworm *(Allolobophora tuberculata)*	Mortality	Artificial	6	2 weeks	Whole organism	108	LC50	Neuhauser et al. 1986
2,4,6-Trichlorophenol	Common oat *(Avena sativa)*	General growth	Humic sand	7.5	14 days	Aboveground	100	NOEC	Adema and Henzen, 1989
2,4,6-Trichlorophenol	Common oat *(Avena sativa)*	Biomass	Artificial	7.5	17 days	Aboveground	1000	EC50	Pestemer and Auspurg, 1989
2,4,6-Trichlorophenol	Lettuce *(Lactuca sativa)*	General growth	Humic sand	7.5	14 days	Aboveground	32	NOEC	Adema and Henzen, 1989
2,4,6-Trichlorophenol	Tomato	General growth	Humic sand	7.5	14 days	Aboveground	100	EC50	Adema and Henzen, 1989
2,4,6-Trichlorophenol	Oats	General growth	Humic sand	7.5	14 days	Aboveground	514	EC50	Adema and Henzen, 1989
2,4,6-Trichlorophenol	Lettuce *(Lactuca sativa)*	General growth	Humic sand	7.5	14 days	Aboveground	144	EC50	Adema and Henzen, 1989
2,4,6-Trichlorophenol	Earthworm *(Eisenia foetida)*	Mortality	Artificial	Not reported	14 days	Whole organism	44	LC50	Adolphi et al. 1984
2,4,6-Trichlorophenol	African earthworm *(Eudrilus eugeniae)*	Mortality	Artificial	6	2 weeks	Whole organism	85	LC50	Neuhauser et al. 1986
2,4,6-Trichlorophenol	Lettuce *(Lactuca sativa)*	General growth	Humic sand	7.5	14 days	Aboveground	100	NOEC	Adema and Henzen, 1989
2,4,6-Trichlorophenol	Lettuce *(Lactuca sativa)*	Biomass	Artificial	5.1	14 days	Whole organism	47	EC50	Adolphi et al. 1984
2,4,6-Trichlorophenol	Tomato *(Lycopersicon esculentum)*	General growth	Humic sand	7.5	14 days	Aboveground	398	EC50	Adema and Henzen, 1989
2,4,6-Trichlorophenol	Tomato *(Lycopersicon esculentum)*	Biomass	Artificial	7.5	21 days	Aboveground	1000	EC50	Pestemerand Auspurg, 1989
2,4,6-Trichlorophenol	India blue earthworm *(Perionyx excavatus)*	Mortality	Artificial	6	2 weeks	Whole organism	78	LC50	Neuhauser et al. 1986

4.3.17 Pentachlorophenol

For pentachlorophenol, there were 17 studies consisting of five soil invertebrate studies and 12 vegetation studies. Two soil invertebrate studies were eliminated for either not reporting an endpoint or using a filter paper, which is not an acceptable medium. Ten vegetation studies were also eliminated for either not reporting an endpoint or only measuring biochemical effects that cannot be directly related to effects of pentachlorophenol on plants. The two remaining vegetation studies and the three soil invertebrate studies were acceptable; therefore, there is sufficient information to develop a standard for Pentachlorophenol.

The Weight of Evidence Method, which uses the distribution of effects/no effects data was chosen to derive a direct soil contact value for pentachlorophenol. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All “adverse effects” and “no observed adverse effects” were compiled together in a spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 17 µg/g, and the 50th percentile was µg/g. For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the “effects only” data was 17 µg/g.

The derived direct soil contact value for pentachlorophenol is 17 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 31 µg/g for Industrial/Commercial/Community land use category.

Table 4.24. Studies of Pentachlorophenol toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
Pentachlorophenol	Bird rape *(Brassica rapa)*	Weight	Natural	6.1	10 days	Shoot	11.32	EC50	Gunther and Pestemer, 1990
Pentachlorophenol	Bird rape *(Brassica rapa)*	Emergency	Natural	6.32	23 days	Seed	27.6	EC20	TN&Associates Inc., 2000
Pentachlorophenol	Bird rape *(Brassica rapa)*	Height	Natural	6.32	23 days	Shoot	17	EC20	TN&Associates Inc., 2000
Pentachlorophenol	Bird rape *(Brassica rapa)*	Biomass	Natural	6.32	23 days	Shoot	10	EC20	TN&Associates Inc., 2000
Pentachlorophenol	Earthworm *(Eisenia andrei)*	General growth	Artificial	6	3 weeks	Whole organism	60	NOEC	Van Gestel et al. 1992
Pentachlorophenol	Earthworm *(Eisenia andrei)*	Fertile cocoons	Artificial	6	3 weeks	Whole organism	40	NOEC	Van Gestel et al. 1992
Pentachlorophenol	Earthworm *(Eisenia andrei)*	Fertile cocoons	Artificial	6	3 weeks	Whole organism	32	NOEC	Van Gestel et al. 1989
Pentachlorophenol	Earthworm *(Eisenia andrei)*	Mortality	Artificial	7	14 days	Whole organism	28.5	LC50	Van Gestel and van Dis, 1988
Pentachlorophenol	Earthworm *(Eisenia andrei)*	Fertile cocoons	Artificial	6	3 weeks	Whole organism	55	EC50	Van Gestel et al. 1992
Pentachlorophenol	Earthworm *(Eisenia andrei)*	Fertile cocoons	Artificial	6	3 weeks	Whole organism	58	EC50	Van Gestel et al. 1989
Pentachlorophenol	Lettuce *(Medicago sativa)*	Emergency	Natural	6.32	23 days	Seed	31	EC20	TN&Associates Inc., 2000
Pentachlorophenol	Lettuce *(Medicago sativa)*	Height	Natural	6.32	23 days	Shoot	31	EC20	TN&Associates Inc., 2000
Pentachlorophenol	Lettuce *(Medicago sativa)*	Biomass	Natural	6.32	23 days	Shoot	33	EC20	TN&Associates Inc., 2000
Pentachlorophenol	*Raphanus sativus*	Emergency	Natural	6.32	19 days	Seed	56	EC20	TN&Associates Inc., 2000
Pentachlorophenol	*Raphanus sativus*	Height	Natural	6.32	19 days	Shoot	17	EC20	TN&Associates Inc., 2000
Pentachlorophenol	*Raphanus sativus*	Biomass	Natural	6.32	19 days	Shoot	13	EC20	TN&Associates Inc., 2000

4.3.18 Hexachlorocyclohexane,gamma

For hexachlorocyclohexane, gamma, there were 33 studies consisting of 16 soil invertebrate studies and 17 vegetation studies. Of the 16 soil invertebrate studies, only five met the criteria set for the standard development. The rest were eliminated because they either didn't report an endpoint or were conducted on filter paper which is not an acceptable medium of exposure. Thirteen vegetation studies were also eliminated since they didn't report an endpoint or only measured biochemical or physiological effects, which can't be directly related to adverse effects on vegetation. Since there are five soil invertebrate studies and four vegetation studies which are acceptable, there is sufficient information to set a standard for hexachlorocyclohexane,gamma.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for hexachlorocyclohexane,gamma for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an LC_{50} value, therefore, an initial uncertainty factor of 10 was applied. There was no need to use an additional uncertainty factor. The Median Effects Method is not recommended for deriving a direct soil contact value for commercial/industrial scenarios, therefore a standard was not developed for these land use categories.

The derived direct soil contact value for hexachlorocyclohexane, gamma for Agricultural/Other and Residential/Parkland/Institutional land use is 5.9 µg/g.

Table 4.25. Studies of Hexachlorocyclohexane,gamma toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
Hexachlorocyclohexane, gamma	Cutworm *(Agrotis ipsilon)*	Abundance	NOEC	1	Patel, 1981
Hexachlorocyclohexane, gamma	Common oat *(Avena sativa)*	General growth	EC50	426	Ballhorn et al. 1984
Hexachlorocyclohexane, gamma	Common oat *(Avena sativa)*	General growth	EC50	1000	Friesel et al. 1984
Hexachlorocyclohexane, gamma	Common oat *(Avena sativa)*	General growth	EC50	1000	Friesel et al. 1984
Hexachlorocyclohexane, gamma	Common oat *(Avena sativa)*	General growth	EC50	100	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Pak-choi *(Brassica chinensis)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Rape *(Brassica napus-Napus)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Bird rape *(Brassica rapa)*	General growth	EC50	66.5	Ballhorn et al. 1984
Hexachlorocyclohexane, gamma	Bird rape *(Brassica rapa)*	General growth	EC50	1050	Friesel et al. 1984
Hexachlorocyclohexane, gamma	Bird rape *(Brassica rapa)*	General growth	EC50	760	Friesel et al. 1984
Hexachlorocyclohexane,	Turnip	General growth	EC50	100	Pestemer and

Compound	Organism	Effect measurement	Endpoint	Concentration (µg/g)	Reference
gamma	*(Brassica rapa - rapa)*				Auspurg, 1989
Hexachlorocyclohexane, gamma	Earthworm *(Eisenia andrei)*	Mortality	LC50	59	Heimbach, 1985
Hexachlorocyclohexane, gamma	Earthworm *(Eisenia foetida)*	Mortality	LC50	210	Ballhorn et al. 1984
Hexachlorocyclohexane, gamma	Earthworm *(Eisenia foetida)*	Mortality	LC50	630	Friesel et al. 1984
Hexachlorocyclohexane, gamma	Earthworm *(Eisenia foetida)*	Mortality	LC50	169.9	Haque and Ebing, 1983
Hexachlorocyclohexane, gamma	Lettuce *(Lactuca sativa)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Lettuce *(Lactuca sativa)*	Germination	EC50	1000	Hulzebos et al. 1989
Hexachlorocyclohexane, gamma	Lettuce *(Lactuca sativa)*	Germination	EC50	1000	Hulzebos et al. 1989
Hexachlorocyclohexane, gamma	Garden cress *(Lepidium sativum)*	General growth	EC50	100	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Prennial ryegrass *(Lolium perenne)*	General growth	EC50	100	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Earthworm *(Lumbricus terrestris)*	Mortality	LC50	141.6	Haque and Ebing, 1983
Hexachlorocyclohexane, gamma	*Raphanus sativus*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	White mustard *(Sinapis alba)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Grain sorghum *(Sorghum bicolor bicolor)*	General growth	EC50	100	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Red clover *(Trifolium pratense)*	General growth	EC50	1000	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Bread wheat *(Triticum aestivum)*	General growth	EC50	100	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	*Vicia sativa*	General growth	EC50	100	Pestemer and Auspurg, 1989
Hexachlorocyclohexane, gamma	Goldern gram *(Vigna radiata radiata)*	General growth	EC50	1000	Pestemer and Auspurg, 1989

4.3.19 Endosulfan

For endosulfan, there were 16 studies consisting of seven soil invertebrate studies and nine vegetation studies. For the seven soil organism studies, two honey bee studies was eliminated since bees are not soil organisms. Two earthworm studies were eliminated since the worms were exposed to endosulfan for 48 hours on filter paper, which is not an acceptable media type. Of the nine vegetation studies, seven didn't report any endpoint and were consequently eliminated. The eighth study was also eliminated since the reported LOEC was a beneficial effect on the plant. The remaining study, which investigated the effect of endosulfan on lettuce germination, is acceptable. In total there are four acceptable (three soil invertebrate and one vegetation) studies, therefore, there is sufficient information to create a standard for endosulfan.

Since the minimum data requirements cannot be met for both the Weight of Evidence and LOEC Methods, the Median Effects Method was used to derive a direct soil contact value for endosulfan for agricultural/other and residential/parkland/institutional land uses. The lowest datum selected was an LC_{50} value; therefore an initial uncertainty factor of 10 was applied. An additional uncertainty factor of 2 was applied since there were only three taxonomic groups represented. The Median Effects Method is not recommended for deriving a direct soil contact value for commercial/industrial scenarios, therefore, a standard was not developed for these land use categories.

The derived direct soil contact value for endosulfan for Agricultural/Other and Residential/Parkland/Institutional land use is 0.15 µg/g.

Table 4.26. Studies of Endosulfan toxicity on terrestrial plants and soil invertebrates

Compound	Organism	Effect Measurement	Media type	Soil pH	Exposure duration	Endpoint	Concentration (µg/g)	Reference
Endosulfan	Earthworm (*Eisenia foetida)*	Mortality	Artificial	7	14 days	LC50	9.4	Heimbach, 1985
Endosulfan	Earthworm *(Eisenia foetida)*	Mortality	Artificial	7	14 days	LC50	6.7	Heimbach, 1984
Endosulfan	Earthworm *(Eisenia foetida)*	Mortality	Artisol	Not reported	14 days	LC50	3	Heimbach, 1984
Endosulfan	*Lactuca sativa*	Germination	Not reported	Not reported	Not reported	EC50	1000	Hulzebos et al. 1989
Endosulfan	*Lactuca sativa*	Germination	Not reported	Not reported	Not reported	EC50	1000	Hulzebos et al. 1989
Endosulfan	*Lumbricus terrestris*	Mortality	Natural	7	14 days	LC50	23.9	Haque and Ebing, 1983

4.3.20 DDT

For DDT (1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene), there were 43 studies consisting of 30 soil invertebrate studies and 13 vegetation studies. Twenty-seven soil invertebrate studies were eliminated because they either didn't report an endpoint or the test organisms were honeybees, which are not soil organisms or in some cases the test organisms were exposed to DDT on filter paper which is different from soil. Eleven vegetation studies were also discarded because they either didn't report an endpoint or were done in hydroponic solution, which is not an acceptable exposure medium. These studies also measured several biochemical and physiological effects, which can't be directly correlated to measurable adverse effects on terrestrial plants.

The remaining three soil invertebrate studies and two vegetation studies met the criteria set for the standard development; therefore, there is sufficient information to set a standard for DDT.

The Weight of Evidence Method, which uses the distribution of effects/no-effects data was chosen to derive a direct soil contact value for DDT. Redundant data points for the same species were combined into a single composite response concentration calculated as the geometric mean of the individual values. All "adverse effects" and "no observed adverse effects" were compiled together in a Spreadsheet and rank percentiles determined for each data point. The 25th percentile of the rank distribution was 1 µg/g, and the 50th percentile was 6.25 µg/g. For purpose of comparing the latter value with that which would be derived using the CCME method for Industrial/Commercial land use, the 25th percentile of the "effects only" data was 3.6 µg/g.

The derived direct soil contact value for DDT is 1 µg/g for Agricultural/Other and Residential/Parkland/Institutional land use and 6.2 µg/g for Industrial/Commercial/Community land use category.

Table 4.27. Studies of DDT toxicity on terrestrial plants and soil invertebrates

DDT compound	Organism	Effect measurement	Media Type	Soil pH	Exposure Duration	Response site	Concentration (µg/g)	Endpoint	Reference
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Mite subclass *(Acari)*	Abundance	Natural	Not reported	1 year	Whole organism	6.25	LOEC	Edwards et al. 1967
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Beetle order *(Coleoptera)*	Abundance	Natural	Not reported	1 year	Whole organism	6.25	LOEC	Edwards et al. 1967
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Fly, mosquito, midge order *(Diptera)*	Abundance	Natural	Not reported	1 year	Whole organism	6.25	LOEC	Edwards et al. 1967
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Common field cricket *(Gryllus pennsylvanicus)*	Mortality	Natural	7.2	20 hours	Whole organism	14	LD50	Harris, 1964
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Waterbug order *(Hemiptera)*	Abundance	Natural	Not reported	1 year	Whole organism	6.25	NOEC	Edwards et al. 1967
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Nematode phylum *(Nemata)*	Abundance	Natural	Not reported	1 year	Whole organism	6.25	NOEC	Edwards et al. 1967
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Pauropod, Prgoneate class *(Pauropoda)*	Abundance	Natural	Not reported	1 year	Whole organism	6.25	LOEC	Edwards et al. 1967
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Bean *(Phaseolus vulgaris)*	Biomass	Natural	Not reported	8 weeks	Unspecified	1	LOEC	Cole et al. 1968
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Thrip order *(Thysanoptera)*	Abundance	Natural	Not reported	1 year	Not reported	6.25	NOEC	Edwards et al. 1967
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Black-eyed pea (*Vigna unguiculata)*	Biomass	Natural	6.3	Grown to maturity	Seed	0.5	NOEC	Perfect et al. 1979
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Corn *(Zea mays)*	Height	Natural	6.3	105 days	Above ground	0.5	NOEC	Perfect et al. 1979
1,1'-(2,2,2-Trichloroethylidene) bis(4-chlorobenzene)	Corn *Zea mays*	Biomass	Natural	Not reported	8 weeks	Unspecified	1	LOEC	Cole et al. 1968

The plant and soil invertebrate protection values that have been derived through this process of literature review and use of the protocol are summarized in Table 4.28 below. These as well as values used from the Ontario 1996 guidelines and from other jurisdictions are presented in appendix B2.

Table 4.28. Summary Table of Plant and Soil Invertebrate Protection Values

Parameter	Agricultural/Residential/Park	Industrial/Commercial	Derivation Method
Arsenic	22	34	Weight of Evidence
Benzene	31	180	CCME 2004
Cadmium	10	24	Weight of Evidence
Chloroanaline- p	20	40	Median Effects
Chromium (total)	312	500	Weight of Evidence
Cobalt	33	72	Weight of Evidence
Copper	141	232	Weight of Evidence
DDT	1	6.25	Weight of Evidence
Dichloroethylene -1,1	50	100	Median Effects
Endosulfan	0.15	0.30	Median Effects
Hexachlorobenzene	100	200	Median Effects
Hexachlorocyclohexane-gamma	5.9	11.8	Median Effects
Lead	246	1100	Weight of Evidence
Nickel	100	270	Weight of Evidence
Pentachlorophenol	17	31	Weight of Evidence
Phenol	17.4	34.8	Median Effects
Trichlorobenzene	12.7	25.4	Effects Method
Trichloroethylene	100	200	Median Effects
Trichlorophenol -2,4,6	4.4	8.8	Median Effects
Zinc	400	600	Weight of Evidence

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5 DEVELOPMENT OF SOIL PROTECTION VALUES FOR MAMMALS AND BIRDS

5.1 Background

When the MOE generic criteria were developed for the 1996 Guideline there were insufficient ecotoxicity data to consider potential ecological impacts to wildlife receptors in the criteria development process. Only a portion of the 117 generic criteria had a terrestrial ecological component value and for those chemical parameters with an ecological component value, the value was based mainly on protection of vegetation and soil organisms. The MOE recognizes a need to update the ecological toxicity data used in the development of the current Site Condition Standards to include impacts to birds and animals in addition to vegetation and soil organisms. The inclusion of animal and bird receptors in the Generic Site Condition Standards development process will ensure that the MOE Site Condition Standards will provide adequate protection to potential ecological receptors in Ontario. It is noted that the original intent was to include reptiles and amphibians as well, but due to the lack of information on these classes, criteria protective of them have not been included in this revision, and the section title includes only mammals and birds so as not to be misleading.

5.2 Development and Description of Models

A literature review of wildlife exposure models for ingestion, inhalation and dermal contact of soil contaminants was conducted by a consultant under contract with MOE. The recommended exposure models were then incorporated into a food web model set up in a spreadsheet for generating ecological component values for the revised generic soil criteria.

5.2.1 Selection of Valued Ecological Components (VECs)

Ecosystems consist of complex food and energy webs involving hundreds of species. For this reason, it is not possible to consider all terrestrial organisms which could be potentially affected by a chemical parameter. Therefore, terrestrial receptors were chosen which represent groups of species that are typical of agricultural and natural ecosystems in southern Ontario, and include most of Ontario in their breeding range. Species linked with the aquatic environment are not considered here. The following VECs were selected as representatives of each trophic level in the food web:

- **meadow vole(Microtus Pennsylvanicus)** – also called field mouse
  - a very common herbivorous small mammal that lives in grassy fields, woodlands and marshes as well as near shores of rivers and lakes
  - consumes vegetation in large amounts relative to body weight

- can make up a signifcicant component of the diet of larger mammals (e.g. fox) and raptors.
- life history data readily available
- can be a good surrogate for other small herbivorous mammals.

- **short-tailed shrew (Blarina brevicauda)** - a small vermivorous or omnivorous mammal common in wooded areas
  - diet consists mainly of terrestrial invertebrates
  - very high rate of food consumption relative to body weight, which increases exposure and is therefore representative of sensitive species expected in Ontario.

- **red-winged blackbird (Agelarius phoeniceus)**- a herbivorous or granivorous bird
  - is very common across Ontario,
  - resides in summer months near fresh water marshes, lakes and rivers
  - majority of diet is grains and seeds
  - developmental stage (sensitive life stage) is spent in Ontario
  - a good surrogate for many herbivorous bird species

- **American woodcock (Scolopax minor)**- a vermivorous or omnivorous bird
  - consumes mainly soil invertebrates
  - lives in moinst early successional woodlots near open fields or forest clearings, abandoned fields, edges of streams and ponds.
  - data on life history are readily available
  - appropriate surrogate for other omnivorous birds such as robin, killdeer.

- **red fox (Vulpes vulpes)**
  - a carnivorous mammal
  - red fox preys on field voles as well as invertebrates, amphibians, reptiles, fish and birds eggs
  - as a top carnivore, it is very common in both rural and urban environments
  - an appropriate surrogate for other predators of small mammals (e.g. coyote, bobcat, lynx, mink)

- **red-tailed hawk (Buteo jamaicensis)**
  - a carnivorous bird
  - lives in shrubby grassland, marshes
  - majority of its diet consists of small mammals
  - like the red fox it is a very common top carnivore
  - readily subjected to increased exposures of chemicals that may bio-accumulate

- **sheep (Ovis aries)**
  - a domestic ruminant
  - sheep were chosen over cattle because sheep accumulate Cu to a greater degree
  - sheep are less tolerant of Cu than other ruminants
  - a surrogate for other ruminants such as deer

- **garter snake (Thamnophis sirtalis parietalis)**
  - a reptile
  - very common in a wide range of habitats across Ontario
  - diet consists of small rodents, birds eggs, invertebrates
  - a surrogate for all other snakes

- **spring peeper (Hyla crucifer)**- an amphibian
  - relatively common, terrestrial amphibian (except breeding)
  - inhabitits marshes, ponds, and damp forest areas across eatern Canada
  - less sensitive to habitat disturbance than terrestrial amphibians such as salamanders.

5.2.2 Food Web Model Exposure Pathways

Exposure pathways that have a direct or indirect link to soil were chosen for the food web model which will allow for the incorporation of wildlife exposure modelling into the revisions of generic soil criteria. This model allows the transparent identification of both the receptors within the food web as well as the exposure pathways by which the receptors are exposed to the chemicals. Exposure pathways were chosen which have a direct or indirect link to soil, and include ingestion of plants or soil invertebrates, dermal contact with soil, incidental ingestion of soil resulting from feeding on plants and soil invertebrates, and ingestion of prey by carnivores. Although direct ingestion of surface water is recognized as a pathway of exposure, it has not been included in the calculations due to both the complexity of conducting the calculations and since protection for aquatic organisms living directly within the surface waters should provide a higher level of protection than is required for organisms merely drinking the water. There is currently not enough information to include either the assessment of dermal and inhalation exposures for mammals and birds, or evaluate exposures to amphibians and reptiles in the food web model. Even so, these pathways and receptors have been included in the following descriptions and tables as markers for future reviews and possible inclusion when sufficient data become available.

Several types of wildlife exposure models currently used in ecological risk assessment were reviewed and compared as to their suitability for the Ontario situation (refer to Cantox Inc. Final Report, June 24, 2002 for details). The following models were selected and compiled into a spreadsheet:

i) Estimate uptake of chemical from soil into soil invertebrate
- Sample et al., 1998b (soil to earthworm uptake model)
- U.S. EPA, 1999 (uptake factors)
- ECOTOX, 2001 (uptake factors in U.S. EPA database)

ii) Estimate uptake of chemical from soil into plant
- BJC, 1998; Travis and Arms, 1988; Baes et al.1984 (soil-to-plant uptake model)
- U.S. EPA, 1999 (uptake factors - combustion facility guidance)
- ECOTOX, 2001 (uptake factors in U.S. EPA database)

iii) Estimate chemical concentration in small mammal tissue

- Sample et al. 1998a (soil-to-small mammal uptake model)
- Travis and Arms, 1988 (soil-to-plant uptake model)
- U.S. EPA 1999 (uptake factors)

iv) Estimate incidental soil ingestion

- U.S. EPA, 1993 (receptor parameters)

5.2.3 Compilation of Exposure Factors and Exposure Pathways.

All factors and equations were incorporated into a spreadsheet for deriving terrestrial ecological component values. Total exposure to a contaminant through ingestion, inhalation and dermal contact is represented by the following universal equation:

$$E_{total} = E_{food} + E_{soil\ injestion} + E_{inhalation} + E_{dermal} \quad \text{(Equation.5.1)}$$

where:

E_{total} = total exposure
E_{food} = exposure from food consumption
E_{soil} = exposure from soil ingestion
$E_{inhalation}$ = exposure from inhalation
E_{dermal} = exposure from dermal contact

and: $E_{food} = C_{food} * IR_{food}$ (Equation 5.2)
where C_{food} is the chemical concentration in food (mg/kg);
and IR_{food} the food ingestion rate (kg/d)

$E_{soil\ ingestion} = C_{soil} * IR_{soil}$ (Equation 5.3)
where C_{soil} is the chemical concentration in soil (mg/kg);
and IR_{soil} is the soil ingestion rate (kg/d)

$E_{inhalation} = C_{air} * IR_{air}$ (Equation 5.4)
where C_{air} is the chemical concentration in air (mg/m^3)
and IR_{air} is the inhalation rate (m^3/d).

Note: Inhalation exposures may result in impacts on different organs than ingestion exposures. Therefore, the two exposures cannot be summed; a single oral TRV cannot be used for both.

$E_{dermal} = C_{soil} * AdF * SA * AF_{dermal} * CF$ (Equation 5.5)
where :
C_{soil} is the concentration of chemical in soil (mg/kg),
AdF is the soil-to-skin adherence factor (mg/cm^2),
SA is the skin surface exposed each day (cm^2/d),
AF_{dermal} is the dermal absorption factor (unitless) and
CF is a conversion factor ($1x10^{-6}$ kg/mg).

Exposure parameters, for the above calculations, were compiled for each VEC from appropriate allometric equations found in the U.S. EPA Wildlife Exposure Factor Handbook (1993), Sample and Suter (1994) as well as other sources in the ECOTOX database (2001). There is currently insufficient information to add modelling for inhalation and dermal exposure to this process, and it is commonly thought (CCME, 1996, U.S.EPA, 1999) that inhalation and dermal exposure are not significant pathways of exposure. However, these pathways have been incuded in this description such that future users may consider using them when sufficient information becomes available. Data on reptiles and amphibians were very limited and for this reason, it was not possible to derive exposure parameters for the garter snake or the spring peeper. Exposure parameters were derived for the other VECs (refer to Table 5.1) and included:

- Food ingestion rate
- composition of diet
- incidental soil ingestion rate
- body weight
- inhalation rate
- dermal absorption (chemical-specific)
- soil-to-skin adherence factor
- skin surface area

5.2.4 Ecological Generic Soil Standard Calculation Spreadsheet

For each chemical parameter, receptor-specific ecological soil component values were estimated using a spreadsheet-based model. The spreadsheet-based model is divided into four distinct spreadsheet pages, each representing a different data set, and a fifth spreadsheet page in which the generic ccomponent values are actually calculated. The spreadsheet model is organized in the following way:

a) Chemical Data

All the chemical specific data pertaining to the; i) soil-to-plant bioaccumulation model, ii) soil-to-small mammal bioaccumulation model and iii) soil-to-earthworm bioaccumulation model are stored in the ‘chemical data’ page. Each model provides either a regression equation or uptake factor which describes the bioaccumulative relationship between soil concentration and tissue concentration. These values are then used in the calculation of the generic soil criterion.

Chemical specific regression equations for soil to plant (dry weight) uptake factors were used for the inorganic chemicals, As, Cd, Cu, Pb, Hg, Ni, Se, and Zn (BJC, 1998). For inorganic chemicals not covered by BJC, 1998, soil to plant uptake factors were taken from Baes et al., 1984. These included Be, B, Mo, Tl, and V. For organic chemicals, soil to plant uptake factors were taken from U.S.E.P.A. 1999 and from McKone, 1994. Where no factors were available from the first two sources, the regression relationships developed in Travis and Arms, 1988 were

used. A soil-to-plant regression was derived by relating plant uptake factors for 29 organic chemicals to a chemical's octanol-water partition coefficient (Kow) using a geometric mean function regression method ,i.e.

$$\log B_v = 1.588 - 0.578 \log Kow,$$

where B_v is the bioconcentration factor from soil to plants.

Travis and Arms (1988) also developed a regression equation for biotransfer factors to beef, based on data from 36 chemicals and studies found in the literature; 15 of these chemicals are in the MOE generic standard list.

A bio-transfer factor is the ratio of the chemical concentration in animal tissue to the daily intake of chemical by the animal through ingestion of food and soil. The geometric regression method was applied to relate the biotransfer factors to a chemical's octanol-water partition coefficient (Kow); i.e. $\log B_b = -7.6 + \log Kow$. This model is used to create soil to mammal BCFs for all organic compounds in the model. These are added to the food- mammal BCFs created using the USEPA 1999 method (column w in the spreadsheet model) to give an overall uptake factor (column O in the spreadsheet model), which is then used for calculation of the uptake by higher predators. For metal, an uptake factor from Sample et al 1998 is used.

b) Receptor Data

The 'receptor data' page contains all receptor-specific data for each of the VECs; *i.e.* body weight (kg), food ingestion rate (g ww/d), soil ingestion rate (g dw/d), inhalation rate (m^3/kg/d), skin surface area (cm^2), and consumption patterns (% of overall diet) for invertebrates, plants and mammals.

Table 5.1: Recommended Exposure Parameters for Representative Wildlife Species

Species	Body Weight (kg)	Food Ingestion Rate (g ww/d)	Soil Ingestion Rate (g dw/d)	Inhalation Rate (m^3/kg/d)	Skin Surface Area (cm^2)	Food Source
American Woodcock	0.198 [a,b]	150 [a,b]	2.5 [b]	0.594 [b]	340 [b]	Invertebrates
Meadow Vole	0.044 [a]	5 [a]	0.018 [a,b]	1.02 [b]	144 [b]	Plants
Red Fox	4.5 [a,b]	430 [b]	3.85 [a,b]	0.403 [b]	2929 [b]	Mammals
Red-tailed Hawk	1.13 [b]	98.7 [b]	1.8[h]	0.397 [b]	1090 [b]	Mammals

Red-winged Blackbird	0.064 [c]	91 [c]	1.09 [f]	1.92 [e]	160 [b]	Plants
Domestic Sheep	52 [d]	10,300 [e]	65 [f]	0.248 [e]	14299 [e]	Plants
Short-tailed Shrew	0.015 [a,b]	9 [a,b]	0.187 [b]	1.26 [b]	71.5 [b]	Invertebrates
Spring Peeper	0.001 [g]	NA	NA	NA	1.1 [e]	Invertebrates

References:
[a] Sample and Suter, 1994
[b] U.S. EPA, 1993 –for woodcock, calculation based on earthworms at 84% moisture being the major portion of the diet, not averaged across all intvertebrates. Therefore the soil ingestion rate is 150 g ww food/d *0.16 dw/ww *0.104 g soil/g food = 2.5 g soil dw/d.for the woodcock and 9 g ww food/d *0.16 dw/ww *0.13 g soil/g food = 0.187 g soil dw/d for the shrew.
[c] NatureServe, 2001
[d] U.S. EPA, 1988
[e] allometric equation in U.S. EPA 1993
[f] estimated soil in diet from similar species in U.S. EPA, 1993
[g] average values from Morin (1987) and Russel et al. (1995).
[h] Based on USEPA 2007 ECO-SSL using 5.7% of FIR dry wt, for Hawk and 68% moisture of feed). (0.0987 kg wet *0.32*.057)

Model runs were originally conducted assuming no soil ingestion for the red-tailed hawk., as no data were available. Those runs produced results for the red-tailed hawk that were inconsistent when compared with the results for other receptors. For example the result for methyl mercury was 209,000 mg/kg for the hawk as compared to 4.4 mg/kg for the red fox, clearly a problematic difference. Recent documents from the Eco-SSL process of the USEPA have used a soil ingestion rate of 5.7% of dry food intake rate. When this rate is incorporated into the model, the soil component value for the hawk drops to 40 mg/kg, which is much more reasonable in comparison to other receptors. It was therefore decided to utilize the USEPA value for soil ingestion rate for the hawk.

c) Toxicity Reference Values (TRVs)

MOE's objective is to set generic soil values to protect ecological receptors at or below lowest observable effects levels(LOELs) from controlled dose-response studies for the selected 'representative' species showing the most sensitive response (effect) to a given contaminant dose (exposure). For each given chemical parameter, the scientific literature was searched for LOEL data pertaining to mammals and birds which can be utilized for the selected VECs (refer to Section A1). The corresponding toxicity reference values (TRV units = mg contaminant/ kg receptor body weight/day), associated with the selected LOEL was used in the appropriate

exposure model. The TRV page stores all ecological receptor-specific toxicity reference values for each of the assessed chemicals.

d) Miscellaneous Data

Miscellaneous data that may be utilized in the development of the generic component values are stored here. At present, this spreadsheet only contains water content for each food group (i.e. plants, invertebrates, mammals). The water content is used in the model to convert the food ingestion rate (in Table 5.1) from a wet basis to a dry basis during the calculation of exposure from food consumption..

e) References - Acronyms and Variable Definitions

The 'references' spreadsheet page provides a full literature reference for any scientific or regulatory documents cited for data values used in the spreadsheet model. The 'acronyms and variable definitions' page provides a list of acronyms and variables used in the model, and their definitions.

5.2.5 Procedure to Determine an Ecological Soil Generic Component Value

In order to calculate an ecological effects-based soil value, one must;

- specify the portion of the contaminated site that is suitable habitat. This is set at 100% for the development of generic component value.
- specify desired target hazard quotient, known also as the Exposure Ratio (ER). ER is set at 1. If the soil generic standard were based on 20% apportionment of the ER, then ER is set at 0.2. This could be the case for animals that may receive a significant portion of their exposure from sources other than soil and plant uptake.
- The spreadsheet model uses a goal-seeking function to calculate, for each chemical/receptor group, a soil concentration for which the ER is equal to the desired benchmark (e.g. 1).
- The overall equation that is used for determining a soil value is:

$$ER = \frac{[(\mathbf{C}_{\mathbf{s}} \times IR_s) + (C_f \times IR_f)] / BW}{TRV} \qquad \text{(Equation 5.6)}$$

Where:

ER = Exposure Ratio (hazard quotient)

$\mathbf{C_s}$	=	Soil concentration of the chemical parameter (mg/kg)*** [**Note: This is the ecological soil value to protect a given receptor]**
IR_s	=	Incidental ingestion rate of soil (kg/d)
C_f	=	Concentration of chemical parameter in food (mg/kg)
IR_f	=	Food ingestion rate (kg/d)
BW	=	Body weight (kg)
TRV	=	Toxicity Reference Value (mg/kg/d)

Prior to the above process taking place the value for C_f must be calculated. Calculating C_f is chemical dependent as well as receptor species dependent. For example, to determine a soil lead value for a meadow vole (which represents the small herbivore mammal group) necessitates calculating the concentration of lead in the vegetation in its diet. The regression equation from BJC (1998) is utilized here:

$$\ln(C_f) = -1.328 + 0.561\,[\ln(\mathbf{C_s})] \qquad \text{(Equation 5.7)}$$

Calculations are done on a dry weight basis, ingestion rates being convereted from the wet weight to dry weight prior to the Equation 5.7 calculations being done.

Since the soil concentration is required to calculate the concentration in the food, and since soil concentration is the value required to obtain the desired ER, then an iterative procedure, such as as a goal-seeking function is required to determine the desired soil concentration.that produces the desired ER. The program estimates the soil concentration required, uses it in the equation and then revises the estimate until an ER is reached that is within a given error tolerance. The final estimate is the Cs.

The Excel-based model employs a number of macros to control processing buttons and to conduct the Excel GoalSeek operations. These macros are viewable by accessing the Visual Basic Editor option under the Windows Tools menu item.

5.3 Determination of Toxicity Reference Values

5.3.1 Use of Lowest Observable Effects Levels (LOELs) to Determine the Appropriate TRVs

MOE's objective is to set generic soil values to protect ecological receptors at or below lowest observable effects levels (LOELs) from controlled dose-response studies for the selected

'representative' species showing the most sensitive response (effect) to a given contaminant dose (exposure). The scientific literature was searched to provide appropriate LOELs. If mortality measurements were the only type of effects data available for a chemical parameter, then a LOEL was estimated from the LD50 data (i.e. a 10x safety factor was applied).

Although the literature was searched for effects data pertaining to a wide range of animal and bird species, only a very limited set of dose-response data was available, and for very few of the chemical parameters listed in the Site Condition Standards list. At present, the most reliable TRV data were available from two sources; CCME and the Risk Assessment Program, Health Sciences Research Division, Oak Ridge, Tennessee (published by U.S. National Technical Information Service (NTIS), Springfield, Virginia). For these sources, endpoints such as reproductive and developmental toxicity, reduced survival and reduced growth were preferred,; however, for some contaminants, limitations in available data necessitated the use of other endpoints, such as organ specific effects.

The MOE has been an active participant in the development of protocols for setting effects-based soil quality criteria under the National Contaminated Sites Remediation Programme of the CCME. These protocols are summarized in the CCME document titled "A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (1996). The Ministry of the Environment is committed to consider work by the CCME for the Ontario situation. For this reason TRVs from CCME documents were selected over TRVs which were provided from another source. All references to CCME publications in the following table are to the technical scientific supporting documents in the CCME series "Canadian Soil Quality Guidelines" and are for the relevant individual chemical.

TRVs were derived from CCME supporting documents for Canadian Soil Quality. In most cases, the TRVs were derived from surrogate species and applied to their corresponding VEC. Since there are little data available for birds and there was rarely, if ever, a close match between test species and VECs, the values chosen for bird TRVs were the lowest of the available LOECs for all bird species at the same trophic level as the VEC in the literature. The selected TRVs are provided below along with the reference. In addition, soil concentrations generated by the animal exposure model, with each given TRV as an input, are also provided.

Additional TRVs were available from Sample et al., 1996 'Toxicological Benchmarks for Wildlife'report. These TRVs were utilized in the animal exposure models for chemical parameters and VECs for which the CCME sources did not provide values. TRVs were estimated from 1) LOELs (mg/kg/d) derived from chronic effects dose-response studies using domestic animals and birds or 2) applying a 0.1 factor to acute and sub-chronic effects studies as listed in Appendix C of the Sample et al. report. Dose-response data in Appendix C were obtained from the TERRE-TOX database (Meyers and Schiler 1986).

Comments received from experts during the public consultation and peer review process indicated that allometric dose scaling is no longer considered appropriate for chronic TRVs. This was confirmed through personal communication with Dr. B. Sample. Since the objective is to use chronic TRVs, allometric dose scaling of TRVs was determined to be inappropriate on the basis of comments received and was not conducted

5.3.2 Soil Values Based on TRVs Obtained from CCME Soil Criteria Reports or Sample et al. 1996

1) Acenaphthene:

Selected Toxicity Data (CCME, 2007a)
Test species: mouse – chronic LOEL (endpoint: increased liver weight) = 175 mg/kg/d
Reference: ATSDR 1995c as cited in CCME, 2007a
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 175 mg/kg/d

Summary Table for Acenaphthene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*175*	*6630*
Meadow Vole	*Mouse*	*175*	*46000*
Red fox	*Mouse*	*175*	*206000*
Sheep	*Mouse*	*175*	*24400*

2) Acetone

Selected Toxicity Data (Sample et al.1996):
Test species = rat - subchronic LOEL (endpoint: liver/kidney damage) = 500 mg/kg/d
Reference: EPA 1986c as cited in Sample et al.1996
TRVs estimated for mammalian VECs by applying 0.1 factor to subchronic LOEL for rat
TRV for mammals = 50 mg/kg/d

Summary Table for Acetone:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tailed shrew	*Rat*	*50*	*2360*
Meadow Vole	*Rat*	*50*	*56*
Red Fox	*Rat*	*50*	*58900*
Sheep	*Rat*	*50*	*32*

3)Aldrin

Selected Toxicity Data (Sample et al.1996):
Test species = rat - chronic LOEL (endpoint: reproduction) = 1.0 mg/kg/d
Reference: Treon amd Cleveland 1955 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammals = 1.0 mg/kg/d

Summary Table for Aldrin:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tailed shrew	*Rat*	*1.0*	*0.0024*
Meadow Vole	*Rat*	*1.0*	*1200*
Red Fox	*Rat*	*1.0*	*1170*
Sheep	*Rat*	*1.0*	*501*

4) Anthracene:

Selected Toxicity Data (CCME, 2007a)
Test species: Mouse – chronic **NOEL** (endpoint: no effects) = 1000 mg/kg/d
Reference: ATSDR 1995 as cited in CCME, 2007a
TRVs for mammalian VECs based on chronic **NOEL** for mouse
TRV for mammals = 1000 mg/kg/d

Summary Table for Anthracene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*1000*	*37900*
Meadow Vole	*Mouse*	*1000*	*473000*
Red fox	*Mouse*	*1000*	*1000000*
Sheep	*Mouse*	*1000*	*237000*

5) Antimony

Selected Toxicity Data (Sample et al. 1996):
Test Species = Mouse - chronic LOEL (endpoint: longevity) = 1.25 mg/kg/d
Reference: Schroeder et al.1968b as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 1.25 mg/kg/d

Summary Table for Antimony:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tailed shrew	*Mouse*	*1.25*	*24.6*
Meadow Vole	*Mouse*	*1.25*	*2144*
Red Fox	*Mouse*	*1.25*	*1470*
Sheep	*Mouse*	*1.25*	*804*

6) Arsenic

Selected Toxicity Data (Sample et al. 1996)

Test species: Mouse – chronic LOEL (endpoint: reproduction) = 1.26 mg/kg/d
Reference: Schroeder and Mitchner 1971 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 1.3 mg/kg/d

Test species: Brownheaded cowbird – chronic LOEL (endpoint: mortality) = 7.38 mg/kg/d
Reference: Dunning 1984 as cited in Sample et al. 1996
TRVs for avian VECs based on chronic LOEL for cowbird
TRV for birds = 7.4 mg/kg/d

Summary Table for Arsenic

VEC	***Surrogate Species***	***TRV used in Model (mg/kg/d)***	***Soil Value Generated (ug/g)***
Shorttail Shrew	*Mouse*	*1.3*	*51*
Meadow Vole	*Mouse*	*1.3*	*2690*
Red Fox	*Mouse*	*1.3*	*1420*
Sheep	*Mouse*	*1.3*	*890*
Redwing Blackbird	*Brownheaded cowbird*	*7.4*	*384*
American woodcock	*Brownheaded cowbird*	*7.4*	*333*
Red-tail hawk	*Brownheaded cowbird*	*7.4*	*4530*

7) Barium:

Selected Toxicity Data (Sample et al. 1996):
Test species: Rat - subchronic LOEL (endpoint: mortality) = 198mg/kg/d
Reference: Borzelleca et al. 1988 as cited in Sample et al. 1996
TRVs estimated for mammalian VECs by applying 0.1 factor to subchronic LOEL for rat
TRV for mammals = 20 mg/kg/d

Test species: chicks - subchronic LOEL (endpoint: mortality) = 417 mg/kg/d
Reference: Johnson et al. 1960 as cited in Sample et al. 1996
TRV estimated for avian VECs by applying 0.1 factor to subchronic LOEL for chicks
TRV for birds = 42 mg/kg/d

Summary Table for Barium:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Rat*	*20*	*394*
Meadow Vole	*Rat*	*20*	*4950*
Red fox	*Rat*	*20*	*6750*
Sheep	*Rat*	*20*	*2640*

Redwing blackbird	*Chicken (chicks)*	*42*	*672*
American woodcock	*Chicken (chicks)*	*42*	*689*
Red-tail hawk	*Chicken (chicks)*	*42*	*11900*

8) Benzene Selected Toxicity Data (Sample et al. 1996):

Test species: Mouse – chronic LOEL (endpoint: reproduction) = 263.6 mg/kg/d
Reference: Nawrot and Staples 1979 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 264 mg/kg/d

Summary Table for Benzene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Mouse*	*264*	*373*
Meadow Vole	*Mouse*	*264*	*6810*
Red fox	*Mouse*	*264*	*311000*
Sheep	*Mouse*	*264*	*3870*

9) Benzo(a)pyrene

Selected Toxicity Data (CCME, 2007a, CCME, 1996c):
Reference: Mackenzie and Angevine 1981 as cited in CCME, 2007a
Test species = mouse – chronic LOEL (endpoint: reproduction) = 40 mg/kg/d
TRVs for mammaliam VECs based on chronic LOEL for mouse
TRV for mammals = 40 mg/kg/d

Summary Table for Benzo(a)pyrene

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Mouse*	*40*	*1620*
Meadow Vole	*Mouse*	*40*	*69000*
Red fox	*Mouse*	*40*	*46300*
Sheep	*Mouse*	*40*	*25800*

10) Beryllium

Selected Toxicity Data (Sample et al. 1996):
Test species = Rat - chronic **NOEL** (endpoint: longevity/weight loss)= 0.66 mg/kg/d

Reference: Schroeder and Mitchner 1975 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic **NOEL** for rat
TRV for mammals = 0.66 mg/kg/d

Summary Table for Beryllium:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*0.66*	*13*
Meadow Vole	*Rat*	*0.66*	*1140*
Red fox	*Rat*	*0.66*	*776*
Sheep	*Rat*	*0.66*	*426*

11) Bis(2-ethylhexyl)-phthalate

Selected Toxicity Data (Sample et al. 1996):
Test species = mouse – chronic LOEL (endpoint: reproduction) = 183 mg/kg/d
Reference: Lamb et al. 1987 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 183 mg/kg/d

Summary Table for Bis(2-ethylhexl)-phthalate

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Mouse*	*183*	*0.80*
Meadow Vole	*Mouse*	*183*	*136000*
Red fox	*Mouse*	*183*	*215000*
Sheep	*Mouse*	*183*	*63400*

12)Boron

Selected Toxicity Data (Sample et al. 1996)
Test species = rat - chronic LOEL (endpoint: reproduction) = 94 mg/kg/d
Reference: Weir and Fisher 1972 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for the rat
TRV for mammals = 94 mg/kg/d

Test species = mallard duck - chronic LOEL (endpoint: reproduction) = 100 mg/kg/d
Reference: Smith and Anders 1989 as cited in Sample et al. 1996
TRVs for avian VECs based on chronic LOEL for the mallard duck
TRVs for birds = 100 mg/kg/d

Summary Table for Boron

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Rat*	*94*	*4440*
Meadow Vole	*Rat*	*94*	*1370*
Red fox	*Rat*	*94*	*111000*
Sheep	*Rat*	*94*	*781*
Redwing blackbird	*Mallard duck*	*100*	*115*
American woodcock	*Mallard duck*	*100*	*4240*
Red-tail Hawk	*Mallard duck*	*100*	*63000*

13) Cadmium

Selected Toxicity Data (CCME, 1999a, 1996d):
Test species: Rat – chronic LOEL (endpoint: reduced growth) = 2.86 mg/kg/d
Reference: Baranski and Siterek 1987 as cited in CCME, 1996d
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammals = 2.9 mg/kg/d

Test species: lambs – chronic LOEL (endpoint: body weight) = 4.56 mg/kg/d
Reference: Cousins et al. 1973 as cited in CCME, 1999a
TRV for sheep based on chronic LOEL for lambs
TRV for sheep = 4.6 mg/kg/d

Test species: Chicken – chronic LOEL (endpoint: reproduction) = 3.07 mg/kg/d
Reference: Leach et al. 1979 as cited in CCME, 1996d
TRVs for avian VECs based on chronic LOEL for chicken
TRV for birds = 3.0 mg/kg/d

Summary Table for Cadmium

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Rat*	*2.9*	*2.4*
Meadow Vole	*Rat*	*2.9*	*4520*
Red fox	*Rat*	*2.9*	*2390*
Sheep	*Lamb*	*4.6*	*2600*
Redwing Blackbird	*Chicken*	*3.0*	*87*
American woodcock	*Chicken*	*3.0*	*1.9*
Red-tail Hawk	*Chicken*	*3.0*	*1490*

14) Carbon tetrachloride

Selected Toxicity Data (Sample et al. 1996):
Test species = rat – chronic **NOEL** (endpoint: reproduction) = 16 mg/kg/d
Reference: Alumot et al. 1976a as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic **NOEL** for rat
TRV for mammals = 16 mg/kg/d

Summary Table for Carbon tetrachloride:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*16*	*7.6*
Meadow Vole	*Rat*	*16*	*882*
Red fox	*Rat*	*16*	*18800*
Sheep	*Rat*	*16*	*497*

15) Chlordane

Selected Toxicity Data (Sample et al. 1996)
Test species = mouse – chronic LOEL (endpoint: reproduction) = 9.2 mg/kg/d
Reference: WHO 1984 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for mouse = 9.2 mg/kg/d
TRV for mammals = 9.2 mg/kg/d

Test species = redwing blackbird – chronic LOEL (endpoint: mortality) = 10.7mg/kg/d
Reference: Stickel et al. 1983 as per Sample et al. 1996
TRV for Amer.woodcock and red-tail hawk based on chronic LOEL for redwing blackbird = 11 mg/kg/d

Summary Table for Chlordane

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Mouse*	*9.2*	*0.009*
Meadow vole	*Mouse*	*9.2*	*15900*
Red fox	*Mouse*	*9.2*	*10700*
Sheep	*Mouse*	*9.2*	*5940*
Redwing blackbird	*No surrogate*	*11*	*573*
American woodcock	*Redwing blackbird*	*11*	*0.0085*
Red-tail hawk	*Redwing blackbird*	*11*	*6900*

16) Chloroform

Selected Toxicity Data (Sample et al. 1996):
Test species = rat -subchronic LOEL (Endpoint: condition of liver/kidney) = 410 mg/kg/d
Reference: Palmer et al. 1979 as cited in Sample et al. 1996
TRVs estimated for mammalian VECs by applying 0.1 factor to subchronic LOEL for rat
TRV for mammals = 41 mg/kg/d

Summary Table for Chloroform:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*41*	*81*
Meadow Vole	*Rat*	*41*	*825*
Red fox	*Rat*	*41*	*48300*
Sheep	*Rat*	*41*	*470*

17) Chromium (total)

Selectede Toxicity Data (CCME 1996e):
Test species: Cow – chronic LOEL (endpoint: kidney damage) = 9.6 mg/kg/d
Reference: Kreuzer et al. 1985 as cited in CCME, 1996e
TRV for sheep based on chronic LOEL for cow
TRV for sheep = 9.6 mg/kg/d

Selected Toxicity Data (CCME 1999b)
Test species: Dogs and cats – chronic **NOEL** (endpoint: histopathological) = 5.5 mg/kg/d
Reference: Environment Canada 1996 as cited in CCME, 1999b
TRVs for red fox based on chronic **NOEL** for dogs/cats
TRV for red fox = 5.5 mg/kg/d

Selected Toxicity Data (Sample et al. 1996)
Test species = rat – chronic **NOEL** (Endpoint: reproduction, longevity) = 2737 mg/kg/d
Reference: Ivankovic and Preussmann 1975 as cited in Sample et al. 1996
TRVs for mammalian VECs (except sheep) based on chronic **NOEL** for rat
TRV for mammals = 2740 mg/kg/d

Test species = black duck – chronic LOEL (Endpoint: body weight) = 5 mg/kg/d
Reference: Haseltine et al. (unpublished) as per Sample et al. 1996
TRVs for avian VECs are based on chronic LOEL for black duck
TRV for birds = 5 mg/kg/d

Summary Table for Chromium:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Source of TRV*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*2740*	*Sample et al.*	*193000*

Meadow Vole	*Rat*	*2740*	*Sample et al.*	*1000000*
Red fox	*Dog*	*5.5*	*CCME*	*3300*
Sheep	*Cow*	*9.6*	*CCME*	*3000*
Redwing blackbird	*Black duck*	*5*	*Sample et al.*	*161*
Amer. Woodcock	*Black duck*	*5*	*Sample et al.*	*338*
Red-tail hawk	*Black duck*	*5*	*Sample et al.*	*2050*

18) Chromium +6

Selected Toxicity Data (Sample et al. 1996):
Test Species = Rat – subchronic LOEL (Endpoint: mortality) = 131.4 mg/kg/d
Reference: Steven et al. 1976 as cited in Sample et al. 1996
TRVs estimated for mammalian VECs by applying 0.1 factor to subchronic LOEL for rat
TRV for mammals = 13 mg/kg/d

Summary Table for Cr+6:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*13*	*914*
Meadow Vole	*Rat*	*13*	*8540*
Red fox	*Rat*	*13*	*8800*
Sheep	*Rat*	*13*	*4070*

19) Cobalt

Available Toxicity Data (U.S. EPA Eco-SSLs March 2005)
Test species: rat – chronic LOEL (endpoint: body weight loss) = 8.8 mg/kg/d
Reference: Haga et.al. 1996 as cited in U.S. EPA Eco-SSLs March 2005
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammals -= 8.8 mg/kd/d

Available Toxicity Data (U.S. EPA Eco-SSLs March 2005)
Test species: chicken – chronic LOEL (endpoint: body weight loss) = 7.8 mg/kg/d
Reference: Hill, C.H. 1979 as cited in U.S. EPA Eco-SSLs March 2005
TRVs for avian VECs based on chronic LOEL for chicken
TRV for birds = 7.8 mg/kg/d

Summary Table for Cobalt:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Source of TRV*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*8.8*	*Sample et al. Haga et.al. 1996 as cited in U.S. EPA Eco-SSLs March 2005*	*239*
Meadow Vole	*Rat*	*8.8*	*As above*	*14540*
Red fox	*Rat*	*8.8*	*As above*	*10290*
Sheep	*Rat*	*8.8*	*As above*	*5530*
Redwing Blackbird	*Chicken*	*7.8*	*Hill, C.H. 1979 as cited in U.S. EPA Eco-SSLs March 2005*	*400*
Amer. Woodcock	*Chicken*	*7.8*	*As above*	*180*
Red-tail hawk	*Chicken*	*7.8*	*As above*	*4900*

19) Copper

Selected Toxicity Data (CCME 1997a):
Test species: Lambs – chronic LOEL (endpoint: haemolytic crisis, jaundice) = 0.885 mg/kg/d
Reference: Adamson et al. 1969 as cited in CCME, 1997a
TRV for sheep based on chronic LOEL for lambs
TRV for sheep = 0.89 mg/kg/d

Selected Toxicity Data (Sample et al. 1996):
Test species: Mink – chronic LOEL (endpoint: reproduction) = 15.14 mg/kg/d
Reference: Aulerich et al. 1982 as cited in Sample et al. 1996
TRV for mammalian VECs based on chronic LOEL for mink
TRV for mammals = 15 mg/kg/d

Test species: Chicks – chronic LOEL (endpoint: growth/mortality) = 61.7 mg/kg/d
Reference: Mehring et al. 1960 as cited in Sample et al. 1996
TRVs for avian VECs based on chronic LOEL for chicks
TRV for birds = 62 mg/kg/d

Summary Table for Copper:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Source of TRV*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mink*	*15*	*Sample et*	*772*

			al.	
Meadow Vole	*Mink*	*15*	*Sample et al.*	*31900*
Red fox	*Mink*	*15*	*Sample et al.*	*16600*
Sheep	*Mink*	*0.89*	*CCME*	*283*
Redwing Blackbird	*Chicken*	*62*	*Sample et al.*	*3060*
Amer. Woodcock	*Chicken*	*62*	*Sample et al.*	*4080*
Red-tail hawk	*Chicken*	*62*	*Sample et al.*	*38400*

20) Cyanide

Selected Toxicity Data (CCME, 1996f):
Test species: Sheep – chronic LOEL (endpoint: respiration stress) = 0.955 mg/kg/d
Reference: Clawson et al. 1934 as cited in CCME, 1996f
TRV for sheep = 0.96 mg/kg/d

Test species : American Kestrel – LD50 (endpoint: mortality) = 2.12 mg/kg/d
Reference: Weimeyer et al. 1986 as cited in CCME, 1996f
TRVs estimated for avian VECs by applying 0.1 factor to acute toxicity value for American kestrel
TRV for birds = 0.21 mg/kg/d

Available Toxicity Data (Sample et al. 1996):
Test species = rat - chronic **NOEL** (endpoint: reproduction) = 69 mg/kg/d
Reference: Tewe and Maner 1981 as cited in Sample et al. 1996
TRVs for mammalian VECs (except for sheep) are based on chronic **NOEL** for rat
TRV for mammals = 69 mg/kg/d

Summary Table for Cyanide:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Source of TRV*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*69*	*Sample et al.*	*333*
Meadow Vole	*Rat*	*69*	*Sample et al.*	*464*
Red fox	*Rat*	*69*	*Sample et al.*	*81200*
Sheep	*No surrogate*	*0.96*	*CCME*	*3.7*
Redwing blackbird	*American Kestrel*	*0.21*	*CCME*	*0.11*
American woodcock	*American Kestrel*	*0.21*	*CCME*	*0.81*

Red-tail hawk	*American Kestrel*	*0.21*	*CCME*	*132*

21) Dioxane, 1,4

Selected Toxicity Data (Sample et al., 1996):
Test species = rat LOEL chronic LOEL (maternal toxicity and reduced fetal body weight) = 1.0 mg/kg/d
Reference: Giavini et al. 1985

Summary Table for 1,4, Dioxane

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*2.2*	*176*
Meadow Vole	*Rat*	*1.68*	*1.82*
Red fox	*Rat*	*0.53*	*625*
Sheep	*Rat*	*0.28*	***0.174***

22) DDT

Selected Toxicity Data (CCME, 1999c):
Test species = mice – chronic LOEL (endpoint: leukimia and malignant tumors) = 0.7 mg/kg/d
Reference: Tarjan and Kemeny 1969 as cited in CCME 1999c
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammals = 0.7 mg/kg/d

Test species = mallard duck – chronic LOEL (endpoint: reproduction) = 1 mg/kg/d
Reference: Vangilder and Peterle 1980; Kolaja 1977 as cited in CCME 1999c
TRVs for avian VECs based on chronic LOEL for mallard duck
TRV for birds = 1.0 mg/kg/d

Summary Table for DDT:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*0.7*	*0.0011*
Meadow Vole	*Mouse*	*0.7*	*933*
Red fox	*Mouse*	*0.7*	*820*
Sheep	*Mouse*	*0.7*	*379*
Redwing blackbird	*Mallard duck*	*1.0*	*47*

Amer. woodcock	*Mallard duck*	*1.0*	*0.001*
Red-tail Hawk	*Mallard duck*	*1.0*	*628*

23) 1,2-Dichloroethane

Selected Toxicity Data (Sample et al. 1996)
Test species = mouse – chronic **NOEL** (endpoint: reproduction) = 50 mg/kg/d
Reference: Lane et al. 1982 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic **NOEL** for rat
TRV for mammals = 50 mg/kg/d

Test species = chicken – chronic LOEL (endpoint: reproduction) = 34 mg/kg/d
TRVs for avian VECS are based on chronic LOEL for chicken
TRV for birds = 34 mg/kg/d

Summary Table for 1,2-Dichloroethane

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*50*	*245*
Meadow Vole	*Rat*	*50*	*531*
Red fox	*Rat*	*50*	*58900*
Sheep	*Rat*	*50*	*303*
Redwing blackbird	*Chicken*	*34*	*29*
Amer. woodcock	*Chicken*	*34*	*134*
Red-tail Hawk	*Chicken*	*34*	*21400*

24) 1,1- Dichloroethylene

Selected Toxicity Data (Sample et al. 1996)
Test species: Rat - chronic NOEL = 30 mg/kg/d
Reference: Quast et al. 1983 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic NOEL for rat
TRV for mammals = 30 mg/kg/d

Summary Table for 1,1-Dichloroethylene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value G0enerated (ug/g)*
Short-tail shrew	*Rat*	*30*	*43*
Meadow Vole	*Rat*	*30*	*757*
Red Fox	*Rat*	*30*	*35300*
Sheep	*Rat*	*30*	*430*

25) 1,2- Dichloroethylene

Selected Toxicity Data (Sample et al. 1996)
Test species: Mouse – subchronic NOEL (endpoint: weight/liver function = 452 mg/kg/d
Reference: Palmer et al. 1979 as cited in Sample et al. 1996
TRVs estimated for mammalian VECs by applying 0.1 factor to the subchronic NOEL for mouse
TRV for mammals = 45 mg/kg/d

Summary Table for 1,2-Dichloroethylene*

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*45*	*84*
Meadow Vole	*Mouse*	*45*	*935*
Red Fox	*Mouse*	*45*	*53000*
Sheep	*Mouse*	*45*	*532*

*These values were used for both cis and trans isomers.

26) Dieldrin

Selected Toxicity Data (Sample et al. 1996)
Test species = rat – chronic LOEL (Endpoint: reproduction) = 0.2 mg/kg/d
Reference: Treon and Cleveland 1955 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic LOEL for rat
TRV for mammals = 0.2 mg/kg/d

Summary Table for Dieldrin:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*0.2*	*0.00096*
Meadow Vole	*Rat*	*0.2*	*312*
Red fox	*Rat*	*0.2*	*235*
Sheep	*Rat*	*0.2*	*82*

27) Diethylphthalate

Selected Toxicity Data (Sample et al. 1996)
Test species = mouse – chronic **NOEL** (endpoint: reproduction) = 4583 mg/kg/d
Reference: Lamb et al. 1987 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic **NOEL** for mouse
TRV for mammals = 4580 mg/kg/d

Summary Table for Diethylphthalate

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*4580*	*85*
Meadow Vole	*Mouse*	*4580*	*1000000*

Red fox	*Rat*	*4580*	*1000000*
Sheep	*Rat*	*4580*	*1000000*

28) Dioxins/Furans

Toxicity Reference Values for Dioxins/furans are based on 2,3,7,8-TCDD, but must be compared to soil concentrations calculated using TEQs (from WHO).

Selected Toxicity Data (Sample et al. 1996)
Test species = rat – chronic LOEL (endpoint: reproduction) = 0.00001 mg/kg/d
Reference: Murray et al. 1979 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic LOEL for rat
TRV for mammals =0.00001 mg/kg/d

Test = ringneck pheasant – chronic LOEL (endpoint: reproduction) = 0.00014 mg/kg/d
Reference: Nosek et al. 1992 as cited in Sample et al. 1996
TRVs for avian VECS are based on chronic LOEL for pheasant
TRV for birds = 0.00014 mg/kg/d

Summary Table for Dioxins/furans:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug TEQ/g)*
Short-tail shrew	*Rat*	*0.00001*	*0.000013*
Meadow Vole	*Rat*	*0.00001*	*0.017*
Red fox	*Rat*	*0.00001*	*0.00032*
Sheep	*Rat*	*0.00001*	*0.0065*
Redwing blackbird	*Ringneck pheasant*	*0.00014*	*0.0073*
American woodcock	*Ringneck pheasant*	*0.00014*	*0.000099*
Red-tail hawk	*Ringneck pheasant*	*0.00014*	*0.0037*

29) Endosulfan

Selected Toxicity Data (Sample et al. 1996)
Test species = rat – subchronic **NOEL** (endpoint: reproduction) = 1.5 mg/kg/d
Reference: Dikshith et al. 1984 as cited in Sample et al. 1996
TRV estimated for mammalian VECs by applying 0.1 factor to subchronic NOEL for rat
TRV for mammals = 0.15 mg/kg/d

Test species = grey partridge – chronic **NOEL** (endpoint: reproduction = 10 mg/kg/d
Reference: Abiola 1992 as cited in Sample et al. 1996
TRVs for avian VECs are based on chronic NOEL for partridge
TRV for birds = 10 mg/kg/d

Summary Table for Endosulfan:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*0.15*	*0.023*
Meadow Vole	*Rat*	*0.15*	*22*
Red fox	*Rat*	*0.15*	*177*
Sheep	*Rat*	*0.15*	*12*
Redwing blackbird	*Grey partridge*	*10*	*102*
American woodcock	*Grey partridge*	*10*	*1.2*
Red-tail hawk	*Grey partridge*	*10*	*6300*

30) Endrin

Selected Toxicity Data (Sample et al. 1996)
Test species = mouse – chronic LOEL (endpoint: reproduction) = 0.92 mg/kg/d
Reference: Good and Ware 1969 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic LOEL for mouse
TRV for mammals = 0.92 mg/kg/d

Test species = Mallard duck – chronic NOEL (endpoint: reproduction) = 0.3 mg/kg/d
Reference: Spann et al. 1986 as cited in Sample et al. 1996
TRVs for American woodcock and redwing blackbird are based on chronic LOEL for Mallard duck
TRV for redwing blackbird and American woodcock = 0.3 mg/kg/d
Test species = screech owl – chronic LOEL (endpoint: reproduction) = 0.1 mg/kg/d
Reference: Fleming et al. 1982 as cited in Sample et al. 1996
TRV for red-tail hawk is based on chronic LOEL for screech owl = 0.1 mg/kg/d

Summary Table for Endrin:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*0.92*	*0.0044*
Meadow Vole	*Mouse*	*0.92*	*843*
Red fox	*Mouse*	*0.92*	*1080*
Sheep	*Mouse*	*0.92*	*377*
Redwing blackbird	*Mallard duck*	*0.3*	*12*
American woodcock	*Mallard duck*	*0.3*	*0.0011*
Red-tail hawk	*Screech Owl*	*0.1*	*63*

31) Ethylbenzene Selected Toxicity Data (CCME, 1996h):
Test species: Rat – chronic LOEL (endpoint: liver/kidney damage) = 408 mg/kg/d
Reference: Wolf et al. 1956 as cited in CCME, 1996h
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammals = 408 mg/kg/d

Summary Table for Ethylbenzene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Shorttail shrew	*Rat*	*408*	*90*
Meadow vole	*Rat*	*408*	***38400***
Red fox	*Rat*	*408*	*480000*
Sheep	*Rat*	*408*	*21400*

32) Fluoranthene:
Selected Toxicity Data (CCME, 2007a)
Test species = mouse – chronic LOEL (endpoint: liver weight) = 125 mg/kg/d
Reference: ATSDR 1995c as cited in CCME, 2007a
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 125 mg/kg/d

Summary Table for Fluoranthene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*125*	*0.69*
Meadow Vole	*Mouse*	*125*	*115000*
Red fox	*Mouse*	*125*	*147000*
Sheep	*Mouse*	*125*	*51200*

33) Heptachlor
Selected Toxicity Data (Sample et al. 1996):
Test species = mink – chronic LOEL (endpoint: reproduction) = 1.0 mg/kg/d
Reference: Crum et al. 1993 as cited in Sample et al. 1996
TRVs for mammalian VECS are based on chronic LOEL for mink
TRV for mammals = 1.0 mg/kg/d

Summary Table for Heptachlor:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mink*	*1.0*	*3.9*
Meadow Vole	*Mink*	*1.0*	*1090*
Red fox	*Mink*	*1.0*	*1180*
Sheep	*Mink*	*1.0*	*467*

34) Lead

Selected Toxicity Data (CCME, 1999d)
Test species: Calves – chronic LOEL (endpoint:weight loss) = 7.7 mg/kg/d
Reference: Lynch et al. 1976 as cited in CCME 1999d
TRV for sheep based on chronic LOEL for calves
TRV for sheep = 7.7 mg/kg/d

Test species: Chicken – chronic LOEL (endpoint: reproduction) = 1.8 mg/kg/d
Reference: Edens et al. 1983 as cited in CCME 1999d . CCME 1999d states that a lower concentration of Calcium in the diet of the Japanese Quail compared to the chickens may have enhanced the toxicity of lead in the quail egg production. Edens and Garlich 1983 suggest that the decrease in the Japanese Quail egg production is associated with reduction in plasma calcium. For this reason, the chicken TRV was selected from that paper
TRVs for redwing blackbird and American woodcock based on chronic LOEL for chicken = 3.3. mg/kg/d

Test species: American kestrel – chronic NOEL (survival/body wt.) = 28 mg/kg/d
Reference: Custer et al. 1984 as cited in CCME 1999d
TRV for redtail hawk based on chronic NOEL for American kestrel
TRV for redtail hawk = 28 mg/kg/d

Selected Toxicity Data (Sample et al. 1996)
Test species: Rat – chronic LOEL (endpoint: reproduction) = 80 mg/kg/d
Reference: Azar et al. 1973 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammals = 80 mg/kg/d

Summary Table for Lead:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Source of TRV*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*80*	*Sample et al.*	*1760*
Meadow Vole	*Rat*	*80*	*Sample et al.*	*185000*
Red fox	*Rat*	*80*	*Sample et al.*	*88200*
Sheep	*Lamb*	*7.7*	*CCME*	*5380*
Redwing blackbird	*Chicken*	*3.3*	*CCME*	*140*
American woodcock	*Chicken*	*3.3*	*CCME*	*32*
Red-tail hawk	*American kestrel*	*28*	*CCME*	*163000*

35) Mercury

Selected Toxicity Data (Sample et al. 1996)

Test species: Mink – chronic LOEL (endpoint: reproduction) = 1.01 mg/kg/d
Reference: Aulerich et al. 1974 as cited in Sample et al.1996
TRVs for mammalian VECs based on chronic LOEL for mink
TRV for mammals = 1 mg/kg/d

Test species: Japanese Quail – chronic LOEL (endpoint: reproduction) = 0.9 mg/kg/d
Reference: Hill and Schaffner 1976 as cited in Sample et al. 1996
TRVs for avian VECs based on chronic LOEL for quail
TRV for birds = 0.9 mg/kg/d

Summary Table for Mercury:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mink*	*1.0*	*32*
Meadow Vole	*Mink*	*1.0*	*1590*
Red fox	*Mink*	*1.0*	*216*
Sheep	*Mink*	*1.0*	*532*
Redwing blackbird	*Japanese Quail*	*0.9*	*26*
American woodcock	*Japanese Quail*	*0.9*	*20*
Red-tail hawk	*Japanese Quail*	*0.9*	*178*

36) Mercury (methyl)

Selected Toxicity Data (Sample et al. 1996)
Test species = rat - chronic LOEL (endpoint: reproduction) = 0.16 mg/kg/d
Reference: Verschuuren et al. 1976 as cited in Sample et al. 1996
TRVs for other mammalian VECs are based on chronic LOEL for rat
TRV for mammals = 0.16 mg/kg/d

Test species = Mallard duck – chronic LOEL (reproduction) = 0.064 mg/kg/d
Reference: Heinz 1979 as cited in Sample et al. 1996
TRVs for avian VECs are based on chronic LOEL for the mallard duck
TRV for birds = 0.064 mg/kg/d

Summary Table for Methyl Mercury:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*0.16*	*0.11*
Meadow Vole	*Rat*	*0.16*	*174*
Red fox	*Rat*	*0.16*	*188*
Sheep	*Rat*	*0.16*	*75*

Redwing blackbird	*Mallard duck*	*0.064*	*2.7*
American woodcock	*Mallard duck*	*0.064*	*0.034*
Red-tail hawk	*Mallard duck*	*0.064*	*40*

37) Methoxychlor

Selected Toxicity Data (Sample et al. 1996)::
Test species = rat – chronic LOEL (endpoint: reproduction) = 8 mg/kg/d
Reference; Grey et al. 1988 as cited in Sample et al. 1996
TRV for other mammalian VECS are based on chronic LOEL for rat
TRV for mammals = 8 mg/kg/d

Summary Table for Methoxychlor:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*8*	*0.13*
Meadow Vole	*Rat*	*8*	*4120*
Red fox	*Rat*	*8*	*9410*
Sheep	*Rat*	*8*	*2040*

38) Methylene chloride

Selected Toxicity Data (Sample et al. 1996):
Test species = rat – chronic LOEL (Endpoint: liver histology) = 50 mg/kg/d
Reference: NCA 1982 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic LOEL for rat
TRV for mammals = 50 mg/kg/d

Summary Table for Methylene chloride:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*50*	*350*
Meadow Vole	*Rat*	*50*	*401*
Red fox	*Rat*	*50*	*58900*
Sheep	*Rat*	*50*	*229*

39) Methyl ethyl ketone

Selected Toxicity Data (Sample et al. 1996)
Test species = rat – chronic LOEL (endpoint: reproduction) = 4570 mg/kg/d
Reference: Cox et al. 1975 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic LOEL for rat
TRV for mammals = 4750 mg/kg/d

Summary Table for Methyl ethyl ketone:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*4570*	*137000*
Meadow Vole	*Rat*	*4570*	*9920*
Red fox	*Rat*	*4570*	*1000000*
Sheep	*Rat*	*4570*	*5680*

40) Molybdenum

Selected Toxicity Data (Sample et al. 1996)
Test species = mouse – chronic LOEL (endpoint: reproduction) = 2.6 mg/kg/d
Reference: Schroeder and Mitchner 1971 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on chronic LOEL for mouse
TRV for mammals = 2.6 mg/kg/d

Test species = chicken – chronic LOEL (endpoint: reproduction) = 35.3 mg/kg/d
Reference: Lepore and Miller 1965 as cited in Sample et al. 1996
TRVs for avian VECs are based on chronic LOEL for chicken
TRV for birds = 35 mg/kg/d

Summary Table for Molybdenum:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*2.6*	*6.9*
Meadow Vole	*Mouse*	*2.6*	*557*
Red fox	*Mouse*	*2,6*	*3050*
Sheep	*Mouse*	*2.6*	*299*
Redwing blackbird	*Chicken*	*35*	*497*
American woodcock	*Chicken*	*35*	*74*
Red-tail hawk	*Chicken*	*35*	*22000*

41) Naphthalene

Selected Toxicity Data (CCME, 1997b)
Test species: mouse – LD50 (endpoint: mortality) = 101.4 mg/kg/d
Reference: Shopp et al. 1984 as cited in CCME 1997b
TRVs estimated for mammalian VECs by applying 0.1 factor to acute toxicity value for mouse.
TRV for mammals = 10 mg/kg/d

Summary Table for Naphthalene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*10*	*379*
Meadow Vole	*Mouse*	*10*	*1260*
Red fox	*Mouse*	*10*	*11800*
Sheep	*Mouse*	*10*	*697*

42) Nickel

Selected Toxicity Data (Sample et al. 1996)
Test species = rat – chronic LOEL (endpoint: reproduction) = 80 mg/kg/d
Reference: Ambrose et al. 1976 as cited in Sample et al. 1996
TRVs for mammalian VECS are based on chronic LOEL for rat
TRV for mammals = 80 mg/kg/d

Test = mallard duck – chronic LOEL (endpoint: growth/behaviour = 107 mg/kg/d
Reference: Cain and Pafford 1981 as cited in Sample et al. 1996
TRVs for avian VECs are based on chronic LOEL for mallard duck
TRV for birds = 107 mg/kg/d

Summary Table for Nickel:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*80*	*5010*
Meadow Vole	*Rat*	*80*	*160000*
Red fox	*Rat*	*80*	*88500*
Sheep	*Rat*	*80*	*55000*
Redwing blackbird	*Mallard duck*	*107*	*5430*
American woodcock	*Mallard duck*	*107*	*6300*
Red-tail hawk	*Mallard duck*	*107*	*65000*

43) Pentachlorophenol

Selected Toxicity Data (Sample et al. 1996):
Test species = rat – chronic LOEL (endpoint: reproduction) = 3.0 mg/kg/d
Reference: Schwetz et al. 1978 as cited in Sample et al. 1996
TRVs for mammalian VECs are based on the chronic LOEL for rat
TRV for mammals = 2.4 mg/kg/d

Summary Table for Pentachlorophenol:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*2.4*	*0.013*
Meadow Vole	*Rat*	*2.4*	*2040*
Red fox	*Rat*	*2.4*	*2820*
Sheep	*Rat*	*2.4*	*927*

44) Phenanthrene

Selected Toxicity Data (CCME, 2007a)
Test species: Rat – LD50 (endpoint: mortality) = 700 mg/kg/d
Reference: Eisler 1987 as cited in CCME, 2007a
TRVs estimated for mammalian VECs by applying 0.1 factor to acute toxicity value for rat
TRV for mammals = 70 mg/kg/d

Summary Table for Phenanthrene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*70*	*2650*
Meadow Vole	*Rat*	*70*	*36000*
Red fox	*Rat*	*70*	*82400*
Sheep	*Rat*	*70*	*17800*

45) Phenol

Selectede Toxicity Data (CCME, 1997d, 1996h):
Test species: Mouse – LD50 (endpoint: mortality) = 300 mg/kg/d
Reference: Von Oettingen and Sharpes, 1946 as cited in CCME, 1997d
TRVs estimated for mammalian VECs by applying 0.1 factor to acute toxicity value for mouse
TRV for mammals = 30 mg/kg/d

Test species: Redwing blackbird – LD50 (endpoint: mortality) = 113 mg/kg/d
Reference: Schafer et al. 1983 as cited in CCME, 1996h
TRVs estimated for avian VECs by applying 0.1 factor to acute toxicity value for redwing blackbird
TRV for birds = 11 mg/kg/d

Summary Table for Phenol:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short tail shrew	*Mouse*	*30*	*139*
Meadow vole	*Mouse*	*30*	*324*
Red fox	*Mouse*	*30*	*35300*

Sheep	*Mouse*	*30*	*185*
Redwing blackbird	*No surrogate*	*11*	*9.4*
American woodcock	*Redwing blackbird*	*11*	*41*
Redtail hawk	*Redwing blackbird*	*11*	*6930*

46) Polychlorinated Byphenels (PCBs)

Selected Toxicity Data (CCME, 1999e)
Test species: mouse – chronic LOEL (endpoint: reproduction) = 0.9 mg/kg/d.
(Calculated based on diet containing 5 mg PCB (aroclor 1254)/kg of food and 5.5 g of food /day ingested, and body weight of 30 g using formula in Sample et al. 1996.)
Reference: McCoy et al. 1995 as cited in CCME, 1999e
TRV for mammalian VECs based on chronic LOEL for mice
TRV for mammals = 0.9 mg/kg/d

Test species: Leghorn chicken – chronic LOEL (endpoint: reproduction) = 0.35 mg/kg/d
Reference: Platonow and Reinhart 1973 as cited in CCME 1999e
TRVs for avian VECs based on chronic LOEL for chicken
TRV for birds = 0.35 mg/kg/d

Summary Table for PCBs:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug TEQ/g)*
Short-tail shrew	*Mouse*	*0.9*	*1.2*
Meadow Vole	*Mouse*	*0.9*	*1700*
Red fox	*Mouse*	*0.9*	*1040*
Sheep	*Mouse*	*0.9*	*617*
Redwing blackbird	*Chicken*	*0.35*	*19*
American woodcock	*Chicken*	*0.35*	*1.1*
Red-tail hawk	*Chicken*	*0.35*	*218*

47) Pyrene

Selected Toxicity Data (CCME, 2007a)
Test species = Mouse – chronic LOEL (endpoint: nephropathy and decreased liver wt.) = 125 mg/kg/d
Reference: USEPA 1989d as cited in CCME, 2007a
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 125 mg/kg/d

Summary Table for Pyrene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*125*	*4740*
Meadow Vole	*Mouse*	*125*	*99100*
Red fox	*Mouse*	*125*	*147000*
Sheep	*Mouse*	*125*	*45700*

48) Selenium

Selected Toxicity Data (CCME, 2007b; 2002; Sample et al. 1996)
Test species = rat – chronic LOEL (endpoint: reproduction) = 0.33 mg/kg/d
Reference: Rosenfeld and Beath 1954 as cited in CCME 2007 and Sample et al. 1996
TRVs for mammalian VECs are based on chronic LOEL for rat
TRV for mammals = 0.33 mg/kg/d

Test species = sheep – chronic LOEL (endpoint: intoxication) = 0.08 mg/kg/d
Reference: Puls et al. 1994 as cited in CCME, 2002
TRV for sheep = 0.08 mg/kg/d

Test species = mallard duck – chronic LOEL (endpoint: reproduction) = 0.8 mg/kg/d
Reference: Heinz et al. 1989 as cited in CCME 2007b and Sample et al. 1996
TRVs estimated for avian VECs are based on chronic LOEL for mallard duck
TRV for birds = 0.8 mg/kg/d

Test species = screech owl – chronic LOEL (endpoint: reproduction) = 3.75 mg/kg/d
Reference: Wiemeyer and Hoffman 1996 as cited in CCME 2007b
TRV for redtail hawk based on chronic LOEL for screech owl
TRV for redtail hawk = 3.8 mg/kg/d

Summary Table for Selenium:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*0.33*	*2.4*
Meadow Vole	*Rat*	*0.33*	*26*
Red fox	*Rat*	*0.33*	*212*
Sheep	*No surrogate*	*0.08*	*4.3*
Redwing blackbird	*Mallard duck*	*0.8*	*5.5*
American woodcock	*Mallard duck*	*0.8*	*5.7*
Red-tail hawk	*Screech owl*	*3.8*	*2190*

49) Tetrachloroethylene

Selected Toxicity Data (Sample et al. 1996):
Test species = Mouse – subchronic LOEL (endpoint: hepatoxicity) = 70 mg/kg/d
Reference: Buben and O'Flaherty 1985 as cited in Sample et al. 1996
TRVs for mammalian VECs estimated by applying 0.1 factor to subchronic LOEL for mouse
TRV for mammals = 7 mg/kg/d

Summary Table for Tetrachloroethylene

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*7.0*	*4.54*
Meadow Vole	*Mouse*	*7.0*	*310*
Red fox	*Mouse*	*7.0*	*8240*
Sheep	*Mouse*	*7.0*	*175*

50) Thallium

Selected Toxicity Data (CCME, 1999):
Test species = rat – chronic NOEL (endpoint: hair loss, blood chemistry) = 0.2 mg/kg/d
Reference: Stolz et al. 1986 as cited in CCME 1999
TRVs for mammalian VECs based on chronic **NOEL** for rat
TRV for mammals = 0.2 mg/kg/d

Summary Table for Thalium:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*0.2*	*3.9*
Meadow Vole	*Rat*	*0.2*	*419*
Red fox	*Rat*	*0.2*	*47*
Sheep	*Rat*	*0.2*	*146*

51) Toluene

Selected Toxicity Data (Sample et al. 1996)
Test species = mouse – chronic LOEL (endpoint: reproduction) =260 mg/kg/d
Reference: Nawrot and Staples 1979 as cited in Sample et al. 1996
TRV estimated for other mammalian VECS (based on mouse LOEL) = 260 mg/kg/d

Summary Table for Toluene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*260*	*135*
Meadow Vole	*Mouse*	*260*	*13600*

Red fox	*Mouse*	*260*	*306000*
Sheep	*Mouse*	*260*	*7650*

52) 1,1,1-Trichloroethane

Selected Toxicity Data (Sample et al. 1996):
Test species = mouse – chronic **NOEL** (endpoint: reproduction) = 1000 mg/kg/d
Reference: Lane et al. 1982 as cited in Sample et al. 1996
TRVs mammalian VECs are based on chronic **NOEL** for mouse
TRV for mammals = 1000 mg/kg/d

Summary Table for 1,1,1-Trichloroethane:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*1000*	*824*
Meadow Vole	*Mouse*	*1000*	*38500*
Red fox	*Mouse*	*1000*	*1000000*
Sheep	*Mouse*	*1000*	*21800*

53) Trichloroethylene

Selected Toxicity Data (Sample et al. 1996):
Test species = mouse – subchronic LOEL (Endpoint: hepatatoxicity) = 100 mg/kg/d
Reference: Buben and O'Flaherty 1985 as cited in Sample et al. 1996
TRVs estimated for mammalian VECs by applying 0.1 factor to mouse subchronic LOEL
TRV for mammals = 10 mg/kg/d

Summary Table for Trichloroethylene:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Mouse*	*10*	*8.1*
Meadow Vole	*Mouse*	*10*	*385*
Red fox	*Mouse*	*10*	*11800*
Sheep	*Mouse*	*10*	*218*

54) Uranium

The CCME has recently developed soil quality criteria for Uranium. (CCME 2007c). The CCME process included the development of a component for the protection of small mammals. The soil value of 33 mg/kg developed by the CCME for the protection of rabbits has been utilized directly within the Ontario spreadsheets and has been applied to meadow voles only.

55) Vanadium

Selected Toxicity Data (Sample et al. 1996)
Test species: Rat – chronic LOEL (endpoint: reproduction) = 2.1 mg/kg/d
Reference: Domingo et al. 1986 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammals = 2.1 mg/kg/d

Selected Toxicity data (CCME, 1996k)Test species: Chicken: chronic LOEL (endpoint: weight loss) = 0.38 mg/kg/d
Reference: Berg 1963 as cited in CCME, 1996k
TRV for avian VECs based on chronic LOEL for chicken
TRV for birds = 0.38 mg/kg/d

Summary Table for Vanadium:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Source of TRV*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*2.1*	*Sample et al.*	*108*
Meadow Vole	*Rat*	*2.1*	*Sample et al.*	*4180*
Red fox	*Rat*	*2.1*	*Sample et al.*	*2470*
Sheep	*Rat*	*2.1*	*Sample et al.*	*1490*
Redwing blackbird	*Chickem*	*0.38*	*CCME*	*21*
American woodcock	*Chicken*	*0.38*	*CCME*	*18*
Red-tail hawk	*Chicken*	*0.38*	*CCME*	*239*

56) Vinyl chloride

Available Toxicity Data (Sample et al. 1996)
Test species = rat – chronic LOEL (Endpoint: longevity) = 1.7 mg/kg/d
Reference: Feron et al. 1981 as cited in Sample et al. 1996
TRVs for mammalian VECs based on chronic LOEL for rat
TRV for mammal = 1.7 mg/kg/d

Summary Table for Vinyl chloride:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*1.7*	*14*
Meadow Vole	*Rat*	*1.7*	*12*
Red fox	*Rat*	*1.7*	*2000*
Sheep	*Rat*	*1.7*	*6.8*

57) Xylenes

Selected Toxicity Data (CCME, 1996i; CCME, 2004
Test Species: Rat – chronic LOEL (endpoint: body wt. and survival) = 500 mg/kg-d

Reference: NTP 1986 as cited in CCME 1996i and CCME 2004
TRVs for mammalian VECs based on chronic LOEL for mouse
TRV for mammals = 500 mg/kg-d

Note: Marks et al. (1982) treated pregnant CD-1 mice on days 6-15 of gestation by gavage with mixed xylenes in cotton seed oil at total daily doses of 0.52, 1.03, 2.06, 2.58, 3.10, or 4.13 g/kg/day. ATSDR and RAIS toxicity profiles indicate that the author incorrectly reported a chronic LOEL (fetal demormation) for mice at 2.06 mg/kg-d which is 1000 times lower than the actual effects level of 2.06 g/kg-d.

Summary Table for Xylenes:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*500*	*96*
Meadow Vole	*Rat*	*500*	*47000*
Red fox	*Rat*	*500*	*589000*
Sheep	*Rat*	*500*	*261000*

58) Zinc

Selected Toxicity Data(Sample et al. 1996)
Test species = rat – chronic LOEL (Endpoint: reproduction) = 320 mg/kg/d
Reference: Schlicker and Cox 1968 as cited in Sample et al. 1996
TRV for shorttail shrew, meadow vole and red fox based on chronic LOEL for rat
TRV for mammals (except sheep) = 320 mg/kg/d

Test species: chicken – chronic LOEL (endpoint: reproduction) = 131 mg/kg/d
Reference: Stahl et al. 1990 as cited in Sample et al. 1996
TRV for avian VECs based on chronic LOEL for chicken
TRV for birds = 131 mg/kg/d

Test Species:sheep - Lambs, liver function : LOEL = 33 mg/kg/d (Campbell and Mills, 1979)
Pregnant ewes: reduced survival of newborns = 20 mg/kg/d (Davies et. Al. 1977)
TRV for sheep (based on above) = 20 mg/kg/d

Summary Table for Zinc:

VEC	*Surrogate Species*	*TRV used in Model (mg/kg/d)*	*Soil Value Generated (ug/g)*
Short-tail shrew	*Rat*	*320*	*5520*
Meadow Vole	*Rat*	*320*	*492000*
Red fox	*Rat*	*320*	*36900*
Sheep	*no surrogate*	*20*	*4200*
Redwing	*Chicken*	*131*	*2770*

blackbird			
American woodcock	*Chicken*	*131*	*337*
Red-tail hawk	*Chicken*	*131*	*79000*

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6 AESTHETIC CRITERIA

6.1 Background

The 1996 generic criteria provided for protection of remediated sites from unacceptable odours in indoor air, soil and groundwater. During the review of the methodologies used, there was a desire to move away from the use of ceiling concentrations as applied in the development of the odour index, especially in the case of soils. As a result, it was decided to utilize updated odour thresholds for air as the basis for calculating both acceptable limits for indoor air concentrations and for soils directly. The calculations utilize the same partitioning models as are used for other calculations in the spreadsheets, thereby maintaining internal consistency in the modelling. Odour thresholds are not applied directly to groundwater, as drinking water standards that are used for the GW1 pathway have been through a thorough national and provincial acceptance process, and contain any necessary protections for odours in drinking water. The odour thresholds are used for GW1 only when neither an ODWQS or a CDWQG exists, in which case the air odour thresholds are divided by the unitless Henry's law constant to obtain the odour threshold for GW1. Odour thresholds are applied for the GW2 pathway as protection against odours in indoor air emanating from contaminated groundwater, and are calculated from the odour threshold values using the same modelling procedures as for human health GW2 components. For soils, rather than using an odour index based on vapour pressure and three categories within each soil exposure scenario, the new criteria are the modelled (partitioned) soil vapour concentrations for each parameter that do not allow an exceedence of the air odour thresholds, assuming a five fold dilution (air mixing) and one year of source depletion, which is limited to not exceeding a ten fold factor.

6.2 Odour Thresholds

The odour thresholds used in this document have been extracted from two review articles.

The primary source of data is a review publication by the American Industrial Hygiene Association (AIHA, 1989) which shows all published odour thresholds for the 184 chemicals found to have both threshold limit values (TLVs) and reported odour thresholds. This listing is preferred because of the coding system that is used to distinguish between acceptable (critiqued, more reliable data) and unacceptable (rejected, or not reviewed) odour thresholds. The listing separates the values into detection thresholds and recognition thresholds, and also names the specific researcher and publication year for each value. Many of the acceptable values in the AIHA document came from a careful study by T.H. Hellman and F.H. Small (1974) on 101 petrochemicals.

The secondary source is a review publication by J.E.Amoore and E. Hautala (1983), which shows odour thresholds for 214 volatile compounds and gases listed as having TLVs in

1982. The values are geometric means (median values) of all published data for detection thresholds, but recognition thresholds were also accepted if detection thresholds were not available. The average recognition threshold is about three times the detection threshold concentration.

Detection thresholds are preferred (over recognition thresholds) because people may become concerned whenever odours are detected and not just when the concentration is increased to the recognition threshold level. The AIHA listing is the first source to be consulted because it denotes detection thresholds which came from reliable, high quality studies.

For compounds for which there were values in the 1996 Guidelines, and for which there were no values in the above sources, the 1996 values were used. These numbers were taken from MADEP, 1994, which had obtained them from ATSDR (see references), Verschueren, 1983, Fazzalari, 1978, USEPA, 1992, and USEPA, 1992a.

Table 6.1 Odour Thresholds

CHEMICAL PARAMETER	Odour Threshold in Air mg/m^3	Basis
ACENAPHTHENE	0.5	ATSDR (1995)
ACETONE	150	AIHA
BENZENE	195	AIHA
BIPHENYL, 1,1-	0.0062	Amoore - Hautala
BIS(2-CHLOROETHYL)ETHER	0.29	MADEP
BIS(2-CHLOROISOPROPYL)ETHER	2.24	MDEP
BROMOFORM	13	Amoore - Hautala
BROMOMETHANE	80.00	MADEP
CARBON TETRACHLORIDE	1500	AIHA
CHLORDANE	0.01	MADEP
CHLOROBENZENE	5.9	AIHA
CHLOROFORM	960	AIHA
DICHLOROBENZENE, 1,2- (o-DCB)	4.2	AIHA
DICHLOROBENZENE, 1,4- (p-DCB)	0.73	AIHA
DICHLOROETHANE, 1,1-	125.00	MADEP
DICHLOROETHANE, 1,2-	110	AIHA
DICHLOROETHYLENE, 1,1-	760	Amoore - Hautala
DICHLOROETHYLENE, TRANS-1,2-	67	Amoore - Hautala
DICHLOROPROPANE, 1,2-	1.2	AIHA
DICHLOROPROPENE, 1,3-	4.61	MADEP
ETHYLBENZENE	10	Amoore - Hautala
ETHYLENE DIBROMIDE	200.00	MADEP
HEPTACHLOR	0.30	MADEP
HEPTACHLOR EPOXIDE	0.30	MADEP
HEXACHLOROBUTADIENE	12.00	MADEP
HEXACHLOROETHANE	1.5	Amoore - Hautala

CHEMICAL PARAMETER	Odour Threshold in Air mg/m^3	Basis
METHYL ETHYL KETONE	47	AIHA
METHYL ISOBUTYL KETONE	3.6	AIHA
METHYLENE CHLORIDE	550	AIHA
METHYLNAPHTHALENE, 2- (*1-)	0.07	MADEP
NAPHTHALENE	0.2	AIHA
PHENOL	0.23	AIHA
STYRENE	0.6	AIHA
TETRACHLOROETHANE, 1,1,2,2-	50	AIHA
TETRACHLOROETHYLENE	320	AIHA
TOLUENE	6	AIHA
TRICHLOROBENZENE, 1,2,4-	11	Amoore - Hautala
TRICHLOROETHANE, 1,1,1-	2100	AIHA
TRICHLOROETHYLENE	440	AIHA
VINYL CHLORIDE	6000	Amoore - Hautala
XYLENES	100	AIHA

6.3 References

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7 SUBSURFACE TRANSPORT

Section 7 is structured to give the reader an introduction to the processes used to develop the particular component value for exposure pathways that involve subsurface transport (Section 7.1), then to present the assumptions, equations, and algorithms that are used in these exposure pathways (Section 7.2 and 7.3), and then to show how these are used to generate the allowable maximum concentration for each pathway (Sections 7.4 to 7.13). Although this structure results in some replication, it allows the reader to follow the logic of the modelling for each pathway without having to refer back to previous sections for the equations.

7.1 Introduction to the Generic Settings and Attenuation Methods

Subsurface transport of contaminants in soil and/or groundwater is involved in the following pathways through which individuals and ecological receptors become exposed to a contaminant:

- volatile contaminants from soil or groundwater enter a residential or commercial/industrial building, mix with indoor air and are inhaled by humans;
- leachable contaminants in soil enter groundwater, migrate in an aquifer to a domestic water well, mix with other groundwater in the well bore and are ingested by humans;
- leachable contaminants in soil enter groundwater, migrate in an aquifer and discharge to surface water, mix with the water column and reach ecological receptors;
- volatile contaminants from surface soil mix with outdoor air and are smelled by humans; and
- volatile contaminants from soil mix with outdoor air and are inhaled by humans.

Development of the soil and groundwater component values for the subsurface pathways begins with conceptualizing a physical setting, called the generic setting, for each subsurface pathway. The generic settings, presented in Figure 7.1, are based on those used in the Canada Wide Standards (CCME, 2002) and are modified for Ontario. They consist of a uniformly-contaminated source zone, a residential building, a commercial/industrial building, an uppermost aquifer containing a domestic water well, and a nearby surface water body receiving the aquifer discharge. The generic settings have the same finite volume of contaminated soil, the same depth to water table (the annual high) and the same underlying aquifer, regardless of the overlying soil texture. The vertical position of the soil source zone varies in the exposure pathways in that sometimes it is the upper two metres, and sometimes the lower two; however, the source-zone position is conceptual only, and the generic soil SCSs apply throughout the full thickness of the overburden. A temperature of 15 degrees Celsius is assumed for all pathways to address the warming which may occur due to the basement slab (Straube, 2000) and the urban, heat-island effect. While the generic settings contain a mix of reasonable and reasonable worst-case physical conditions such that, in total, they generate generic soil and groundwater SCSs which are likely to be of no societal concern, Sections 1.4 and 7.3.3 present examples of site characteristics which could preclude the application of the Generic Site Condition Standards. The generic settings assume Non-Aqueous Phase Liquid (NAPL) is absent.

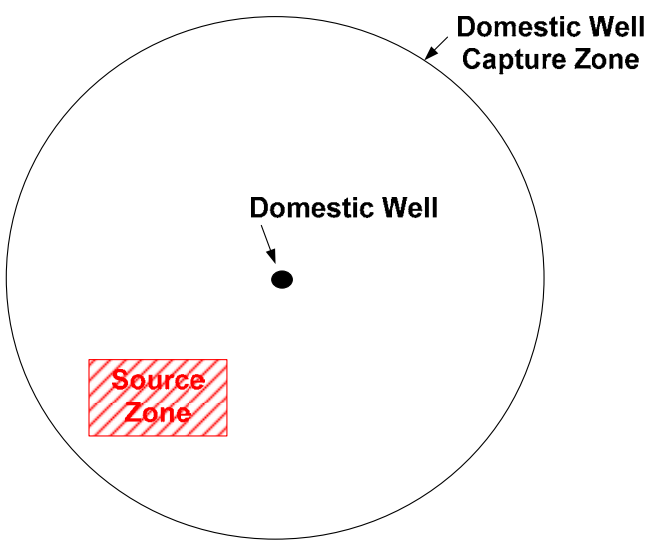
To each generic setting mathematical models are applied to estimate the amount of physical attenuation that would occur en route from the contaminant source to the receptor and, for certain pathways (S-GW1, S-IA, S-O), to estimate the rate of decline in concentration with time of the finite, contaminant source in soil. These estimates, when applied to the acceptable receptor concentration, determine the soil and groundwater concentrations that are protective for that pathway. Attenuation is modelled considering the following processes: biodegradation in the vadose zone, well-bore mixing in the water well, mixing with indoor and outdoor air, dispersion in groundwater en route to surface water, and mixing with surface water. All dilution is assumed to be with clean water or air. Biodegradation in groundwater en route to surface water (GW3) is not invoked in the Generic Site Condition Standards, or in Tier 2, because biodegradation is a site-specific, highly-variable process that does not occur at every site and no studies were identified that supported biodegradation rates which could be guaranteed to be present at 95% of sites in Ontario.

Depletion of the contaminant source in soil is incorporated into all the soil standards, except S-GW3, by assuming a finite source of contamination above the water table and a rate of mass loss equal to the allowable receptor dose. Source depletion was not used in the groundwater standards because the location of the contaminant source might be offsite or upgradient and therefore the initial mass of the contaminant, needed to estimate the rate of concentration decline, was unknown.

Generic SCSs are developed for coarse-textured soils, medium-and-fine-textured soils, and groundwater.

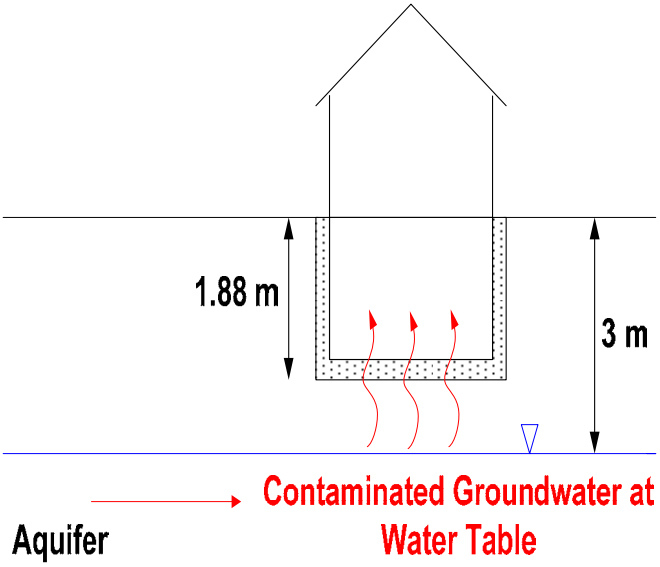
Figure 7.1 illustrates the site conceptual models of all the generic settings and lists the attenuation mechanisms used.

Figure 7.1 Conceptual Model of Generic Setting

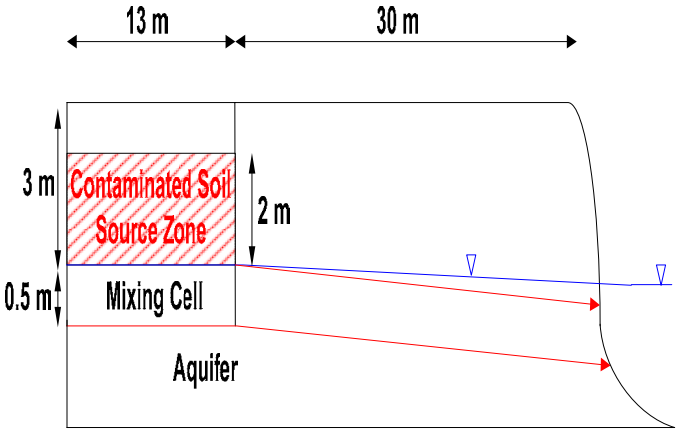


Subsurface Pathway

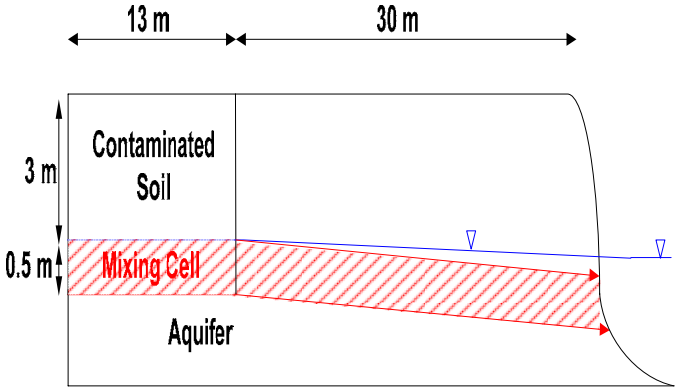
Soil to Potable Groundwater (S-GW1) A domestic water well creates a hydraulic capture zone that includes the source zone of uniformly-contaminated soil. Attenuation mechanisms used are well-bore dilution and source depletion via mass loss by leaching to the aquifer. The equilibrium partition equation determines the total soil concentration, which varies with soil texture.



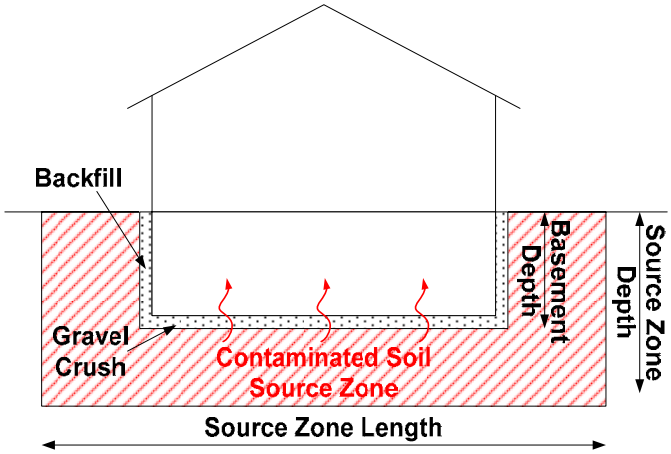
Water table to Indoor Air (GW2) A building overlies contaminated groundwater containing volatiles at the water table. Volatiles diffuse up from the water table through the capillary fringe and unsaturated zone and are swept into the building due to lower air pressure via cracks in the foundation. The Johnson-Ettinger (J&E) algorithm is used to estimate the attenuation coefficient, which is the concentration ratio between mixed indoor air and the soil gas at the water table interface. Henry's Law constants for 15 degrees C are used to determine the groundwater concentration at the water table. A ten times multiplier is applied to incorporate biodegradation and a two times factor for Koc to address partitioning uncertainty in the overlying soil.



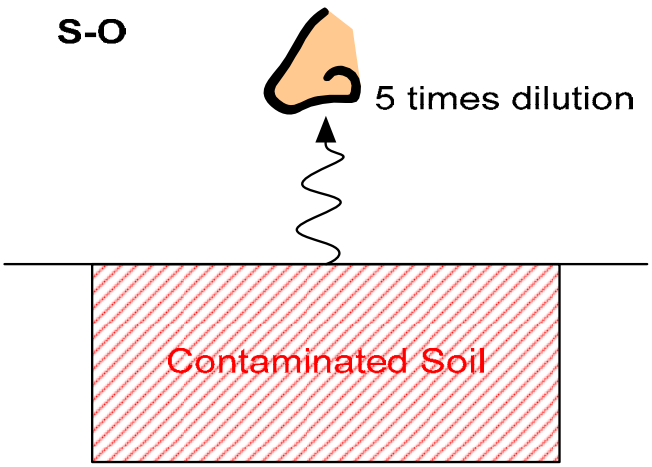
Soil to Groundwater to Surface Water (S-GW3) Recharge through two metres of contaminated soil leaches contaminants to groundwater in an aquifer which discharges to surface water. The soil leachate concentration is estimated by a mixing cell which dilutes the soil leachate with lateral flow in the aquifer. No source depletion is considered. The mixing cell concentration is the groundwater concentration in the GW3 pathway. The equilibrium partition equation with a two times Koc increase to account for partitioning uncertainty was used to estimate the soil concentration from the soil leachate concentration.



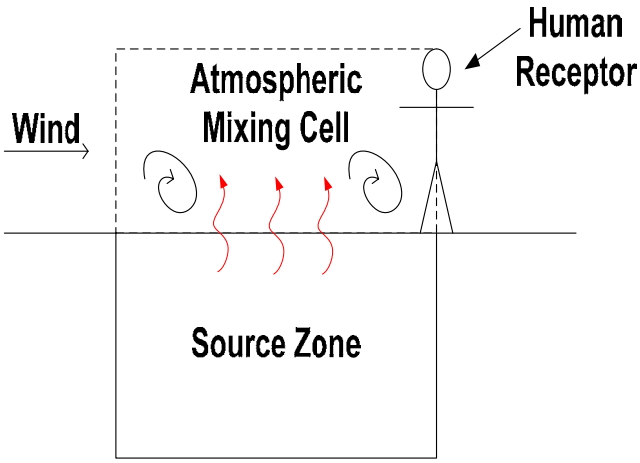
Groundwater to Surface Water (GW3) The Domenico transport model uses 2–D hydrodynamic dispersion to estimate the groundwater concentration at the water table beneath a continuous, finite-source zone that results in the aquatic protection value in surface water 30 m downgradient at 300 years of travel time in the aquifer. Biodegradation is not assumed. Ten times dilution by surface water is assumed. The GW3 value for coarse and medium and fine textured soils is the same since 2-D modelling causes the lateral groundwater movement to surface water to occur in an identical aquifer.



Soil to Indoor Air (S-IA) The building is surrounded by contaminated soil. Attenuation processes used are: dilution of soil vapour by indoor air via the Johnson-Ettinger model; source depletion via mass entering the building; and, for the commercial /industrial setting, a ten-times bioattenuation factor for the lower 0.5 m of soil of the two-metre thick soil source. The equilibrium partition equation with a two times Koc increase to account for partitioning uncertainty estimates the soil concentration from the allowable soil vapour concentration which varies with soil texture.



Soil Odour (S-O) A gardener smells a handful of soil. The equilibrium soil partitioning equation, mixing with outdoor air, and source depletion factors generated from the Jury Reduced Solution Finite Source Volatilization Model, are used to estimate contaminant concentrations in soil that meet the soil odour standard. Soil concentrations vary with soil texture.



Soil to Outdoor Air (S-OA) A human receptor located at the downwind edge of the source zone breathes outdoor air. The Jury Reduced-Solution, Finite-Source Volatilization Model, combined with an atmospheric mixing cell, determines the soil concentrations which protect this pathway. Soil concentration varies with soil texture.

7.2 Site Assumptions Used for the Generic Settings for Subsurface Transport to Receptors

7.2.1 Soil

Two soil textures are considered in the generic, site-condition standards and in Tier 2: coarse, and medium and fine (M/F). Coarse soils are defined as having a median grain diameter of >75 micrometres. In Ontario, common coarse-grained soils are sand and silty sand, while common medium-and-fine soils are loam, silt, sandy silt, clay and till. Above the capillary fringe the values for the soil properties of dry bulk density, total porosity and volumetric moisture content were chosen to harmonize with CCME's choices for these parameters. Soil properties of the capillary fringe, used in the analysis of the GW2 pathway, were selected from the Soil Conservation Service's (USSCS) soil classes presented in the Soil Properties Lookup Table contained in USEPA's online version of the J&E model (USEPA, 2004b). The USSCS soil classes used for the capillary fringe for the coarse, and medium-and-fine soil settings are Sand and Loam, respectively. By allowing different soil properties for the capillary fringe than for the rest of the soil column, a greater level of flexibility is allowed in Tier 2 to better characterize contaminant transport from groundwater diffusing up through the vadose zone to the receptor.

Foc values for both generic soil textures were selected by MOE. Because soil odour is a separate pathway that can drive the soil standard, foc values more representative of the upper 0.5 m of the soil profile are used.

For Tier 2, the clay-type soils of the USSCS classification (clay, silty clay, sandy clay) were removed from the available choices to ensure the porous-media attenuation calculations are not done on potentially fractured soils.

Soil Characteristics for all pathways are listed below.

Soil Above Capillary Fringe	**Coarse**	**Medium/Fine**
Total porosity (v/v)	0.36	0.47
Moisture-filled porosity (v/v)	0.119	0.170
Foc (g/g)	0.005 (0.010 for Soil Odour)	0.005 (0.035 for Soil Odour)
Dry bulk density (g/cm^3)	1.70	1.40
Temperature (˚C)	15	15
Depth to water table (m)	3.00	3.00
Recharge rate to aquifer (m/a)	0.28	0.20

Soil of the Capillary Fringe**	Sand (USSCS)	Loam (USSCS)
A1 (1/cm)	0.0352	0.0111
N (unitless)	3.177	1.472
M (unitless)	0.6852	0.3207
Total Porosity (v/v)	0.3750	0.3990
Residual moisture content (v/v)	0.0530	0.0610
Mean grain diameter (cm)	0.0440	0.0200

** parameters listed are used to calculate capillary fringe height and diffusion coefficient

7.2.2 Contaminated Soil Source Size

The width, length, and thickness of the contaminated soil source zone are the same for all the pathways and soil types and are listed below.

Length (m)	13.0
Width (m)	13.0
Thickness (m)	2.0

7.2.3 Aquifer

The aquifer underlying both the coarse and M/F soil in the generic settings is identical. Aquifer properties are listed below.

Horizontal hydraulic conductivity (m/s)	3.0×10^{-5}
Horizontal hydraulic gradient	0.003
Effective (and total)* Porosity (v/v)	0.25
Foc	0.0003
Mixing cell thickness (m)	0.50
Dry bulk density (g/cm3)_	1.81

*** MGRA-approved spreadsheet has one input for aquifer porosity; value for effective porosity was used.**

7.2.4 Surface Water Receiving Aquifer Discharge

Dissolved contaminants from the soil source zone leach down to the aquifer, flow in groundwater, and discharge to surface water through the bottom sediment. Dilution by surface water in a mixing zone is assumed since it is the ecological receptors in the water column which are the most sensitive and therefore determine the acceptable surface water concentration.
The acceptability of specific uses of mixing zones is captured in Policy 5 of the Blue Book (1994). MOE acknowledges that dilution will occur when groundwater discharges to surface water and has chosen a conservative, order of magnitude dilution factor of 10 times for the GW3 pathway.

The assumptions related to surface water are listed below.

Travel distance used to model groundwater transport from centre of source zone to edge of surface water	36.5 m
Dilution in surface water	10 times
Time used in the generic setting to model groundwater transport to surface water.	300 years

7.2.5 Water Well Used for Domestic Consumption

The generic setting for the potable groundwater pathway assumes that the contaminant source zone is within the hydraulic capture zone of a domestic well. The well is pumped, for calculation purposes, at 7.5 Lpm which is the peak requirement for two people (MOE Procedure D-5-5, 1996). Increasing the pumping rate to provide for more people increases the well bore dilution (WBD) factor and is non conservative. All dilution calculations assume the aquifer contains no contaminants.

7.2.6 Buildings

The building characteristics used in the generic settings are listed below.

	Residential	Commercial /Industrial
Enclosed space length (cm)	1225	2000
Enclosed space width (cm)	1225	1500
Air exchange rate per hour	0.30	1.0
Depressurization (Pa)	4.0	2.0
Depth to underside of basement/foundation slab (cm)	158	11.25
hB, gravel crush thickness beneath basement/ foundation slab (cm)	30	30

Effective enclosed space height (cm)	366	300
Lcrack, basement floor thickness (cm)	8.0	11.25
Floor-wall crack width (cm)	0.10	0.10
Ratio of Crack Area to Total Subsurface Area	0.0002	0.0002

7.2.6.1 Air Exchange Rate

The air exchange rate for residential buildings typically ranges from 0.2 air changes per hour (ACH) for airtight homes to 2.0 ACH for leaky homes (U.S. EPA, 1988). In an Ontario study, air change rates from 70 houses ranged from 0.06 to 0.77, with the lowest air exchange occurring in summer with closed windows in R-2000 houses (Walkinshaw, 1987). In a study completed in Saskatchewan and Tillsonburg, Ontario, the average measured air change rate from 44 houses was 0.34 ACH (SRC, 1992), while in a study completed in the Greater Toronto area, the average air exchange rate from 44 houses was 0.45 ACH (Otson and Zhu, 1997). In regions with relatively cold climates, the recent trend has been to construct "air-tight" houses with reduced ventilation rates to minimize energy consumption and costs (e.g., "R-2000" houses in Canada; Gusdorf and Hamlin, 1995). In Canada, the minimum required ventilation rate under the CSA F326 standard for "*Residential Mechanical Ventilation Systems*" depends on the number and types of rooms in the house but usually works out to about 0.30 air changes per hour.

For commercial buildings, the minimum ventilation requirement is 0.15 cubic feet per minute per square foot of building space. For a single story commercial building, this equates to approximately 1.0 air exchanges per hour based upon the minimal ventilation requirements pursuant to the 2001 Energy Efficiency Standards for Nonresidential Buildings (California Energy Commission, 2001).

7.2.6.2 Indoor-Outdoor Pressure Differential (ΔP)

Advective transport of soil vapours into buildings occurs as the result of the depressurization of buildings relative to the pressure in the surrounding soil. This indoor-outdoor pressure differential (ΔP), which is referred to as negative pressure, drives the flow of vapours into the building. The soil vapour flows into the building through cracks, gaps, and opening within the foundation. The pressure differential is caused by meteorological, mechanical, and occupant behaviour factors. The meteorological factors include indoor-outdoor temperature differences, wind loading on the building superstructure, and barometric pressure changes. Examples of mechanical and occupant behavioral factors that lead to building depressurization include the operation of exhaust fans, ceiling fans, fireplaces, and furnaces.

The potential range of values for indoor-outdoor pressure differential is from 0 to 20 Pascals (1 Pa = 10 g/cm*s^2) (Loureiro et al., 1990; Eaton and Scott, 1984) and therefore some degree of negative pressure should be incorporated into any vapor intrusion evaluation. Quantifying the degree of building depressurization is a highly uncertain process. Due to this uncertainty and the inability to estimate the simultaneous interactions of all the depressurization factors, values for building depressurization of 4 Pascals (40 g/cm*s^2) for residential and 2 Pascals for commercial/industrial were chosen as conservative defaults for Ontario.

7.2.6.3 Crack Width and Crack-to-Total Subsurface Area Ratio (η)

The default values for crack width of 0.10 cm and crack ratio of 0.0002 are recommended by USEPA (2004) and are used for Ontario. The crack-to-total subsurface area ratio (η) is the ratio of the total area of cracks in the foundation and building floors and walls available for vapour flow, to the area of the floor and walls below grade. This parameter is also referred to as the "crack factor". With respect to model sensitivity to crack factor, Johnson (2002) states that the J&E model is not sensitive to the selection of a crack factor for scenarios where advection dominates the movement of soil vapour. However, in scenarios where the intrinsic permeability of the soil is below 1.0E-9 cm^2, the movement of vapour will be dominated by diffusion and the selection of a crack factor becomes important.

7.2.6.4 Average Soil and Groundwater Temperature

The Henry's Law constant, used in several equations in this document, is affected by temperature. There are three temperature zones in the generic settings: the water table; the soil under a heated-basement slab; and shallow soil, all potentially in an urban, heat-island setting. For the generic, site-condition standards it was decided that one temperature, 15 degrees Celsius, would be used for Ontario, with the one exception being odour protection for potable groundwater where 25 degrees Celsius is used.

7.2.7 Properties of Atmosphere Mixing Cell for Soil-to-Outdoor-Air Pathway

The amount of dilution provided by the atmosphere mixing cell is determined by three parameters: the length of the contaminated source zone parallel to the predominant wind direction; the average annual windspeed; and the height of the mixing cell for human receptors. The length of the source zone is 1300 cm. (see section 7.2.2). The windspeed used is 410 cm/sec which is the long-term average annual windspeed at Toronto's Pearson International Airport (http://www.theweathernetwork.com/statistics/C02017/caon0696) based on weather statistics representing the monthly mean value from 1961 to 1990. A mixing cell height of two metres (200 cm.) was chosen to represent the breathing height for a human receptor located at the downwind edge of the source zone.

7.3 Equations Used to Model Contaminant Attenuation in the Subsurface

All equations used to develop the generic, site-condition standards are public domain and readily codable for spreadsheet use. The "*" symbol in the equations signifies multiplication.

7.3.1 Soil-water-gas Equilibrium Partitioning Equation

The equilibrium partitioning (E-P) equation assumes equilibrium partitioning of a contaminant between the solid, water and gas phases present in soil. The equation predicts the total concentration of a contaminant from all three phases that would result from a chemical analysis of the soil sample. The equation is based on fundamental principles of chemical partitioning in soil (Feenstra, Mackay and Cherry, 1991).

When the concentration of the soil leachate is known, the total soil concentration for non-ionizing hydrophobic organics is given by:

$$C_s = C_{leachate}\left(K_{oc} * f_{oc} + \frac{\eta_w + \eta_a * H'}{\rho_b}\right) \quad \text{(Equation 7.1)}$$

where:

C_s = the total concentration of contaminant measured in a soil sample, from the gas, water and sorbed phases (ug/g).

$C_{leachate}$ = contaminant concentration in water (mg/L)

K_{oc} = organic carbon-water partition coefficient (cm^3/g)

f_{oc} = fraction organic carbon of the soil (dimensionless)

η_w = water-filled porosity of soil (dimensionless)

η_a = air-filled porosity of soil (dimensionless)

H' = Henry's Law constant at the soil temperature (dimensionless)

ρ_b = dry soil bulk density (g/cm^3)

When the acceptable soil-gas concentration, C_g, is known, then, using Henry's Law ($C_{leachate} = C_{gas}/H'$), Equation 7.1 is rearranged to:

$$C_s = C_{gas} * \left(\frac{f_{oc} * K_{oc}}{H'} + \frac{\eta_w}{H' * \rho_b} + \frac{\eta_a}{\rho_b}\right) \quad \text{(Equation 7.2)}$$

Where C_{gas} = contaminant concentration in soil gas (mg/L)

A correction factor was applied to the equilibrium partition equation to address the observed difference of two to four times between the measured soil gas concentration and that predicted using the equilibrium partition equation (Hers, 2008). Specifically, considering that Henry's Law constants are much more reliable than the organic carbon partitioning coefficients, MOE addressed this discrepancy by multiplying the Koc values by two in the Physical Chemistry and Toxicology section of the spreadsheet model, thereby ensuring the correction was applied wherever Koc was used, i.e., S-IA, S-GW1, S-GW3, GW3, S-O, S-OA and the separate-phase threshold.

Regarding solubility aspects, the E-P equation converts a groundwater or soil vapour standard into an equivalent soil standard without considering the coc's solubility in the soil pore water or soil vapour. For example, if the modelled groundwater value for a pathway exceeds the coc's solubility then the derived soil concentration can not produce pore water at such concentrations. The excess coc mass is present as a fourth phase, NAPL. In this way, soil meeting such a standard means that water or vapour concentrations coming from the soil are lower than that required to attain the allowable concentration at the receptor and hence the site is in compliance. The MGRA method allows soil to have NAPL up to the free-phase threshold which is defined as the soil concentration resulting from entering pore water at 100% solubility into the E-P equation plus NAPL at 1% of the porosity.

7.3.2 Well Bore Dilution Equation

Well bore dilution (WBD) occurs when the screen of a water well is open to non-uniform groundwater quality and contaminated groundwater is blended with clean groundwater as the well is pumped. MODFLOW® modelling of the extent of the capture zone caused by pumping the domestic well in the generic setting (Franz Environmental Inc., in Global Tox, 2007) yielded a WBD factor comparable to the ratio of the annual volume pumped by the well to the annual volume of contaminated recharge from the source zone, and therefore the ratio method was adopted.

WBD = annual volume pumped/(source area*annual recharge) ……(Equation 7.3)

Therefore, the allowable leachate concentration entering the aquifer from the contaminated soil zone in the vadose zone that would not cause exceedence of the Ontario Drinking Water Quality Standard (ODWQS) in the blended well water is:

$C_{leachate}$ = GW1*WBD ……..(Equation 7.4)

where GW1 = the ODWQS

7.3.3 Johnson & Ettinger (J&E) Model

Soil vapour intrusion is the migration of volatile or semi-volatile chemicals from contaminated groundwater or soil into overlying existing or future buildings. If the vapour intrusion pathway is present there may be the potential for unacceptable health risks to building occupants as a result of inhalation of vapours.

To estimate the impact upon indoor air quality due to subsurface contamination the mathematical model developed by Johnson and Ettinger (1991) is used. This model estimates the vapour attenuation coefficient (alpha), which is the gas concentration in the building divided by the gas concentration at the presumed source. The J&E model is a three-compartment, mass-flux model for diffusion in the unsaturated zone, diffusion and soil gas advection through cracks in the building foundation, and uniform mixing of vapours in the building airspace. NAPL is assumed to be absent (USEPA, 2004).

The vapour intrusion pathway into buildings can occur in one of two ways, depending on where the contaminant source is located. The first, the soil-to-indoor air pathway (S/IA), is when the contaminant source is the soil surrounding a building. The second, the groundwater to indoor air pathway (GW2), is when the contaminant source is the water table under the building. The J&E model determines the attenuation coefficient for both scenarios, the only difference being the distance from the source to the building and the effective diffusion coefficient for this distance. When the contaminant source is groundwater at the water table the soil vapour attenuation coefficient, alpha, is the ratio of acceptable indoor air concentration divided by the gas concentration immediately above the water table. Because the water table is separated from the soil by the capillary fringe the effective diffusion coefficient is smaller than for an equidistant S-IA source and therefore GW2 alphas are smaller (more attenuation). Henry's Law is used to derive the groundwater concentration in equilibrium with the soil gas at the water table by dividing the gas concentration by the temperature-corrected Henry's Law constant (dimensionless).

Within the past several years there have been a number of well-characterized sites where empirical data suggest that careful application of the Johnson and Ettinger model provides estimates that are within one order-of-magnitude for non-degrading chemicals (Johnson et al., 2002; Hers et al., 2003).

The equation to calculate the soil vapour attenuation coefficient (Johnson and Ettinger, 1991) is:

$$\alpha = \frac{\left(\frac{D_T * A_B}{Q_{building} * L_T}\right) * \exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right)}{\left(\exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right) + \left(\frac{D_T * A_B}{Q_{building} * L_T}\right) + \frac{D_T * A_B}{Q_{soil} * L_T} * \left[\exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right) - 1\right]\right)}$$

(Equation 7.5)

where:

α = Steady-state, vapour attenuation coefficient, unitless

D_T = Total overall effective diffusion coefficient between source and building, cm^2/s

A_B = Area of the enclosed space below grade, cm^2

$Q_{Building}$ = Building air exchange rate, cm^3/s

L_T = Separation distance from contaminant source to building, cm

Q_{soil} = Flow rate of soil gas into the enclosed space, cm^3/s

L_{crack} = Enclosed space foundation or slab thickness, cm

A_{crack} = Area of total cracks in A_B, cm^2

D_{crack} = Effective diffusion coefficient through the cracks, cm^2/s (assumed equivalent to diffusion coefficient of soil type closest to floor slab).

The equations to calculate the above parameters are presented in the U.S. EPA's User's Guide (December 2000).

Spreadsheet coding of Equation 7.5 is:

Alpha = Q*P/(Q+P+R*(P-1)) ……(Equation 7.5b)

where:

$Q = D_T * A_B/(Q_{building} * L_T)$

$P = \exp(Q_{soil} * L_{crack}/(D^{crack} * A_{crack}))$

$R = D_T * A_B/(Q_{soil} * L_T)$

7.3.3.1 Precluding Factors for Use of J&E Equation

It is important that the site conditions are sufficiently consistent with the conceptual site model (CSM) upon which the mathematical model is based. For this reason, as a first step for contaminants whose SCS's are driven using the J&E model, it is important that precluding factors be evaluated to determine whether the SCS is applicable. The precluding factors are:

Earthen Basements

Buildings with earthen basements where contamination is less than five metres from the building should be precluded.

Very High Gas Permeability Media

Buildings constructed on vertically or near-vertically fractured bedrock, karst, cobbles or other media with unusually high gas permeability should not use J&E regardless of the depth to contamination. Soil gas advection within the unsaturated zone (*i.e.*, beyond the soil zone near to the building), caused by barometric pumping or other environmental factors, can be important in these scenarios and is not part of the CSM described by the J&E model. An empirical alpha, not calculated using J&E, is used for GW2 for Shallow Soils (Table 9 of the SCS)

Gas Under Pressure

Sites where soil gas is under pressure should be precluded since the J&E model does not account for the movement of gas under pressure, which is often the case at landfills where methane is produced and where trace VOCs may move with the landfill gas.

Subsurface Utility Conduit Connecting Contamination Source and Building

Utility conduits that directly connect the contamination source to the enclosed space of the building represent a precluding condition. Common anthropogenic features such as floor drains, sewer lines and utility conduits that are present at most sites are not normally considered a precluding condition, unless they connect indoor air of the building to the location of the contaminant source.

Regarding Shallow Depth to Contamination

A commonly-seen precluding condition for use of the J&E model is "Shallow Depth to Contamination" where the contamination source is less than one metre from the building. This condition exists to account for the uncertainty in the alpha calculation that would result due to the annual, water table fluctuation which would change the separation distance from the building to the contaminated water table. This was not a concern for the generic SCSs since MOE specified the shallowest, annual depth to the water table. For Tier 2, if the shallowest water table is expected to be within the gravel crush layer beneath a floor slab then the J&E model is not used to determine alpha. Instead, alpha is fixed at an empirically-derived value of 0.02 for the Residential setting and 0.004 for the Commercial/Industrial setting (Dawson, 2006). It was assumed in Tier 2 that, where water tables were shallower than the generic depth of the gravel

crush layer, the effective water table depth would be the elevation of the gravel crush layer due to a sump pump.

Regarding Solubility

The J&E model determines an attenuation ratio, or c/C0, which is converted into either a GW2 component value or a soil vapour standard without regard to the coc's solubility. If such values become the driver they cannot generate the allowable starting concentration and hence the site's impact is less than that allowed and the site is in compliance.

7.3.4 Soil Vapour Permeability

Soil vapour permeability is a parameter used in the J&E equation. The properties of the backfill surrounding the building as well as the gravel crush underlying the basement floor are assumed to govern the effective vapour permeability. The effective vapour permeability is the bulk value for the flow path from the ground surface down and under the foundation footing, back up to the gravel crush, and along the gravel crush to the entry crack. A gravel crush layer is required by Ontario Building Code and therefore if the basement floor becomes cracked then soil vapour will flow to the crack through the gravel crush layer. This potential requires that the effective bulk permeability for the travel path include that of the gravel crush. This is not unreasonable as it leads to calculated soil vapour flow rates into the building (Qsoil) of approximately 8 Lpm for the generic coarse setting which is within the range of 1 to 10 Lpm determined to be present at real sites in coarse soils.

The vapour permeability was derived from the effective hydraulic conductivity, $K_{effective,}$ for the total path length, in a manner described in Freeze and Cherry, 1979.

$$K_{effective} = \frac{\text{total path length}}{\frac{d_1}{K_1} + \frac{d_2}{K_2}} \quad \text{……..(Equation 7.6)}$$

where:
total path length = $d_1 + d_2$

d_1 and d_2 = flow path length in backfill and gravel crush, respectively.

K_1 and K_2 = hydraulic conductivity of backfill and gravel crush, respectively.

Values used were as follows:

Residential setting: d_1 = 3 m.**; d_2 = 3 m
Commercial/industrial setting: d_1= 3.2 m.; d_2 = 3.8 m.
Coarse soil setting: K_1 = 7.0 E-3 cm/sec; K_2 = 10 cm/sec
Medium and Fine soil setting: K_1 = 1.0 E-4 cm/sec; K_2 = 10 cm/sec

**Note: The vapour permeability for the vapour intrusion pathway in the residential settting is based on a basement depth used by CCME of 2.44 mBGL. This depth means that, for the air streamlines, the distance that the air would flow *in the backfill soil* before reaching the gravel crush and then the crack would be 2.44 m down plus 0.5 m sideways under the foundation footing for a total travel distance of approximately 3 m. When the basement depth

was revised by MOE to it's current value of 1.58 metres the vapour permeability was not recalculated since it would have increased Qsoil, and Qsoil was already greater than 8 Lpm which is near the high end of the observed range (1 -10 Lpm) for coarse soils.

The intrinsic permeability of the soil for the total path length was determined from K_{eff} using the following relationship (Freeze and Cherry, 1979)

$$k = \frac{K_{effective} * \mu}{\rho * g} \qquad \text{.....(Equation 7.7)}$$

where
k = intrinsic permeability of dry soil = vapour permeability, cm^2

μ = dynamic viscosity of water at 15° C = 0.01139 g/cm-s

ρ = density of water = 1.0 g/cm^3

g = gravity acceleration = 981 cm/sec^2

The soil vapour permeabilities derived as above and used in the generic settings are:

	Coarse soil	Medium/Fine soil
Residential	1.63 E-7 cm^2	2.30 E-9 cm^2
Commercial/Industrial	1.78 E-7 cm^2	2.50 E-9 cm^2

Q_{soil} values resulting from using the above, soil-vapour permeabilities in the generic settings were modified by MOE to meet the following restrictions, based on Johnson, 2002 and USEPA, 2004:
1) Q_{soil} was not allowed to go below 5 Lpm for coarse soil and 1 Lpm for M/F soil. The generic assumptions caused the former constraint not to be necessary for coarse soils. The latter restriction was set by MOE and was necessary to apply.

2) Fraction of surface area with permeable cracks (η) is between 0.0002 and 0.005. This restriction was not necessary to apply.

3) Q_{soil} /$Q_{Building}$, the ratio of the soil gas intrusion rate to the building ventilation rate was kept between 0.05 and 0.0001 for all soil types. This restriction was necessary to apply.

The Qsoil values used in Equation 7.5, based on the above, are:

	Coarse soil	Medium and Fine soil
Residential	140.77 cm^3/s (8.45 Lpm)	16.67 cm^3/s (1.0 Lpm)
Commercial/ Industrial	163.37 cm^3/s (9.80 Lpm)	25.00 cm^3/s (1.5 Lpm)

7.3.4.1 Tier 2 Aspects

Values for soil permeability are not a variable for Tier 2 and remain at the generic values for the following reasons:
-Tier 2 input values are site specific and determining the effective soil permeability for this pathway is not a simple test. In addition, any permeability value determined for a new building might not be representative of the longer term due to settlement, soil cracking or other mechanisms which create preferential air-flow pathways;
-the buildings to be protected may not yet be built, and therefore no site-specific soil permeability testing can be done;
-the Q_{soil} values derived using the generic soil permeabilities and building properties are reasonable as they are within the range of 1 to 10 Lpm observed in tests on real buildings
- inputting a lower soil permeability value than the generic for M/F soils would not change Qsoil since Q_{soil} would default to 1 Lpm, as it does for the generic case, due to the MOE constraint on the lower bound of Q_{soil}.

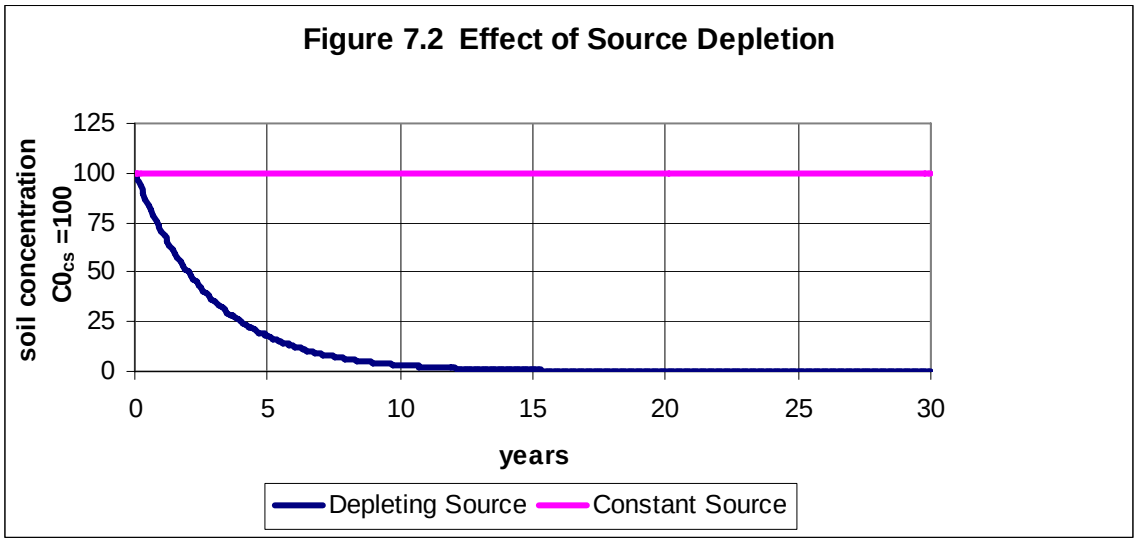
7.3.5 Source Depletion

7.3.5.1 Rationale for Considering Source Depletion Via Receptor Exposure

As chemicals migrate from a source to a receptor, the mass of chemicals in the source must diminish, providing there are no on-going releases. This section describes a method for calculating the acceptable concentrations per exposure pathway that considers source depletion attributable to chemical migration from the source, assuming that the rate of mass lost from the source follows an exponential function with time.

Figure 7.2, below, illustrates the effect that source depletion has on indoor air concentration as compared to a constant source. Although the initial concentrations of the source are identical, the depleting source produces lower and lower concentrations with time. A non-depleting or constant source is often assumed in setting standards, (e.g., a human receptor lives in a constant indoor air concentration for 70 years), and yet, as Figure 7.2 illustrates, a better conceptualization would be to incorporate the declining nature of the exposure. The goal of incorporating source depletion is to better approximate a soil concentration, $C0_{source\ depletion}$ ($C0_{sd}$),

that does not exceed the acceptable risk to the receptor caused by a constant source concentration, $C0_{constant\ source}$ ($C0_{cs}$), over the entire exposure period, and yet does not cause unacceptable short term exposure. This process allows an initial soil concentration, $C0_{source\ depletion}$ that is higher than $C0_{constant\ source}$ and which declines in concentration in a manner similar to Figure 7.2. This source-depletion effect can be visualized by sliding the depleting curve upwards so that the new initial concentration, $C0_{sd}$, is, for example, 125.



To apply the concept of source depletion to the Generic Setting requires sufficient knowledge of the location of the source so that it's current mass can be estimated. For this reason, only the following soil pathways were eligible: soil to indoor air (S-IA); soil odour (S-O); and, soil to potable groundwater (S-GW1). Source depletion could not be applied to the groundwater standards because any elevated groundwater concentrations could be due to an unknown source, perhaps beneath the water table or perhaps some unknown distance upgradient, and therefore estimating the source mass for the purposes of generating a generic $C0_{sd}$ for groundwater to better replace $C0_{cs}$ was not possible. Source depletion also could not be applied to S-GW3 since the ecological receptors cannot experience any exceedences of the surface water standard for any time period regardless of how short; that is, a chronic effect to aquatic species is normally a very short period of time relative to the modelling time frames.

Exposure to receptors cannot occur without contaminants leaving the source. At the very least, the initial rate of mass loss from the source is that which is required to produce the allowable exposure. Mass leaving the finite source causes the contaminant to re-equilibrate between the solid, liquid, and gas phases of the soil, resulting in a decline in the soil gas concentration with time which can be modelled using the standard decay equation:

$$\frac{C}{C_0} = e^{-kt} \quad \text{.....(Equation 7.8)}$$

where:

C = concentration at time = t

C_0 = concentration at time = 0

$k = \frac{\ln 2}{t_{1/2}}$ = decay constant

$t_{1/2}$ = half life

t = time of interest

e = base of natural logarithm (2.71828…)

This equation can also be presented as C/C0 = exp(-kt)

The rate of mass decline due to receptor exposure is compound specific, depending on the total mass of contaminant in the soil and the contaminant's partitioning properties. The rate of decline due to source depletion by exposure is represented mathematically as a half life, $t_{1/2}$, which is determined from rearrangement of the decay equation:

$$\ln \frac{C}{C_0} = -\frac{\ln 2}{t_{1/2}} * t$$

$$t_{1/2} = -\frac{\ln 2}{\ln \frac{C}{C_0}} * t$$

such that, when t = 1 week

$$t_{1/2}\,(\text{years}) = \frac{-\ln 2 * 1 week}{\ln \frac{Mass2}{Mass1} * \frac{365.25}{7} weeks / year} \quad \text{……(Equation 7.9)}$$

where:
One week was arbitrarily chosen to be sufficiently short such that Mass 2, determined by mass lost by transfer to indoor air, could be approximated by using a constant removal rate of the exposure concentration rather than one that declines with time.

The mass ratio is equivalent to the concentration ratio.

Mass 1 (g) = mass of contaminant in soil at t = 0.

Mass 2 (g) = mass of contaminant in soil theoretically remaining after one week of mass loss due to gas influx to building at a constant rate and concentration equal to cause the maximum indoor air concentration.

Using the residential generic setting for S-IA (Figure 7.1) as an example, the equations to determine Mass 1 and Mass 2 are:

Mass 1 = $C0_{cs}$*ρb*($Volume_{Source}$ – Volume $_{\text{Building below grade}}$)*$10^6$

Mass 2 = Mass 1 – Indoor air standard * 10^{-6} * $Volume_{\text{house mixing}}$ * Air Exchange Rate per hour * 24 hr/day * 7 days/week

where:
$C0_{cs}$ = the total soil concentration that, if undiminished, yields the acceptable soil gas concentration for the 70 year exposure period (ug/g)

ρb = dry soil bulk density (g/cm^3)

$Volume_{Source}$ = volume of contaminated soil with concentration $C0_{cs}$

Volume $_{\text{Building below grade}}$ = volume of soil removed from source zone due to the subgrade volume of the building

10^6 & 10^{-6} = units conversion (cm^3 per m^3)

Indoor air standard (μg/m^3) = acceptable indoor air concentration for the exposure period

$Volume_{\text{house mixing}}$ = volume of building used to dilute soil gas (cm^3)

Air Exchange Rate * 24 * 7 = number of air changes of $Volume_{\text{house mixing}}$ per week .
Since the mass loss used to determine the SDM assumes the soil source is a “perfectly-stirred reactor” and does not consider other processes such as volatile losses to the atmosphere or leach losses to groundwater, the SDMs are conservative.

7.3.5.2 Human Exposure Constraints Used to Determine the Source Depletion Multipliers

The human exposure constraints are:

The risk from an increased concentration of a depleting source, $C0_{sd}$, cannot exceed 1e-6 over 70 years. This means that the area integrated under the concentration vs. time curve for an exponential decrease from $C0_{sd}$ cannot exceed the product of the constant $C0_{cs}$ (with a risk of 1e-6) times 70 years;

The soil concentration is allowed to have $C0_{sd}/C0_{cs}$ of up to 100 if this ratio reduces to one within three years. This means that $C0_{sd}$ can be no more than 100 times $C0_{cs}$ if depletion causes the initial concentration of $C0_{sd}$ to be reduced to $C0_{cs}$ within three years;

The soil concentration is allowed to have $C0_{sd}/C0_{cs}$ of up to 10 if this ratio reduces to one within five years. This means $C0_{sd}$ can be no more than 10 times $C0_{cs}$ if depletion causes $C0_{sd}$ to reduce to $C0_{cs}$ within five years; and

If using the Source Depletion Multiplier (SDM) results in concentrations that exceed the relevant indoor air concentration as per Section 2.7.3.4 then the SDM is decreased in a manner described in Section 2.7.3.4.

Further details of the human exposure constraints are presented in Section 2.7.3.4.

7.3.5.3 Calculation of the Source Depletion Multipliers of $C0_{cs}$

This section describes how the human exposure constraints were applied to the decay equation (7.8). To investigate the first constraint the decay equation was integrated over time (t = 0 to 70 years) to determine the sets of half lives ($t_{1/2}$), and initial concentration ratios ($C0_{sd70}/C0_{sd}$), which have an area of 70 under the $C0_{sd70}/C0_{cs}$ vs. time curve. This initial concentration ratio can be viewed as a $C0_{cs}$ multiplier, which in turn can be called a Source Depletion Multiplier (SDM).

The solution to the integral of 7.8 is:

$$\text{Area} = 70 = \text{SDM}^* \, t_{1/2}/\text{LN}(2) * (1-e^{-k70}) \quad \text{(Equation 7.10)}$$

Which, when rearranged and put into spreadsheet code becomes

$$\text{SDM} = 70*\text{LN}(2)/(t_{1/2}*(1-\text{EXP}(-\text{LN}(2)*70/t_{1/2})) \quad \text{(Equation 7.11)}$$

The resulting sets of SDM's and half-life values which satisfy (7.11) comprise curve 1 on Figure 7.3

To investigate the second constraint, (7.8) is rearranged to determine the combinations of depletion half life and SDM that deplete to $C = C0_{cs}$ when t = 3 years, so

$$C0sd/C0cs = \frac{1}{\exp\left(\frac{-\ln 2 * t}{t_{1/2}}\right)} = SDM$$ ……..…(Equation 7.12)

becomes

$$SDM = \frac{1}{\exp\left(\frac{-\ln 2 * 3}{t_{1/2}}\right)}$$ ……(Equation 7.13)

Solving (7.13) for SDM and $t_{1/2}$ generates curve 2 on Figure 7.3. The constraint of a maximum SDM of 100 occurs when $t_{1/2}$ = 0.4515 years and therefore curve 2 truncates there. Contaminants with source depletion half lives less 0.4515 years are assigned SDMs of 100.

Similarly, to investigate the third constraint, the depletion half lives and SDM's which deplete to C = C_{cs} in 5 years is given by:

SDM = 1/EXP(-LN(2)/t1/2*5) ……..…….(Equation 7.14)

The solution to (7.14) generates curve 3 on Figure 7.3. The third constraint of a maximum SDM of 10 occurs when the half life is 1.505 years and therefore curve 3 is truncated there. Contaminants with source depletion half lives less 1.505 years are assigned SDMs of 10.

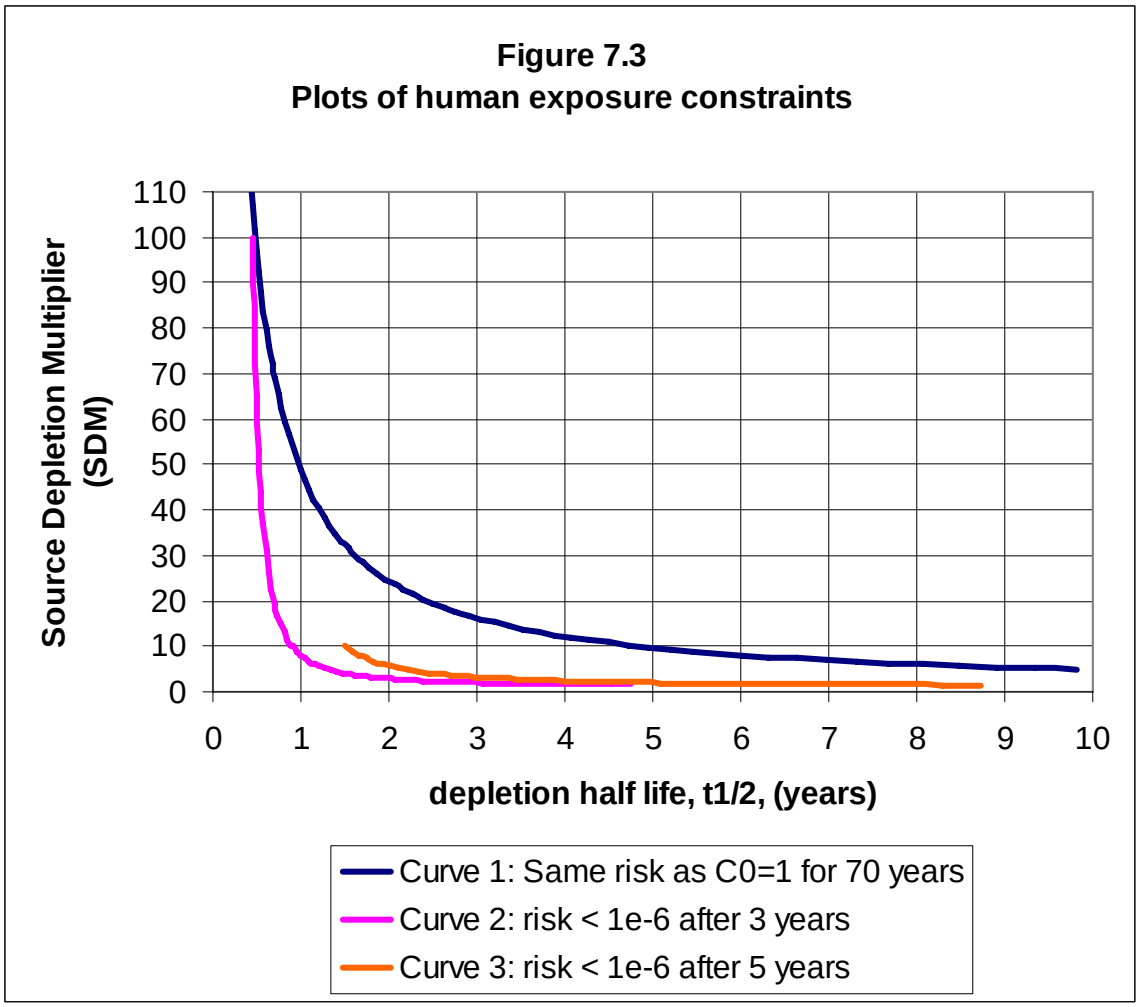
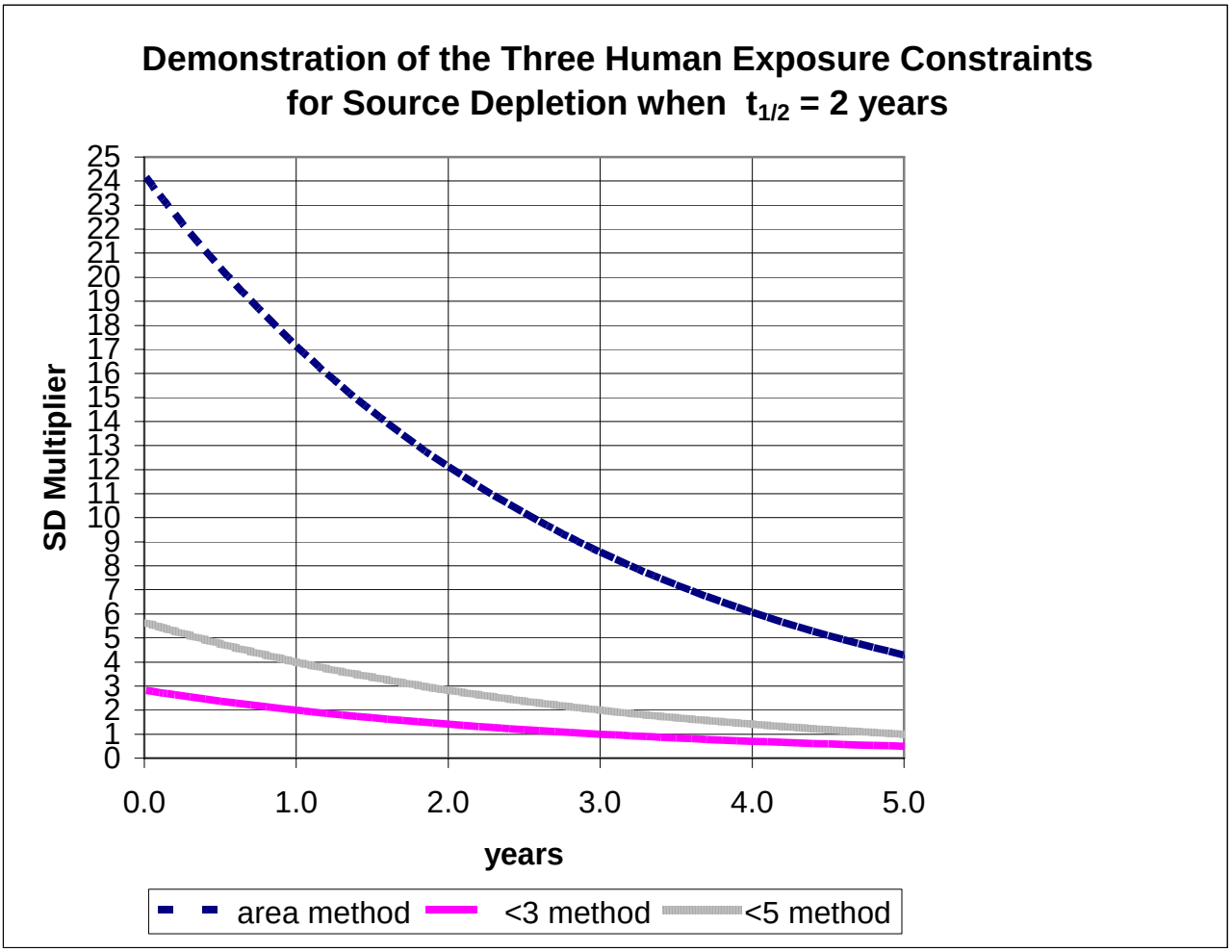


Figure 7.3 illustrates that for any contaminant the first constraint of equivalent area always results in a higher SD multiplier than those posed by time and therefore the equivalent area method provides insufficient protection and therefore is not used.

To further illustrate Figure 7.3, a concentration vs. time graph showing the constraints for a contaminant with a depletion half life of 2.0 years is plotted in Figure 7.4. The SD multipliers for the constraints are read off the y axis and are 24.1, 5.6 and 2.9 respectively. For the time-method constraints the concentrations are shown to decrease to SDM = 1 in three and five years, as expected. The area-method constraint, while it has the same daily average concentration as $C0_{cs}$ for 70 years, always has higher concentrations than either time-constraint method and therefore is insufficiently protective. The 3 year curve has lower concentrations than are permitted by the 5 year curve and therefore the 5 year constraint, with its SD multiplier of 5.6 would be used for this example of a depletion half life.

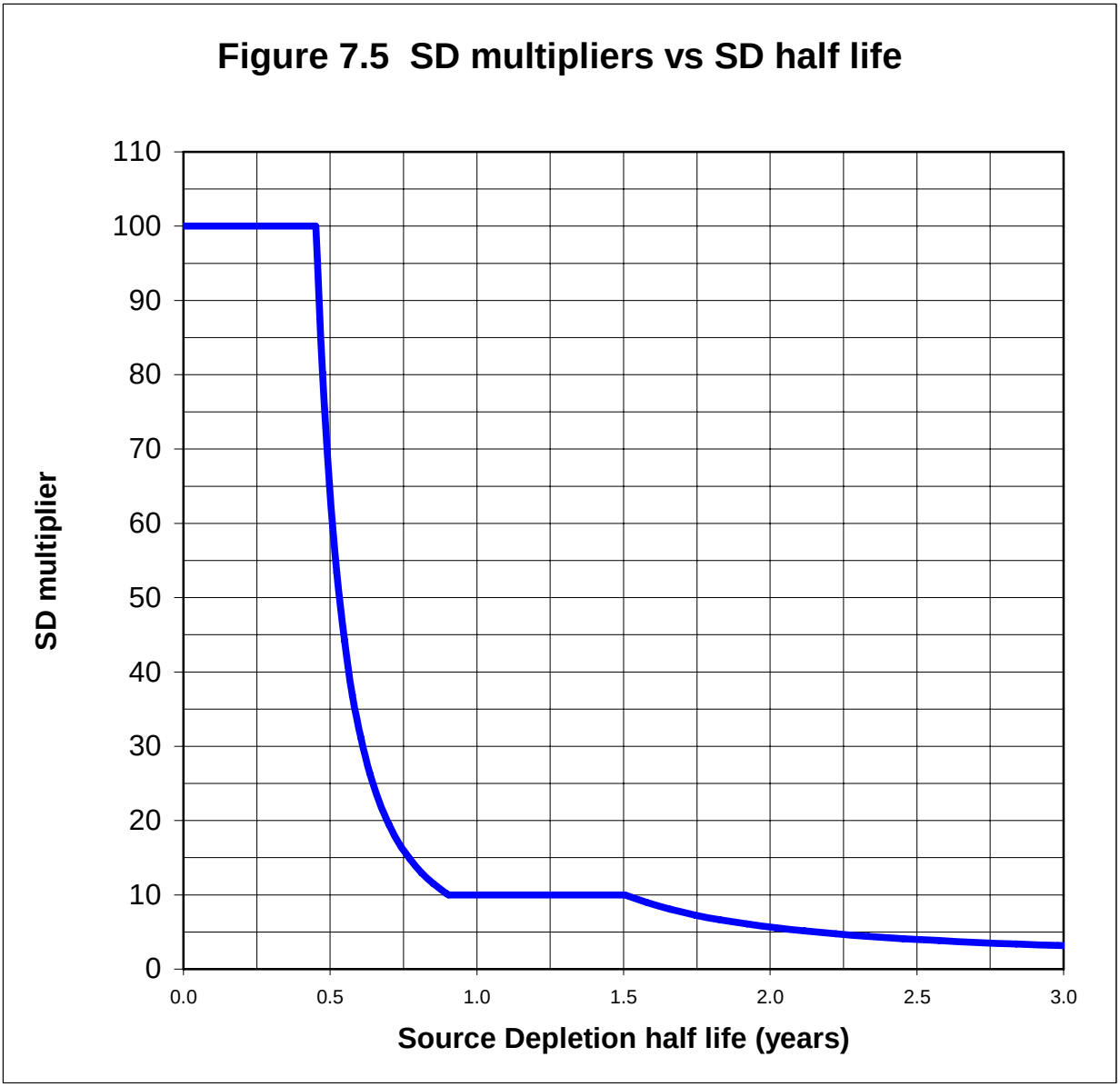
Figure 7.4



Combining all of the above constraints in spreadsheet code, the SD multipliers applied to $C0_{cs}$ in the soil standards are determined as follows:

= IF(halflife<=0.4515,100,IF(halflife<0.905,1/EXP(-LN(2)/halflife*3), IF(halflife <1.505,10, 1/EXP(-LN(2)/half life*5))
……..(Equation 7.15)

Figure 7.5 presents the SD multipliers vs. SD half life (truncated for display purposes at $t_{1/2}$ = 3 years) for the constraints considered for the S-IA and S-GW1 pathways and is presented to visualize Equation 7.15.



7.3.6 Jury Reduced Solution, Finite-Source Volatilization Model

The Jury Reduced Solution, Finite-Source Volatilization Model (Jury et al, 1990, Appendix B; Soil Screening Guidance: Technical Background Document EPA/540/R-95/128) calculates the instantaneous emission flux to the atmosphere from a finite source of contaminated soil at time, t. This model is used to estimate the rate of mass loss for the soil-odour pathway and to determine the allowable soil concentration for the soil-to-outdoor-air pathway.

$$J = C_0 * \sqrt{\frac{D_{Eff}}{\Pi * t}} * \left(1 - \exp\left(\frac{-d^2}{4 * D_{Eff} * t}\right)\right) \quad \text{.....(Equation 7.16)}$$

where:
J = contaminant flux at ground surface (g/cm^2-s)

C_0 = uniform contaminant concentration at t = 0 (g/cm^3)

t = time (s)

d = thickness of contaminated soil (cm)

$$D_{Eff} = \text{effective diffusion coefficient } (cm^2/s) = \left(\frac{\dfrac{n_a^{10/3} * D_{air} * H' + n_w^{10/3} * D_{water}}{n^2}}{\left(\rho_b * K_{oc} * f_{oc} + n_w + n_a * H'\right)} \right) \quad \text{(Equation 7.17)}$$

The Jury, Reduced-Solution, finite-source volatilization model assumes:
- no water evaporation or leaching
- the contamination extends from the surface for a known fixed distance
- there is no clean soil layer above the contamination
- homogeneous soil
- uniform initial contaminant concentration
- no NAPL
- no biodegradation
- instantaneous linear equilibrium adsorption and liquid-vapour partitioning

Limited validation of the model is presented at
http://www.epa.gov/superfund/resources/soil/appd_c.pdf

7.3.7 Domenico 2-D Groundwater Transport Model Used to Determine GW3 Concentrations

Modelling the transport of dissolved contaminants from a finite soil source to the aquifer and then laterally in groundwater to discharge to surface water is a 3–D problem. At the time of consolidation of this document, no public-domain, analytical model readily codable into a spreadsheet was available that could do this and therefore the problem is solved in two steps using a mixing cell and the 2-D model. The first step is to get the contaminants from the unsaturated zone into the aquifer, and is done by using a mathematical convenience called a mixing cell. The second step starts with this contaminated groundwater and transports it laterally to the distance of the surface water interface via a 2-D, transient, infinite-source model (Domenico, 1987, and Domenico and Schwartz, 1998).
For Tier 1 and 2 the 2-D, infinite-source model is preferred because: 1) the aquifer thickness along the flowpath is not known and therefore allowing unlimited vertical dispersion would be non conservative; and 2) it is possible for DNAPL contaminants that DNAPL may be below the water table and therefore GW3 concentrations may be measuring this dissolved DNAPL, in which case, modelling the impact as an infinite source is appropriate.
The mathematical simplifications employed in the Domenico model (Srinivasan et al., 2007; and West et al., 2007) do not significantly affect the GW3 values of the generic settings or Tier 2.

This was determined by independent testing of the Domenico model by comparing results for the generic setting with more exact methods (University of Waterloo, 2002) and MISP (Guyonnet, 2001). This testing showed that acceptably correct GW3 values are predicted by the Domenico model if there is no biodegradation, and concentrations are limited to the centreline of the plume. These constraints were applied to the Domenico modelling used in the generic, site-condition standards and apply to Tier 2.

Regarding solubility, the Domenico model determines an attenuation ratio (c/C0) at the receptor distance which is back calculated into a starting concentration known as the GW3 component value for the coc. The solubility limit of the coc in groundwater is not imposed because not only is ½ solubility always included in the choice of a minimum value, but also such high GW3 values cannot be attained thereby ensuring that the site cannot help but be in compliance if GW3 is the groundwater standard.
One might use the foregoing to argue that if the allowable GW3 value is >solubility then, because solute cannot get that high, groundwater samples need not be taken. While true on one level, an equally important reason to sample groundwater is it's role as a NAPL-presence indicator, which would become the primary reason in this case. Since any groundwater sample >1/10 solubility is an established indicator that there might be NAPL nearby, exceedance of 50% solubility is an even more emphatic indicator and is virtually certain proof of NAPL if negligible particulates are in the water sample and the well screen provides some dilution of the solute plume. Since presence of NAPL > free phase threshold causes an automatic graduation from T2RA to T3RA, groundwater sampling is vital.

Minimum Modelling Time of Three Hundred Years for Groundwater

Since some contaminants move extremely slowly in groundwater due to their very high retardation factors (4000 to over a million in the low-foc aquifer used for the generic setting), MOE made a policy decision to impose a modelling cut-off time. If there was no upper time restriction placed on the GW3 modelling then it was possible for the generic SCS to be determined by a potential impact to surface water 10,000 to 3 million years in the future. Since these geological time periods were felt to be too long to base a standard, MOE chose to employ a vetted method (CCME, 2002) which restricts travel time in the aquifer to 100 years for a travel distance of 10 metres. As a result, since Ontario's generic setting has surface water at a distance of 30 metres from the downgradient edge of the source zone, the modelling time used is 300 years. Three hundred years is considered acceptable since the vast majority of sites meeting the S-GW3 and GW3 generic values would have much more dispersion/ diffusion/ degradation/ dilution before reaching the surface water ecological receptors than is assumed in the generic setting, and, where these additional attenuation processes are insufficient, it is reasonable to assume that, for times beyond 300 years, technology will be available to more easily address it. This cut-off method effectively allows a deferment of that portion of the clean up which may cause an exceedance in >300 years to a future time when it would be more effectively handled. For Tier 2, the groundwater-modelling time is determined by the above 100-years-per-10-metre rule but does not decrease below 300 years for sites closer to surface water than 30 metres.

7.3.7.1 Dilution due to Aquifer Mixing Cell.

The generic setting for the GW3 pathway has the contaminated soil source zone extending two metres above the water table, with precipitation leaching the soil source zone and recharging the water table at 0.28 m/a and 0.20 m/a for coarse and M/F-textured soils respectively. The contaminated recharge is assumed to be diluted by complete mixing with groundwater flowing in the upper 0.5 m of the aquifer, in what is called the aquifer mixing cell. While the mixing cell has no physical basis, and is strictly a mathematical device, it does on the one hand result in some vertical dilution, and therefore does provide for some vertical dispersion, which is not available in Domenico's areal, 2-D model, while on the other, the greater the dilution factor, the higher the S-GW3 componant value.

This amount of dilution obtained by using the mixing cell is:

$$\text{Dilution Factor} = 1 + \frac{K_h * 60 * 60 * 24 * 365.25 * i_h * B}{q_{surface} * L} \quad \text{……(Equation 7.18)}$$

where:

K_h = horizontal hydraulic conductivity of aquifer, (m/s)

i_h = horizontal hydraulic gradient in aquifer (unitless)

B = thickness of mixing cell = 0.5 m

$q_{surface}$ = recharge rate through soil to water table (m/a)

L = length of source of contaminated soil in direction of groundwater flow (m)

60*60*24*365.25 = unit conversion from m/s to m/a.

Note: The Dilution Factors for the generic setting are 1.39 for coarse soil and 1.55 for M/F soil.

7.3.7.2 Domenico 2-D Analytical Model for Transport of Dissolved Contaminants

Domenico (1987) and Domenico and Schwartz (1998) present the following solution for 2-D transient transport, including degradation, from an infinite source of supply of contaminants of width Y in groundwater:

$$\frac{C(x,y,t)}{C0} =$$

$$\frac{1}{4}\exp\left\{\left(\frac{x}{2\alpha_x}\right)\left[1-\sqrt{1+\frac{4k\alpha_x}{\frac{v}{R}}}\right]\right\} * erfc\left[\frac{x-\frac{v}{R}t\sqrt{1+\frac{4k\alpha_x}{\frac{v}{R}}}}{2\sqrt{\alpha_x\frac{v}{R}t}}\right] * \left\{erf\left[\frac{y+\frac{Y}{2}}{2\sqrt{\alpha_y x}}\right] - erf\left[\frac{y-\frac{Y}{2}}{2\sqrt{\alpha_y x}}\right]\right\} \quad \text{…(Equation 7.19)}$$

where:
Y = width of contaminant source perpendicular to groundwater flow

x = contaminant's travel distance from centre of contaminant source area to edge of surface water. *Note: For Tier 2, to facilitate determining this distance so that it is not a variable dependant on surface water levels, the edge of surface water is interpreted to mean the top of the nearest bank of the surface water.*

y = 0 = offset distance from centreline of plume

t = time (limited to 100 years per 10 m. travel distance, with a minimum of 300 years)

C = concentration at x, y and t

C0 = initial concentration at t = 0

α_x = longitudinal dispersivity in aquifer

α_y = transverse dispersivity in aquifer

k = decay constant = $\frac{\ln 2}{R * t_{1/2}}$ …….(Equation 7.20)

$t_{1/2}$ = degradation half life

R = Retardation Factor = $1 + \frac{\rho_b * K_{oc} * f_{oc}}{\eta}$ …….(Equation 7.21)

note: dividing the decay term by R restricts degradation to only the aqueous, non-sorbed phase. For inorganics with no Koc value, R defaults to 1.0 to generate a spreadsheet value.

v = average linear groundwater speed = $\frac{K_h * i_h}{\eta}$ ……..(Equation 7.22)

η = aquifer effective porosity

The values for dispersivity of the aquifer are calculated as follows:
longitudinal dispersivity (m) = 0.10 * distance to surface water (m)
transverse dispersivity (m) = 0.10 * longitudinal dispersivity (m) ……(Equation 7.23)

The Domenico equation (Equation 7.19) was coded in the spreadsheet as follows:

$$C/C0 = \frac{1}{4}\exp(A1 * A2) * erfc(A3) * (erf(A4) - erf(A5))$$

where A1 to A5 are self-evident representations for the functions in Equation 7.19, made to assist comprehension of the calculation.

Biodegradation in the Domenico model was effectively turned off for the GW3 pathway in the generic settings by assigning very large values for the biodegradation half life.

7.3.8 Atmosphere Mixing Cell Equation used in Soil-to-Outdoor Air Pathway

The values used for windspeed and mixing cell height for this pathway are presented in section 7.2.6.5. Consider wind moving onto a contaminated source zone such that contaminants are added uniformly to outdoor air from the surface of the source zone at a rate of J ug/cm2-sec. For calculation purposes assume that along the centreline of the source zone there is no lateral mixing as the wind moves over the site and therefore the effective width of the source zone is unit width or 1 cm. The problem then becomes 2-D with a unit-width "canyon" the length of the site (1300 cm) with a height of 200 cm. It was assumed the outdoor air with an initial concentration of 0.0 ug/cm^3 enters the canyon and receives emitted contaminants for a time period equal to the Length/Windspeed, which is 1300 cm/410 cm/sec., or 3.17 seconds. Since the flux of contaminant into the outdoor air is J ug per cm^2 per second, the mass of contaminant in the last cm of travel before leaving the site is equal to J ug/cm^2-sec * Length/Windspeed. The volume containing this mass is the height of the mixing cell times the unit area of 1 cm^2. Since concentration is equal to mass/volume the equation to determine the outdoor air concentration is:

Outdoor Air Conc. = J * Source Length/Windspeed*1/Height of mixing cell …..(Equation 7.24)

Rearranging 7.24 to solve for J
J (g/cm^2-sec) = Air standard (ug/m^3)*Height (cm)*windspeed (cm/sec)*1e-12/Length (cm) ….(Equation 7.25)

The Jury Reduced-Solution, Finite-Source Volatilization Model (Section 7.3.6) was rearranged to solve for the soil concentration (g/cm^3) yielding the flux, determined above. For this pathway a one-year time period is assumed between Phase II ESA soil sampling and people working at the cleaned-up brownfield. The soil concentration of the contaminant is then changed from g/cm^3 to ug/g as follows:

Soil conc. (ug/g) = soil conc (g/cm^3)*1,000,000(ug/g)/dry bulk density (g/cm^3) .(Equation 7.26)

7.4 Deriving Soil Values Protective of Indoor Air Quality (S-IA)

7.4.1 S-IA - Overview of the Vapour Intrusion Pathway

Soil vapour intrusion is the migration of volatile or semi-volatile chemicals from contaminated groundwater and soil into overlying buildings. When releases occur near buildings, volatilization of chemicals from the dissolved or non-aqueous phases in the subsurface can result in the intrusion of vapour-phase contaminants into indoor air. If the vapour intrusion pathway is viable or complete, there may be the potential for unacceptable health risks to building occupants as a result of inhalation of vapours.

The primary process for soil vapour intrusion into buildings is typically soil gas advection, although vapour migration will also occur as a result of diffusion through the building foundation. Model sensitivity analyses suggest that soil gas advection will be the dominant mechanism when the pressure gradient is greater than about 1 Pascal (Hers et al., 2003; Johnson, 2005). At many residential buildings, pressure gradients due to building depressurization will be greater than 1 Pascal.

Soil gas advection can occur through untrapped floor drains, edge cracks at the building wall and floor slab interface, unsealed entry points for utilities, expansion joints and other cracks and openings, if present. Field research programs that include pressure data for soil adjacent to the building foundation indicate that most of the soil gas flow occurs within 1 m to 2 m of the foundation. Therefore, the properties of the backfill surrounding the foundation are important, as well as any nearby utility corridors. Field measurements and model simulations indicate that for most sites, the permeability of soil near the building will control the rate of soil gas flow, as opposed to the permeability of the building foundation. The presence of preferential pathways (i.e. utility conduits) that intersect a vapour source and connect to the building are of potential concern for soil gas intrusion.

Depressurization of the building airspace relative to the ambient (outdoor) air pressure can be caused by a number of factors including temperature differences between indoor and outdoor air, “stack effect”, barometric pressure changes, wind-loading and operation of the building heating, ventilation and air-conditioning (HVAC) systems. The heating of a building, either by furnace, radiator, or other sources (i.e. sunlight on the roof) creates a “stack effect” as warm air rises in the building. This causes an outward air pressure in upper storeys and inward air pressure near the base of the building. Warm air that escapes is replaced by air infiltrating through doors and windows and soil gas migrating through the foundation. The operation of HVAC systems can cause a building to be depressurized through insufficient combustion air for furnaces or unbalanced heating and ventilation systems where the exhaust air flow rate exceeds the intake flow rate. For commercial buildings, HVAC systems are designed to control the pressure inside buildings. Buildings may be either positively or negatively pressurized depending on HVAC system design, operation and environmental conditions.

While several of the above factors will result in sustained depressurization of a building, barometric pressure fluctuations may result in short-term pressure gradients causing soil gas intrusion. In particular, if there is a low permeability surface seal adjacent to buildings, cross-slab pressure gradients may be generated when the barometric pressure decreases. Conceptually,

different foundation construction could lead to altered behaviour for soil vapour intrusion. For example, higher soil gas advection rates would be expected for houses with basements due to higher depressurization and larger subsurface foundation area for intrusion. For houses with crawlspace foundations, the degree to which the crawlspace is ventilated by outside air and the influence of cross-floor mixing and leakage between the crawlspace and main floor could affect soil vapour intrusion rates. Although working hypotheses have been developed, the influence of foundation type on soil vapour intrusion is still poorly understood. However, there are empirical data indicating that soil vapour intrusion can be significant for several different types of building foundations including basements, crawlspaces and slab-at-grade construction.

Diffusion through the building foundation will readily occur through cracks and openings in the foundation. Diffusion rates through intact building materials are relatively low, but will depend somewhat on material type (e.g., poured concrete slab, concrete block wall, plastic moisture vapour barrier).

Once inside the building, vapours inside enclosed spaces will diffuse as a result of chemical gradients and disperse through air movement. Mixing between building floors will depend on the heating, ventilation and air conditioning (HVAC) system operation and possible unintentional air leakage between floors.

The conceptual site models of the generic settings for vapour intrusion via the soil to indoor air pathway, S-IA, for a residential and commercial/industrial building are presented in Figure 7.6 and Figure 7.7 respectively.

Figure 7.6 Soil to Indoor Air: Conceptual Model of Generic Setting (Residential)

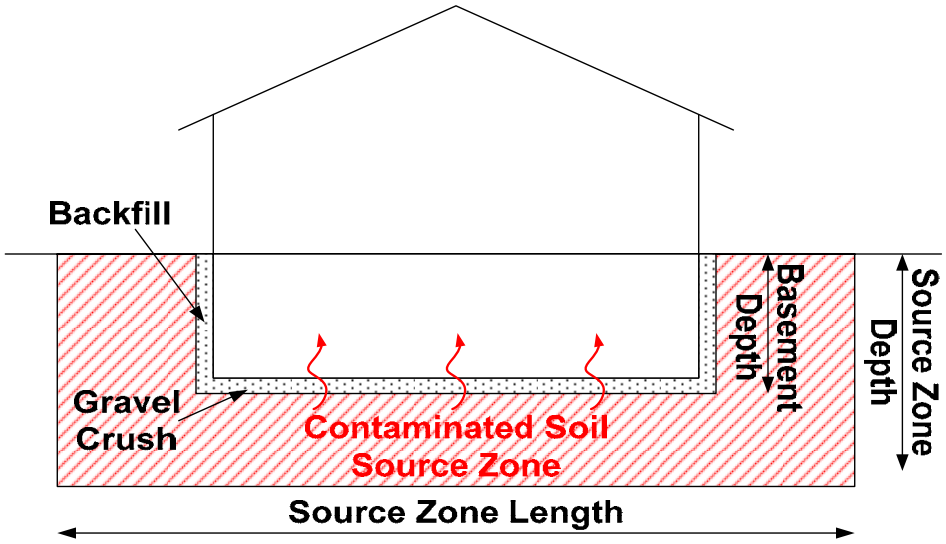
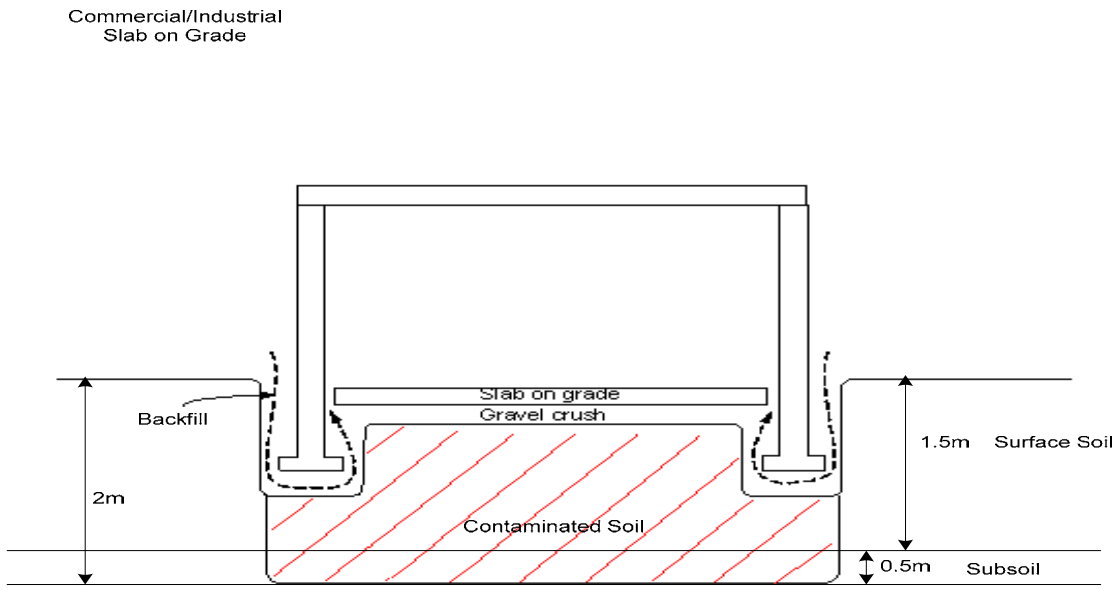


Figure 7.7 Soil to Indoor Air: Conceptual Model of Generic Setting (Commercial/Industrial)



7.4.2 S-IA- Pathway Description and Assumptions: Residential Building

The generic setting is reasonable worst case in that the residential building sits directly within the source, with all below-grade surfaces surrounded by contaminated soil. The separation distance to the contaminated soil from the basement walls and floor is the thickness of the backfill or the underlying gravel crush. Exposure to soil vapour occurs when negative pressure within the building pulls soil gas through openings in the basement walls and floor.

The dimensions and properties of the residential building related to vapour intrusion are described in Section 7.2.6.

The vadose zone properties relevant to vapour transport through the soil are presented in Section 7.2.1

Source depletion, discussed in Section 7.3.5, can be used as an attenuation tool for this pathway since the generic setting assumes a finite mass of contaminated soil whose mass is reduced, at the least, at the rate that the contaminant enters the building, and then leaves the building due to the air exchange rate.

7.4.3 S-IA- Pathway Description and Assumptions: Commercial/Industrial Building

The generic setting has the building sitting directly on top of the source of contaminated soil. This is the reasonable worst case setting in that all below grade surfaces are within the contaminated soil and the full thickness of the source zone is under the building.

The dimensions and properties used for the commercial/industrial building are presented in Section 7.2.6. All other assumptions and constraints are identical to the Residential case with the exception of allowing a subsoil standard for soil below 1.5 metres BGL.

7.4.4 S-IA Contaminant Attenuation Modelling

A soil-water-gas partitioning equation coupled with the Johnson-Ettinger model for vapour intrusion into buildings is used to back calculate a total soil concentration that will be protective of indoor air reference toxicity values. Source depletion by mass removal is considered. The S-IA value will vary with soil texture.

The calculation steps to the soil concentration for the S-IA pathway are as follows:

1) Determine the Vapour Attenuation Coefficient

The Johnson Ettinger model, described in 7.3.3, is used to calculate the vapour attenuation coefficient.

$$\alpha = \frac{\left(\frac{D_T * A_B}{Q_{building} * L_T}\right) * \exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right)}{\left(\exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right) + \left(\frac{D_T * A_B}{Q_{building} * L_T}\right) + \frac{D_T * A_B}{Q_{soil} * L_T} * \left[\exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right) - 1\right]\right)}$$

where:

α = Steady-state vapour attenuation coefficient, unitless

D_T = Total overall effective diffusion coefficient, cm^2/s

A_B = Area of the enclosed space below grade, cm^2

$Q_{building}$ = Building air exchange rate, cm^3/s

L_T = Separation distance from contaminant source to building, cm

Q_{soil} = Flow rate of soil gas into the enclosed space, cm^3/s

L_{crack} = Enclosed space foundation or slab thickness, cm

A_{crack} = Area of total cracks in A_B, cm^2

D_{crack} = Effective diffusion coefficient through the cracks, cm^2/s (assumed equivalent to soil type closest to the building foundation).

The input values for S-IA which differ from the GW2 generic setting are the total effective diffusion coefficient, which is from the soil surrounding the building, through the backfill and gravel crush, to the outside of the building, and the distance to the contaminant source.
The equations used to calculate the values for the parameters in the J&E model are presented in U.S. EPA's User's Guide (December 2000) and are not reproduced here.

Two empirically-based restrictions were applied, with the first taking priority over the second, if necessary:
Q_{soil}/Q_B for Residential and Com/Ind settings is between 0.05 and 0.0001 (Johnson, 2002)
Q_{soil} is not allowed to go below 5 Lpm for coarse soils and 1 Lpm for medium/fine soils

2) Apply Bioattenuation Factors (BAFs)

Based on Health Canada's Vapour Intrusion Guidance (2008), if there is, generally, one metre of clean soil under a building or potential building then the contaminant's concentration below that one metre can be 10 times higher since biodegradation would reduce it ten fold after travelling through that distance. This factor is only for petroleum hydrocarbons (BTEX, F1 and F2 (except when aviation fuel)); trimethylbenzenes; naphthalene; and straight-chain alkane compounds (e.g., hexane, octane). This means also that if there is approximately one metre of clean soil between the top of the capillary fringe and the gravel crush below a building then the underlying groundwater concentration at the watertable (GW2) can be higher by the same factor. Based on the above, a 10 times bioattenuation factor (BAF) was applied to the above compounds for groundwater (GW2) for the Residential and Commercial/Industrial generic settings, and to the Commercial/Industrial coarse and M/F soils (S-IA) below 1.5 metres.

3) Determine the soil concentration in equilibrium with the soil gas concentration

To derive the total soil concentration in equilibrium with a gas concentration, the gas form of the partition equation is used (Equation 7.2). The full description of the partition equation is presented in Section 7.2.2

$$C_s = C_{gas} * \left(\frac{f_{oc} * K_{oc}}{H'} + \frac{\eta_w}{H' * \rho_b} + \frac{\eta_a}{\rho_b} \right)$$

The allowable soil gas concentration is the allowable indoor air concentration divided by the vapour attenuation coefficient. Since indoor air concentration units are $\mu g/m^3$ rather than mg/L, (7.2) is modified to:

$$C_s = \frac{C_{indoorair}}{10^6 * alpha} * \left(\frac{f_{oc} * K_{oc}}{H'} + \frac{\eta_w}{H' * \rho_b} + \frac{\eta_a}{\rho_b} \right)$$

This soil concentration corresponds to an infinite source of contaminant, undiminishing with time. A correction factor was applied to the equilibrium partition equation to address the observed difference of two to four times between the measured soil gas concentration and that predicted using the equilibrium partition equation (Hers, 2008). Specifically, considering that Henry's Law constants are much more reliable than the organic carbon partitioning coefficients, MOE addressed this discrepancy by multiplying the Koc values by two in the Physical Chemistry and Toxicology section of the spreadsheet model, thereby ensuring the correction was applied wherever the equation was used, i.e., S-IA, S-GW1, S-GW3, GW2, GW3, Soil-Odour and the separate-phase threshold.

Spreadsheet coding of above is:

Cs = Cg /(1,000,000*alpha)*(X + Y + Z)

where:
X = (foc*Koc)/H'

Y = η_w/(ρb*H'), and

Z = η_a/ρb

4) Setting the Human Exposure Constraints for Use in Source Depletion

The source depletion concept, discussed in Sections 2.7.3.4 and 7.2.5, can be applied to the S-IA pathway as an attenuation tool since the generic setting assumes a finite mass of contaminated soil whose mass is reduced, at the least, at the rate that the contaminant enters the building, and then exits the building at the air exchange rate.

The human exposure constraints presented in detail in Section 2.7.3.4, are used in determining the SD multipliers (SDMs).

5) Determine Initial Mass of Contaminant in Source Zone

$$\text{Initial Mass } (\mu g) = C_s \left(\frac{\mu g}{g} \right) * \rho_b \left(\frac{g}{cm^3} \right) * \text{volume of source zone} \left(m^3 \right) * 10^6 \left(\frac{cm^3}{m^3} \right)$$

where C_s is determined by Step 3

As shown in Figure 7.6, the volume of the source zone in the residential generic setting is reduced by the volume of the basement sitting within it, therefore

$$Mass1 = C_s * \rho_b * 1{,}000{,}000 * \left[GW3width * GW3length * thickness - WBld * LBld * Lt \right]$$

where:

C_S = the measured total soil concentration whose equilibrium soil gas concentration is allowed, undiminished, for the entire exposure period
ρ_b = rbC = dry bulk density of the contaminated soil zone
GW3width = width of the contaminant source zone
WBld = width of the building
thickness = thickness of contaminated source zone
GW3length = length of the contaminant source zone
LBld = length of the building
L_t = depth to top of contamination = depth below ground level (BGL) to bottom of gravel crush layer. Note: Lt = hA + hB only when determining the SDM; where hA = depth BGL to underside of basement slab, and hB = thickness of gravel crush layer under the basement slab.

For the Commercial/Industrial generic setting the construction is assumed to be slab-on-grade and hence the original volume of contaminated soil is unreduced at 13 m. by 13 m. by 2 m. A subsoil standard was determined by reapplying the J&E equation for a separation distance corresponding to soil at 1.5 metre depth and then applying a SDM determined from the revised total mass of the contaminant in the source zone. See Section 7.4.5.

The codes used in the spreadsheet for this step are:
For Residential
Mass 1 = soil conc*rbC*10^6*(GW3width*GW3L*thickness of contaminant source/100-WBld/100*LBld/100*Lt/100)

Note that the 100 factor is to change cm to metres.

For Commercial/Industrial
Mass 1 = soil conc*rbC*GW3width*GW3L*thickness of surface soil contaminant source/100*10^6 + soil conc of subsoil*rbC*GW3width*GW3L*thickness of subsurface contaminant source/100 *10^6)

6) Determine Contaminant Mass After One Week of Soil Gas Entering Building

The mass remaining, Mass 2, after one week of soil gas entering the building is calculated as follows:

$$Mass2 = Mass1 - \left(\text{indoor air standard} * \frac{LBld * WBld * HBld}{10^6} * 24 * 7 * AER \right)$$

where :
indoor air standard = concentration due to vapour intrusion (ug/m^3)
LBld = length of building (cm)
WBld = width of building (cm)
HBld = height of building used for dilution (cm)
AER = air exchange rate of building (per hour)

The spreadsheet coding is:
Mass 2 = Mass 1 – (Indoor air standard/10^6*LBld*WBld*HBld*24*7*AER)

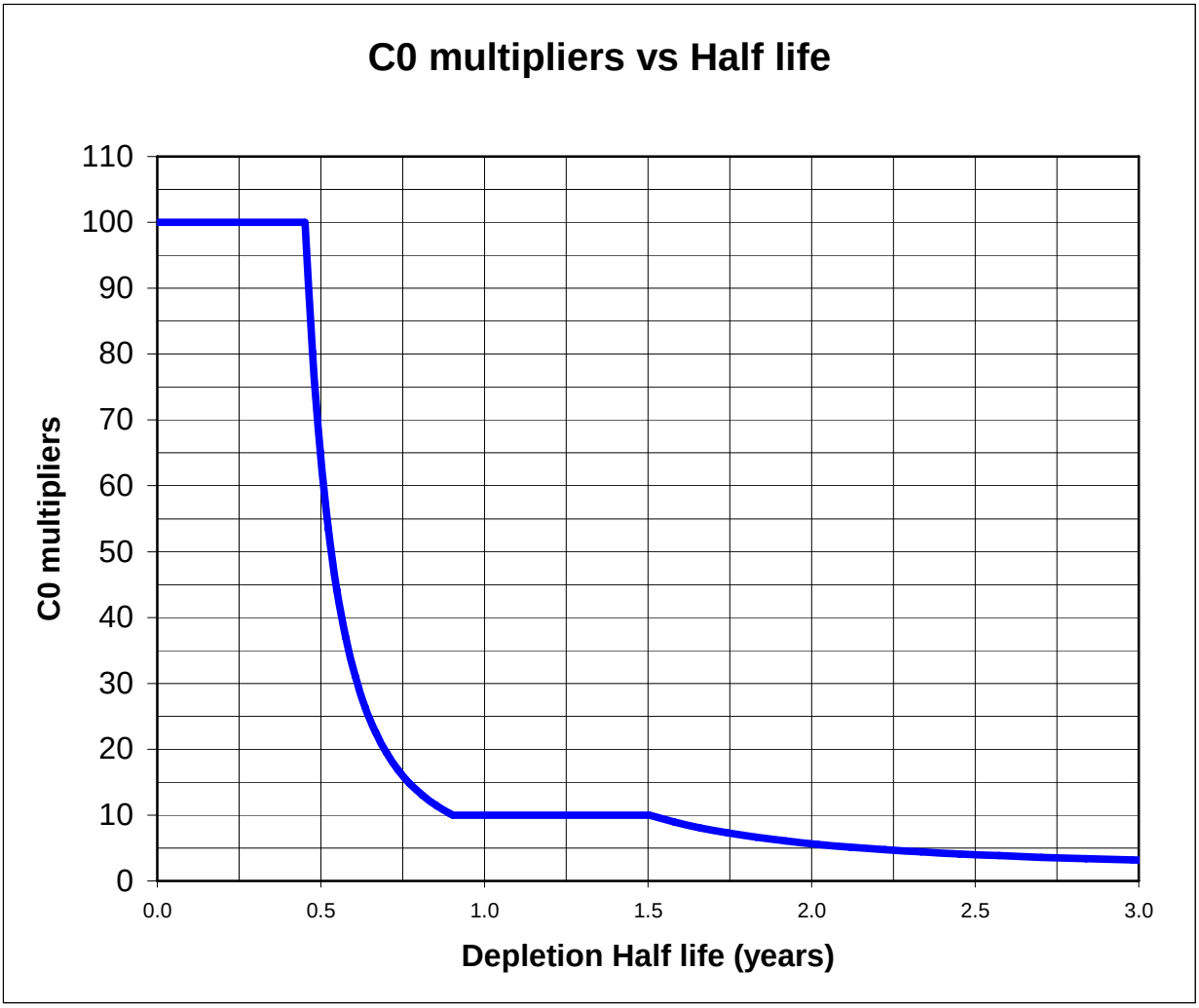
7) Determine the Half Life for Vapour Intrusion into Building

The initial mass, Mass 1, and the mass remaining after one week, Mass 2, are entered into the re-arranged decay equation, (Section 7.3.5) to generate the effective half life for this mode of source depletion for each contaminant. To change t1/2 (week), into t1/2 (years), which is used to calculate the SD multipliers, t1/2 (week) is divided by 52.

$$t_{1/2}\text{ (years)} = \frac{-\ln 2 * 1\text{ week}}{\ln \frac{\text{Mass 2}}{\text{Mass 1}} * \frac{365.25}{7}}$$

8) Determine the Source Depletion Multipliers

Sections 7.3.5 and 2.7.3.4 present the rationale for how the SDMs are determined which satisfy the constraints for the S-IA pathway, for any half life.
Figure 7.5, reproduced below is a graphical presentation of the depletion half life vs. SDM.



The IF statement that generates the above figure and is used in the spreadsheet to determine the SD multipliers is:

IF(halflife<=0.4515,100,IF(halflife<0.905,1/EXP(-N(2)/halflife*3),IF(halflife<1.505,10,1/EXP(-LN(2)/half life*5))

7.4.5 Determination of Subsurface Soil Concentrations for the Comm/Ind Setting

The generic setting for the S-IA pathway has the soil source zone in the upper two metres and therefore there is subsurface soil, defined as >1.5 m. deep, 0.5 metres thick. Because of the Stratified Cleanup Option in Tier 1 and 2, which permits a different soil standard below 1.5 m., this lower half metre can have a different soil standard than the surface soil. The steps taken to determine the concentrations for this upper 0.5 m of subsurface soil are as follows:

1) Determine the new J&E S-IA alpha (subsurface soil alpha) based on a separation distance of 1.5 m. minus the depth to the underside of the Comm./Ind slab-on-grade, 11.25 cm. and divide it into the surface soil alpha based on a 30 cm separation distance to arrive at the alpha ratio.

2) Determine the initial subsurface soil concentration by multiplying the surface soil concentration by the alpha ratio from 1).
3) Determine the new SDM for the new total contaminant mass that includes the higher subsurface soil concentration determined in 2). New initial mass = old initial mass in 2 m thick source zone*0.75+old initial mass/4*alpha ratio.
4) Determine the final subsurface soil concentration for the lower 50 cm by multiplying the results of 2) and 3) along with the applicable BAF since the separation distance is >1.0 metre.

The new SDM, derived in 3) above, was only applied to the lower 0.5 m concentration and not to the surface soil because of a MOE policy decision to keep the surface soil standards for stratified and non-stratified cleanups the same.

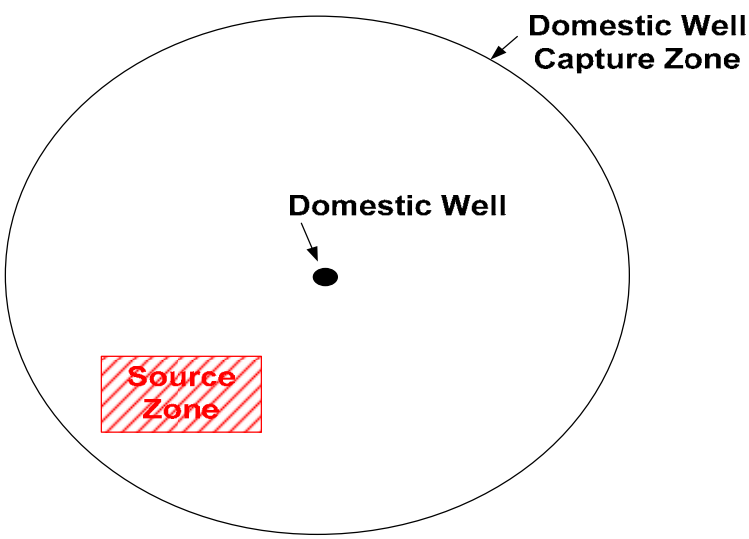
7.4.6 Tier 2 Aspects and Considerations for S-IA

For Tier 2, several soil vapour samples from several soil vapour monitors are required within a two metre radius of each vapour source, as described in the Modified Generic (Tier 2) Risk Assessment Guidance document. J&E is used to determine the allowable, soil-vapour concentration for the depth below the foundation to be protected. To incorporate the effect of bioattenuation, if there is one metre or more of soil separating the top of the soil vapour probe from the elevation of the presumed gravel crush under the building foundation, then the allowable vapour concentration determined by J&E is multiplied by a BAF of 10. If the separation is three metres or more, the BAF applied is 100. This allowance for biodegradation is applied only to the subset of chemcals that are known to biodegrade.

7.5 Deriving Soil Values Protective of Potable Water (S-GW1)

The conceptual site model of the generic setting for the soil-to-potable-groundwater pathway, S-GW1, is presented in Figure 7.9.

Figure 7.9 Soil to Potable Groundwater (S-GW1): Conceptual Site Model of Generic Setting



7.5.1 S-GW1 - Pathway Description and Assumptions

The conceptual site model of the generic setting for S-GW1, Figure 7.9, has the contaminant source zone within the capture zone of the domestic water well pumping at a moderate rate of 7.5 Lpm. All of the contamination leached from the source zone enters the well. The diluting groundwater is assumed to have no contaminants. The contaminated soil dimensions and vadose zone properties related to leaching of contaminants to groundwater are presented in Section 7.2.

7.5.2 S-GW1 - Contaminant Attenuation Modelling

Well bore dilution, source depletion and a water-to-soil partitioning model are used to calculate soil values that are protective of the GW1 values. S-GW1 varies with soil texture.

The calculation steps are:

1) Determine Well Bore Dilution (WBD)

The WBD equation developed in Section 7.3.2. is
WBD = annual volume pumped / (source area*annual recharge)
e.g., for coarse soils
WBD = 7.5 Lpm*60 m/hour*24 h/day*365.25 days/annum / (1000 L/m^3*13 m*13 m*0.28 m/a)**= 83.36**

2) Determine the maximum leachate concentration from soil

The maximum leachate concentration from the contaminated soil is determined by multiplying the ODWQS by the well bore dilution factor.
$C_{leachate}$ = ODWQS * WBD
Where ODWQS = Ontario Drinking Water Quality Standard (ug/L)

3) Determine the Soil Concentration

The total soil concentration in equilibrium with the above leachate concentration is calculated using the water form of the equilibrium partition equation, described in Section 7.3.1, and modified below to allow input of $C_{leachate}$ in ug/L

$$C_s = \frac{C_{leachate}}{1000}\left(K_{oc} * f_{oc} + \frac{\eta_w + \eta_a * H'}{\rho_b} \right)$$

where:
C_s = the total concentration of contaminant measured in a soil sample, from the gas, water and sorbed phases (ug/g).

$C_{leachate}$ = contaminant concentration in water = GW1*WBD (ug/L)

K_{oc} = organic carbon-water partition coefficient (cm^3/g)

f_{oc} = fraction organic carbon in the soil (dimensionless)

η_w = water-filled porosity (dimensionless)

η_a = air-filled porosity (dimensionless)

H' = Henry's Law constant at the soil temperature (dimensionless)

ρ_b = dry bulk density of the soil (g/cm^3)

A correction factor was applied to the equilibrium partition equation to address the observed difference of two to four times between the measured soil gas concentration and that predicted using the equilibrium partition equation (Hers, 2008). Specifically, considering that Henry's Law constants are much more reliable than the organic carbon partitioning coefficients, MOE addressed this discrepancy by multiplying the Koc values by two in the Physical Chemistry and Toxicology section of the spreadsheet model, thereby ensuring the correction was applied wherever the equation was used, i.e., S-IA, S-GW1, S-GW3, GW2, GW3, Soil-Odour and the separate-phase threshold.

4) Setting the Human Health Constraints for use in Source Depletion

Source depletion is used for the soil standards for S-GW1 because:

a) The generic setting assumes a finite volume of contaminated soil
b) The risk to receptors drinking the well water assumes that the soil is open to the atmosphere and precipitation recharges through the contaminated soil to the aquifer at 0.28 m/a for coarse-grained soils and 0.20 m/a for M/F-grained soils. This leaching causes the mass of contaminant in the soil to be removed, at the least, at the rate of leaching. If leaching produces a more constant concentration with time than the decay equation predicts then more mass is removed than assumed and so the SDMs used were conservative.
c) The SDM can have a maximum of 100 but must reduce to one in three years
d) The soil concentration can have a SDM of up to 10 if it reduces to one in five years.

Source depletion is applied to S-GW1 even though the well water can not exceed the GW1 standard for any time period. While this appears counterintuitive, this allows a higher soil concentration as long as it does not cause the well water to exceed the GW1 standard (ODWQS).

5) Determine Initial Mass of Contaminant in Source Zone

$$\text{Initial Mass } (\mu g) = C_s\left(\frac{\mu g}{g}\right) * \rho_b\left(\frac{g}{cm^3}\right) * \text{volume of source zone}\left(m^3\right) * 10^6\left(\frac{cm^3}{m^3}\right)$$

where C_s is determined in Step 3 and

C_S = the measured total soil concentration whose equilibrium leachate concentration, after WDB, yields the ODWQS in the well water consumed in the generic setting

ρ_b = dry bulk density of the contaminated soil zone

6) Determine Contaminant Mass After One Week of Soil Leaching to the Water Table

The mass remaining, Mass 2, after one week of soil leaching to the water table is:

$$Mass2 = Mass1 - \frac{C_{leachate} * 1000 * \text{source area} * \text{annual recharge rate}}{52}$$

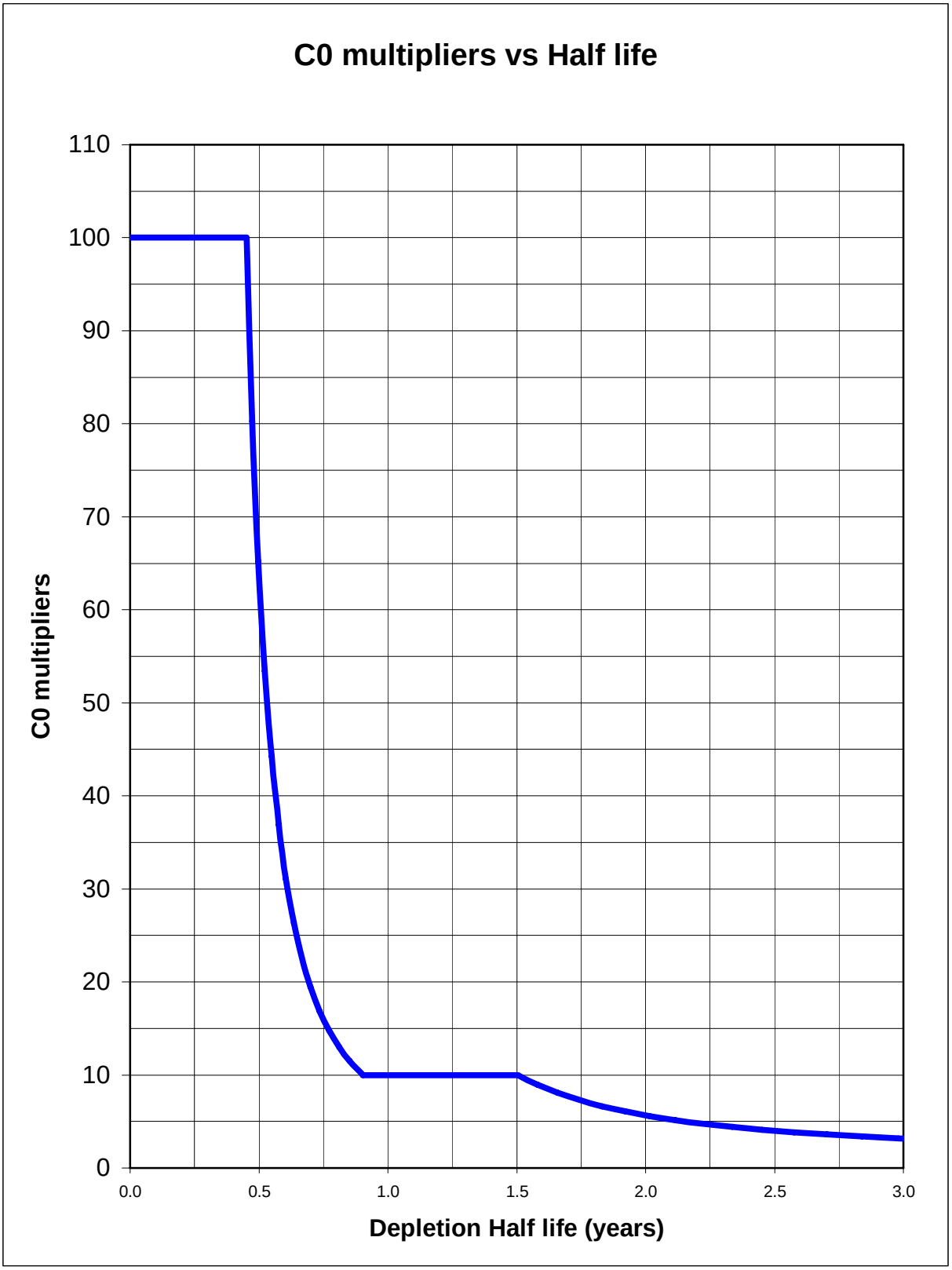
7) Determine the half life for Soil Leaching to Water Table

The initial mass, Mass 1, and the mass remaining after one week, Mass 2, are entered into the re-arranged decay equation, (Section 7.9), to generate the effective half life for this mode of source depletion for each contaminant. To change t1/2 (week), into t1/2 (years), which is used to calculate the SD multipliers, t1/2 (week) is divided by 52.

$$t_{1/2}\text{ (years)} = \frac{-\ln 2 * 1\text{ week}}{\ln\frac{\text{Mass 2}}{\text{Mass 1}} * \frac{365.25}{7}}$$

8) Determine the Source Depletion Multipliers

Section 7.3.5 presents the rationale for how the SD Multipliers are determined which satisfy all three human-health constraints for the S-IA and S-GW1 pathways, for any half life. Figure 7.5, reproduced below with more vertical exaggeration, is a graphical presentation of the half life vs. SD Multipliers used for human health impacts.


C0 multipliers vs Half life
C0 multipliers
110
100
90
80
70
60
50
40
30
20
10
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Depletion Half life (years)

The IF statement corresponding to Figure 7.5 and used in the spreadsheet to determine the SD multipliers is:

IF(halflife<=0.4515,100,IF(halflife<0.905,1/EXP(-N(2)/halflife*3),IF(halflife<1.505,10,1/EXP(-LN(2)/half life*5))

9) Determine the Soil Standard

The total soil concentration determined in Step 3 is multiplied by the SD multiplier.

7.5.3 Tier 2 Aspects and Considerations for S-GW1

The subsurface characteristics allowed to vary in Tier 2 for S-GW1 are the soil type and its representative foc. The allowed range of input values for Tier 2 represent conditions typically found in Ontario and are identified in the Tier 2 (MGRA) model that is available on the Ministry's website.

7.6 Deriving Groundwater Values Protective of Indoor Air Quality (GW2)

The conceptual models of the generic setting for the groundwater to indoor air pathway, GW2, for a residential and commercial/industrial building are presented in Figure 7.10 and Figure 7.11 respectively.

Figure 7.10 Groundwater to Indoor Air Pathway (GW2): Conceptual Model of Generic Setting (Residential)

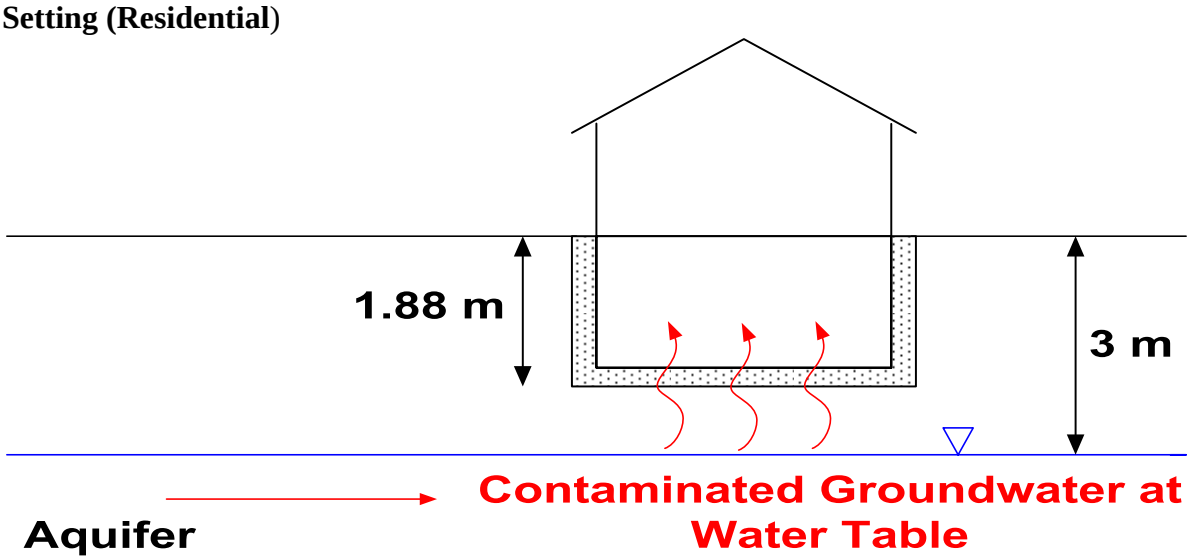
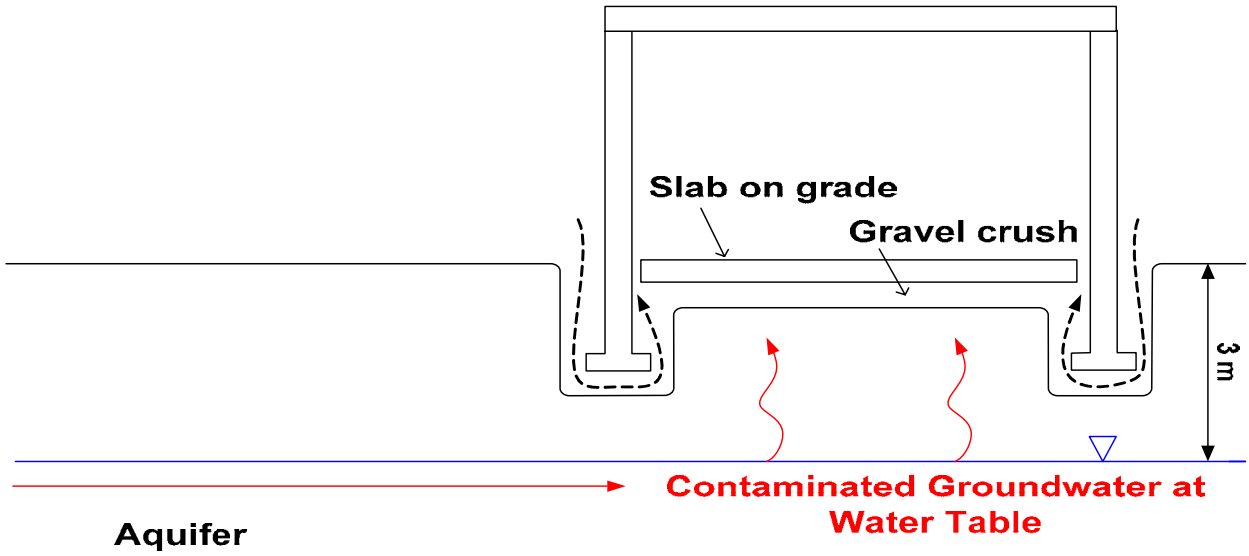


Figure 7.11 Groundwater to Indoor Air Pathway (GW2): Conceptual Model of Generic Setting (Commercial/Industrial)



7.6.1 GW2 Pathway: Description and Assumptions

Cross-media transfer from groundwater to soil vapour occurs when contaminants in groundwater volatilize into air-filled porosity in the vadose zone above the water table. Once in the vadose zone the contaminant vapour diffuses upwards and eventually discharges to either the ground surface, mixing with outdoor air, or into a building.

The generic setting does not assume where the contaminant source for the water table contamination is because, at a real site, it could be off site and therefore, because the source mass is unknown, the concept of source depletion multipliers could not be applied.

The building dimensions and characteristics related to vapour intrusion from the subsurface are presented in Section 7.2. The vadose zone properties relevant to vapour transport are described in Section 7.2.

Since groundwater flows downgradient and usually moves offsite it was deemed necessary in the generic standards to prevent a potential scenario wherein a comm./ind site with groundwater at the GW2 comm/ind standard flows onto a residential property with a house. Such a circumstance could cause the residential property to have too high a GW2 concentration, and therefore, to be protective, all comm./ind GW2 generic standards were made to default to the Residential GW2 value.

The Tier 2 aspects and considerations for the GW2 pathway are described in Section 7.6.3.

7.6.2 GW2 Contaminant Attenuation Modelling

The Johnson-Ettinger model is used to calculate the GW2 vapour attenuation coefficient, which is the ratio between the acceptable indoor air concentration and the gas concentration at the underlying water table. To derive the groundwater concentration in equilibrium with the soil gas at the water table, Henry's Law was used, i.e., the gas concentration divided by the temperature-corrected Henry's Law constant (dimensionless).

The calculation steps to the GW2 groundwater concentration are:

1) Determine the GW2 Vapour Attenuation Coefficient

The Johnson Ettinger model, described in Section 7.3.3, was used to calculate the GW2 vapour attenuation coefficient.

$$\alpha = \frac{\left(\frac{D_T * A_B}{Q_{building} * L_T}\right) * \exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right)}{\left(\exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right) + \left(\frac{D_T * A_B}{Q_{building} * L_T}\right) + \frac{D_T * A_B}{Q_{soil} * L_T} * \left[\exp\left(\frac{Q_{soil} * L_{crack}}{D_{crack} * A_{crack}}\right) - 1\right]\right)}$$

where:

α = Steady-state vapour attenuation coefficient, dimensionless

D_T = Total overall effective diffusion coefficient, cm^2/s

A_B = Area of the enclosed space below grade, cm^2

$Q_{building}$ = Building air exchange rate, cm^3/s

L_T = Separation distance from contaminant source (the water table) to underside of building, cm

Q_{soil} = Flow rate of soil gas into the building, cm^3/s

L_{crack} = Building foundation or slab thickness, cm

A_{crack} = total area of cracks in A_B, cm^2

D_{crack} = Effective diffusion coefficient through the cracks, cm^2/s (assumed equivalent to soil layer closest to contact with the floor).

The equations to calculate the parameter values of the J&E model in Section 7.3.3 are from U.S. EPA's User's Guide (December 2000) and are not reproduced here. The soil gas permeability, used to calculate Qsoil, is determined using Equation 7.7 in Section 7.3.4

2) Determine the Allowable Groundwater concentration at the water table

Henry's Law is applied to the allowable soil gas concentration as follows:

$$C_w = \frac{C_{air}}{alpha * H'}$$

where:
Cw = allowable water table concentration

Cair = allowable indoor air concentratio

alpha = GW2 vapour attenuation coefficient

H' = temperature-corrected Henry's Law constant (unitless)

7.6.3 Tier 2 Aspects and Considerations for GW2 Pathway

Tier 2 is an option which allows the QP to change some of the generic input values in MOE's models to site-specific input values, defended by sufficient, site-specific data so that the site's natural protection is better accounted for from a contaminant-transport perspective than with the values used for the generic setting.

For the GW2 pathway the relevent parameters allowed to vary in Tier 2 are vadose-zone foc, vadose-zone soil type, capillary-fringe soil type, and depth BGL to the highest, annual water table. These inputs affect the value of the GW2 soil-vapour attenuation coefficient and whether the GW2 concentration is multiplied by a bioattenuation factor (BAF) of 1, 10 or 100. Tier 2 input values are allowed to change within a range considered reasonable for Ontario.

For Tier 2, if the property-specific, highest annual water-table depth is deeper than the presumed location of the building's gravel crush sublayer, then J&E was used to calculate the GW2 attenuation coefficient, whereas, if the highest water table is shallower than this, then an empirically-based, "sub-slab" alpha was used. For the Residential setting, the sub-slab alpha value was 0.02, and for the Commercial/Industrial setting the value was five times lower, or 0.004. The rationale for these sub-slab alpha values is as follows:

1) Q_{soil}/Q_{bldg} is the ratio that determines the sub-slab alpha value. The default sub-slab alpha, based on measured data for residential settings, was 0.02 (Dawson, H. 2006 and Health Canada, 2008).
2) MOE's ratio for Qsoil/Qbldg for Comm/Ind (coarse) is about 5 times lower than for Residential (coarse) i.e., 0.00065 vs. 0.00308 and therefore the default Comm/Ind sub-slab alpha was set five times lower than 0.02 at 0.004. These values were applied to M/F soil settings as they were conservative.

The algorithm which performs the Tier 2 calculation of GW2 alpha is:

IF(GW2Lt<LF+hB,0.02,**Q8*P8/(P8+Q8+(R8*(P8-1)**)))

where:
GW2Lt = depth to highest annual water table (cm.)

LF = depth to underside of floor slab (cm.)

hB = thickness of gravel crush layer beneath floor slab (cm.)

0.02 = residential subslab alpha, empirical. (Comm/ind uses 0.004)

Q,P and R function (**bolded**) = J&E equation (section 7.3.3, equation 7.5b equivalent)

When the minimum water table depth was sufficient for the above algorithm to use the J&E model to determine alpha, the calculation of the total effective diffusion coefficient used in the J&E model was adjusted to accommodate potential sites where the capillary-fringe height was truncated by the gravel crush layer due to the large pore sizes. Calculation of the total effective diffusion coefficient for both residential and comm/ind settings to accommodate this requirement in Tier 2 used the distances illustrated below in Figure 7.11b, and was coded for both residential and com/ind settings using the following logic:

DTotal = L/(IF(Lcz>=hC, hB/Db+(WTD-LF-hB)/Dcz, hB/Db+(hC-Lcz)/Dc+Lcz/Dcz))

where:
Dtotal = total effective diffusion coefficient

L = diffusion path length = depth to water table minus depth to underside of building floor slab

Lcz = unreduced capillary fringe height

hC = thickness of soil layer below gravel crush to the water table

hB = thickness of gravel crush layer

Db = diffusion coefficient for gravel crush layer

WTD = water table depth BGL (shallowest annual water table)

LF = depth BGL to underside of building floor slab

Dc = diffusion coefficient for soil layer below gravel crush but above capillary fringe

Dcz = diffusion coefficient of capillary fringe
Units are cm and seconds

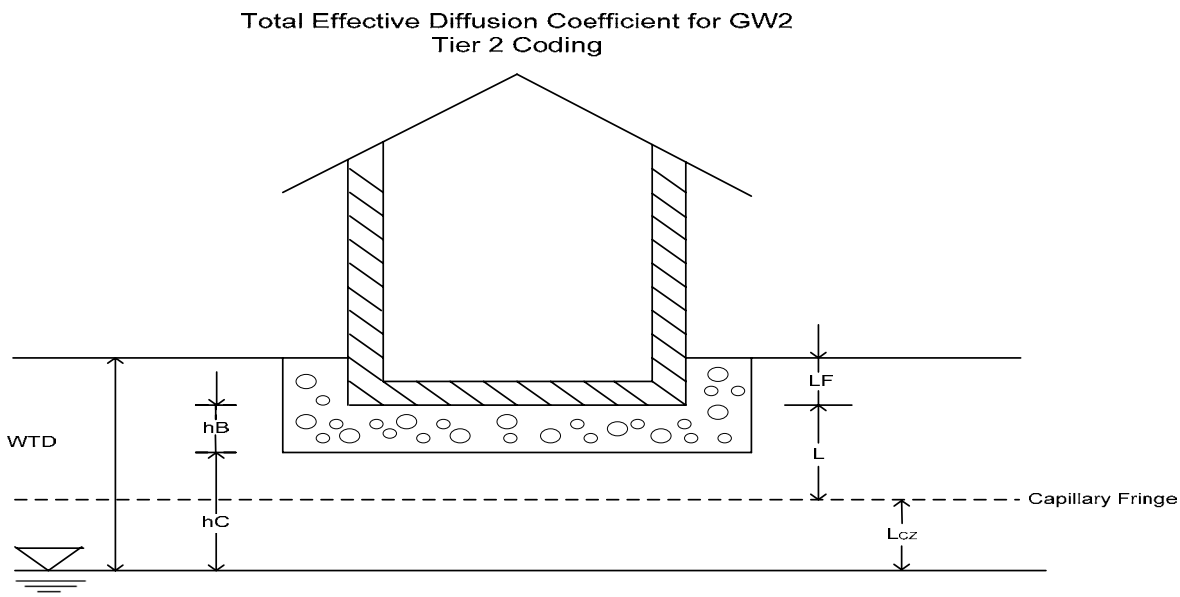


Figure 7.11b Diffusion Distances Used for Effective Diffusion Coefficient in Tier 2.

In Tier 2 for GW2, if the shallowest, annual water table allows more than 0.74 metre of unsaturated soil between the top of the capillary fringe and the bottom of the gravel crush layer, as was done in the generic setting, then the allowable GW2 groundwater concentrations for selected contaminants which easily degrade aerobically were multiplied by a bioattenaution factor (BAF) of 10; likewise, if there was more than a three metre separation distance of unsaturated soil above the capillary fringe then the BAF applied was 100. See Figure 7.11c. These BAFs are applied in a manner that considers other Tier 2 Risk Management Measures as described in the Tier 2 (MGRA) model that is available on the Ministry's website.

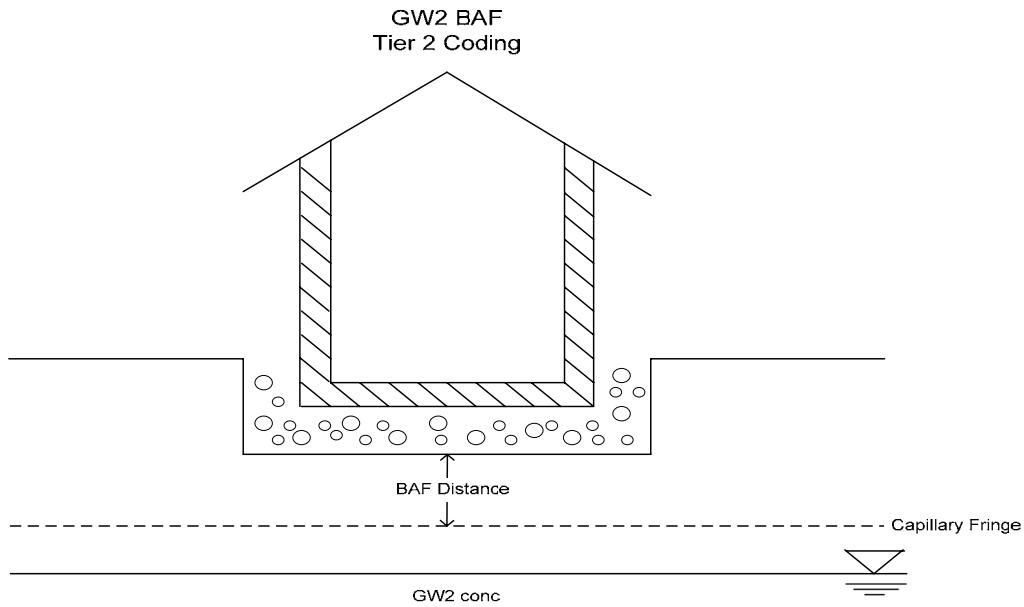


Figure 7.11c Identification of Distance Used to Determine the Bioattenuation Factor (BAF)

In Tier 2, where water tables are shallower than the generic depth of the gravel crush, although the effective GW2 depth would be the elevation of the gravel crush layer due to a sump pump, the relevent groundwater concentration might not be the water table concentration because the sump pump would also pull groundwater from below the water table into the gravel crush layer.

Also, there are procedures available within the Tier 2 (MGRA) model to the QP regarding property use and physical conditions on potentially-affected downgradient properties which can allow removal the GW2 safeguard used in Tier 1 of defaulting to the residential standard in comm./ind settings and allow, if certain characteristics are in place, the comm./ind property-specific groundwater standard to be 100 times the Tier 2 Residential GW2 value.

7.6.4 Tier 2 GW2 for Shallow Soils

For “Shallow Soils” i.e., sites with two metres or less of soil over bedrock, the reasonable worst-case assumption for the GW2 pathway is that any buildings will have had the soil removed and be founded directly on bedrock. That would mean there would be no soil between the water table and the floor slab. Therefore, the default GW2 alpha used for shallow soils was the "subslab alpha" which for residential settings was 0.02 (Dawson, 2006 and Health Canada, 2008) and, for Comm/Ind settings, 0.004, a MOE pro-rated value. The GW2 component values for the

Residential and Commercial/Industrial buildings were determined using the acceptable indoor air conc., subslab alpha and H'. No BAFs were used. MOE conservatively assumed that the subslab alpha is unaffected by water table depth in bedrock and therefore Tier 2 provides no "relief" for deeper water tables in bedrock at Shallow Soil sites.

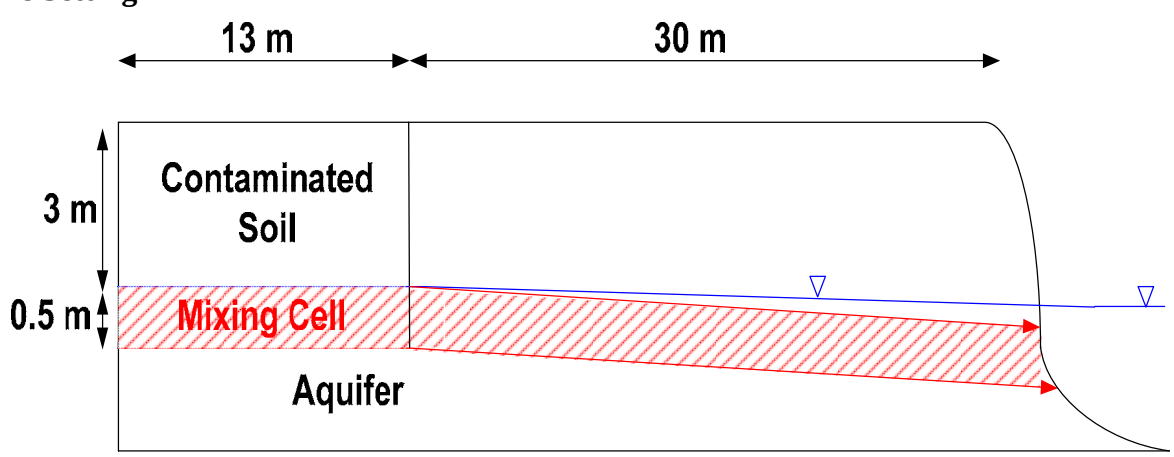
7.7 Deriving Soil Values Protective of GW2 (S-GW2)

The 1996 "Guideline for Use at Contaminated Sites in Ontario" included soil values, S-GW2, for protection of indoor air from movement of volatile and semi-volatile contaminants from soil to groundwater and then back up to indoor air. In examination of internally consistent methods of calculating the S-GW2 pathway and the S-IA pathway, it became clear that the S-IA value is always the more protective of the two since the barrier to gas movement of the capillary fringe does not need to be crossed. As a result it is not necessary to consider an S-GW2 value whenever an S-IA component is being considered, and therefore the S-GW2 component has been dropped from the Site Condition Standards development process.

7.8 Deriving Groundwater Values Protective of Aquatic Receptors (GW3)

The conceptual model of the Generic Setting for the GW3 pathway is shown in Figure 7.12.

Figure 7.12 – Groundwater to Surface water Pathway (GW3): Conceptual Model of Generic Setting



7.8.1 GW3 Pathway Description and Assumptions

The Domenico 2-D transport model, described in Section 7.3.7, is used to calculate the starting groundwater concentration that attenuates to the aquatic protection value after a 36.5 m. travel distance in the aquifer as measured from the centre point of the contaminated zone. Since ten times dilution is assumed to be present in surface water a factor of ten is applied to the starting concentration to arrive at the allowable GW3 concentration. The use of 10 times dilution in surface water still assures that acute toxicity should not occur before dilution since a 10x acute-to-chronic factor is used in deriving the aquatic toxicity value and is therefore consistent

with other MOE policies. In addition, the most sensitive ecological receptors are in the water column, where dilution of the groundwater discharge has to have had occurred, and therefore should be sufficiently protected. This 10 times factor does not equate to allowing the entire stream flow to dilute the incoming groundwater plume. The modelled travel time for each contaminant to reach the surface water body is set at 300 years for the generic scenario as measured from the downgradient edge of the contaminated zone. The GW3 concentrations are the same for the two generic soil types since lateral groundwater movement to surface water is assumed to occur in an equivalent aquifer.

Biodegradation in groundwater en route to surface water is neither invoked for the Generic Site Condition Standards, nor for Tier 2, because biodegradation is a site-specific, highly variable process that does not occur at every site and no studies were identified which supported biodegradation rates that would be present at 95% of sites. Furthermore, because the SCS only need to be met with a Tier 1 site investigation rather than with a Tier 3 Risk Assessment wherein more stringent hydrogeological reasoning can be applied, and be reviewed by MOE, then three metre long well screens and general groundwater quality from "the groundwater" may unavoidably occur and so, to protect against this, which could under-represent the contaminant's groundwater concentrations , the only attenuation mechanism allowed for Tiers 1 & 2, GW3 analysis is hydrodynamic dispersion.

7.8.2 GW3 Contaminant Attenuation Modelling

The calculation steps to the groundwater standard for the GW3 pathway are as follows:

1) Determine Allowable Groundwater Concentration Beneath Site Using Domenico Model

$$\frac{C(x,y,t)}{C0} =$$

$$\frac{1}{4}\exp\left\{\left(\frac{x}{2\alpha_x}\right)\left[1-\sqrt{1+\frac{4k\alpha_x}{\frac{v}{R}}}\right]\right\} * erfc\left[\frac{x-\frac{v}{R}t\sqrt{1+\frac{4k\alpha_x}{\frac{v}{R}}}}{2\sqrt{\alpha_x\frac{v}{R}t}}\right] * \left\{erf\left[\frac{y+\frac{Y}{2}}{2\sqrt{\alpha_y x}}\right] - erf\left[\frac{y-\frac{Y}{2}}{2\sqrt{\alpha_y x}}\right]\right\}$$

where:

Y = total width of contaminant source perpendicular to groundwater flow

x = horizontal travel distance from centre of contaminant source to the closest top of bank of the surface water body

y = 0 = offset distance from centreline of plume

t = time

C = concentration at x, y and t that is allowed in surface water = Aquatic Protection Value

C0 = initial concentration at t = 0

α_x = longitudinal dispersivity in aquifer (=0.1*x)

α_y = transverse dispersivity in aquifer (=0.01*x)

k = decay constant = $\frac{\ln 2}{R * t_{1/2}}$

$t_{1/2}$ = degradation half life

R = Retardation Factor = $1 + \frac{\rho_b * K_{oc} * f_{oc}}{\eta}$

note: dividing the decay term by R restricts degradation to only the aqueous, non- sorbed phase.

v = average linear groundwater speed = $\frac{K_h * i_h}{\eta}$

η = aquifer effective porosity

2) Incorporate 10 x Dilution due to Mixing in Surface Water
Multiply C0 concentration from step 1) by 10 to account for surface water dilution.

7.8.3 Tier 2 Aspects and Considerations for GW3 Pathway

Tier 2 may provide relief for the GW3 pathway by changing the aquifer characteristics of foc, dry bulk density, horizontal hydraulic gradient, bulk hydraulic conductivity and travel distance within the bounds set out in the Modified Generic (Tier 2) Risk Assessment Guidance document.

Regarding the Tier 2 travel distance, the maximum distance to the closest surface water body was set at 5000 metres. For sites approaching this maximum, the actual flowpath distance to the discharge zone may be further as the site may be in the recharge zone of an intermediate or regional flow system.

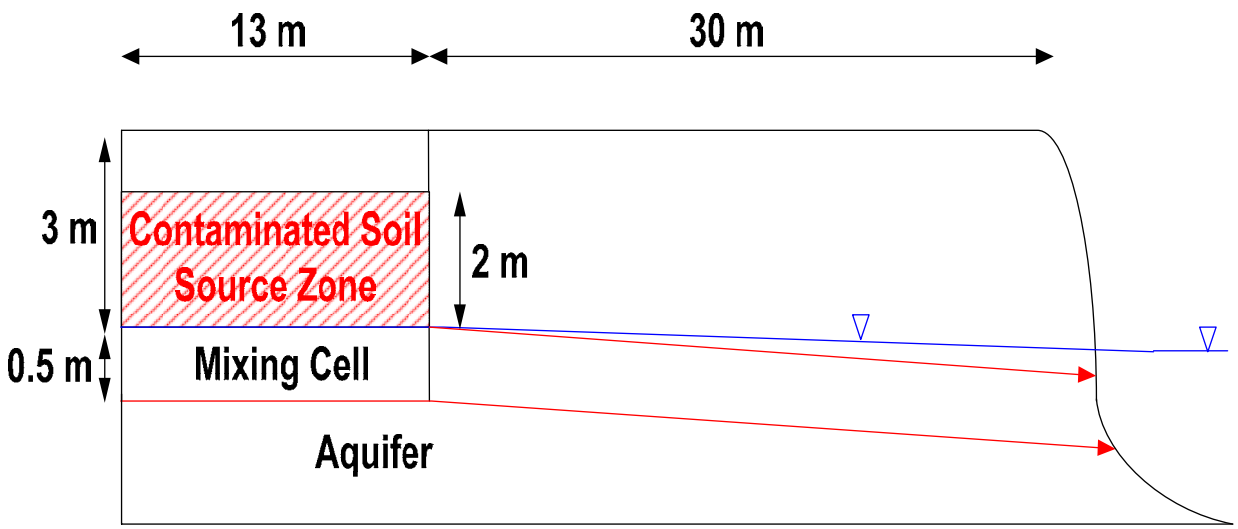
Under certain conditions there may be an effect due to how the modelling-time is specified in the MGRA approved model. While it is true that increasing the distance to surface water causes a COC's GW3 value to increase, it is also true that for certain COCs with velocities < 0.1 m/a the MGRA model may return a decrease in the GW3 value for certain distances to surface water. For distances beyond those, the GW3 values increase above the generic value as expected. This decrease in the GW3 value is an artifact of determining the modelling time by measuring from the edge of the source zone, while determining the modelling distance by

measuring from the centre. This discrepancy between where the model starts and when it determines the COC concentration at the specified distance, causes the GW3 model to determine concentrations in a non-uniform way on the COC breakthrough curve. One example is Heptachlor in the generic setting at a distance of 60 metres. Here, the calculated GW3 value has dropped from the generic value of 2.49 to 2.23 ug/L; however, at >86 m the values increase beyond the generic. Which COCs exhibit this behaviour depends on: the speed of the groundwater, the foc of the aquifer, the Koc of the COC, and the distance to surface water. This phenomenon does not exist if the point-of-origin for travel distance and travel time coincide. Using the MGRA model is flexible in that it does not require that all available Tier 2 parameters be modified to site-specific values.

7.9 Deriving Soil Values Protective of GW3 (S-GW3)

The conceptual model of the Generic Setting for the S-GW3 is shown in Figure 7.13

Figure 7.13 – Soil to Groundwater to Surface water Pathway (S-GW3): Conceptual Model of Generic Setting



7.9.1 S-GW3 Pathway Description and Assumptions

Leachate from the contaminated soil enters groundwater at a concentration that produces the maximum allowable effect on surface water. The leachate concentration in the soil pore water is determined by using a groundwater-mixing module (mixing cell) to provide the link between transport in the unsaturated and saturated zone. This approach defines a dilution factor based on assumed recharge through the soil source and flow through the underlying aquifer via a mixing cell. The equilibrium partition equation determines the total soil concentration that would be in equilibrium with the soil pore water leachate.

7.9.2 S-GW3 Contaminant Attenuation Modelling

The calculation steps to the soil concentration for the S-GW3 pathway are:

1) Determination of Soil Leachate Concentration Entering Aquifer Mixing Cell

The soil leachate concentration is determined by multiplying the GW3 groundwater concentration, determined previously in Section 7.8.2, by the dilution factor provided by the aquifer mixing cell.

$$C_{\text{soil leachate}} = C_{\text{groundwater}} * DF_{\text{mixing cell}}$$

where:

$$DF_{\text{mixing cell}} = 1 + \frac{K_h * 60 * 60 * 24 * 365.25 * i_h * B}{q_{surface} * L}$$

where:

K_h = horizontal hydraulic conductivity of aquifer, m/s

i_h = horizontal hydraulic gradient in aquifer, unitless

B = thickness of mixing cell = 0.5 m

$q_{surface}$ = recharge rate through soil to water table, m/a

L = length of contaminated soil in direction of groundwater flow, m

2) Determination of soil concentration

The soil concentration in equilibrium with the soil leachate concentration determined above is determined by the equilibrium partition equation.

$$C_s = C_{leachate}\left(K_{oc} * f_{oc} + \frac{\eta_w + \eta_a * H'}{\rho_b} \right)$$

where:

C_s = the total concentration of contaminant measured in a soil sample, from the gas, water and sorbed phases (ug/g).

$C_{leachate}$ = contaminant concentration in soil pore water (mg/L)

K_{oc} = organic carbon-water partition coefficient (cm^3/g)

f_{oc} = fraction organic carbon in the soil (dimensionless)

η_w = water-filled porosity (dimensionless)

η_a = air-filled porosity (dimensionless)

H' = Henry's Law constant at the soil temperature (dimensionless)

ρ_b = dry bulk density of the soil (g/cm^3)

A correction factor was applied to the equilibrium partition equation to address the observed difference of two to four times between the measured soil gas concentration and that predicted using the equilibrium partition equation (Hers, 2008). Specifically, considering that Henry's Law constants are much more reliable than the organic carbon partitioning coefficients, MOE addressed this discrepancy by multiplying the Koc values by two in the Physical Chemistry and Toxicology section of the spreadsheet model, thereby ensuring the correction was applied wherever the equation was used, i.e., S-IA, S-GW1, S-GW3, GW2, GW3, Soil-Odour and the separate-phase threshold.

Source depletion is not used for the S-GW3 pathway. Source depletion can only be of use if there are meaningful differences between both the timing and the toxic concentrations or doses of chronic and acute effects. For aquatic organisms, acute effects are derived from very short term tests such as 24 or 48 hours. Chronic tests are based on longer term studies that might often be only 7 day or two week tests. Within the context of groundwater movement to a surface water body 30 m away, changing from a 7 day exposure period down to a one day exposure period at the aquatic protection concentration would not have any meaningful effect on the overall modelling, as travel times are long, and hence would not affect allowable soil concentrations.

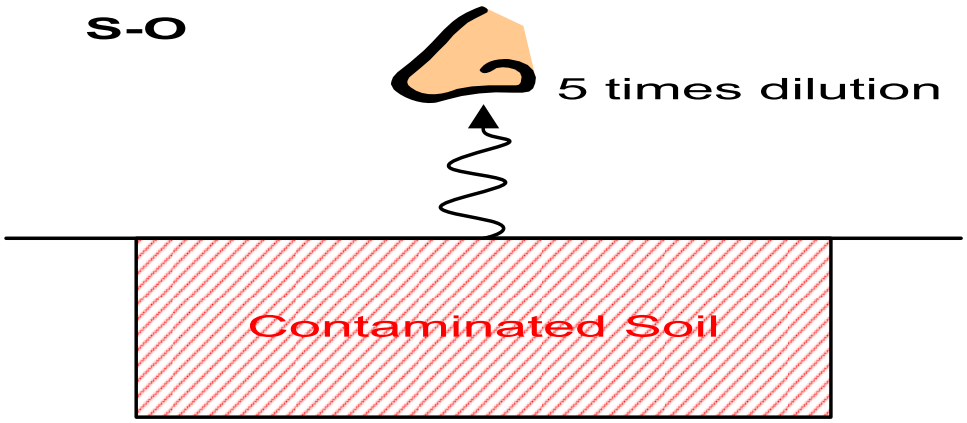
7.9.3 Tier 2 Aspects and Considerations for S-GW3 Pathway

Tier 2 may provide relief for the S-GW3 portion of the GW3 pathway by changing the soil type and foc to better represent the site's behaviour related to environmental impact.

7.10 Deriving Soil Values Protective of Soil Odour

The conceptual model of the Generic Setting for the S-O pathway is shown in Figure 7.14.

Figure 7.14 – Soil Odour Pathway: Conceptual Model of Generic Setting



7.10.1 Soil Odour Pathway Description and Assumptions

The human receptor is exposed to soil odour by smelling a handful of soil during gardening. The assumptions used to generate the soil concentration that will not exceed the aesthetic odour standard at the receptor are:

- gardening by the receptor does not start less than 12 months after the soil samples were collected in Phase 2 of the Environmental Site Assessment
- the contaminant concentration in the soil samples as a result of applying the SDM does not exceed 10 times the aesthetic odour standard, i.e., the maximum SDM allowed is 10.
- the soil is open to the atmosphere and degasses freely during frost-free months (spring, summer and fall); and
- a five times dilution of volume of soil gas with clean outdoor air is assumed while smelling the soil.

7.10.2 Soil Odour Contaminant Attenuation Modelling

Soil properties for the Soil Odour pathway are presented in Section 7.2.1. A partitioning model combined with source depletion factors and dilution are used to calculate contaminant concentrations in soil that will not result in an unacceptable soil odour to the gardener-receptor at a redeveloped brownfield site. Soil concentrations vary with soil texture.

The calculation steps to the soil standard for the S-O pathway are as follows:

1) Determination of infinite source soil concentration

To derive the soil concentration whose equilibrium soil gas concentration is the aesthetic odour concentration, the gas form of the partition equation is used (equation 7.2). The full description of the partition equation is presented in Section 7.3.1

$$C_s = C_{gas} * \left(\frac{f_{oc} * K_{oc}}{H'} + \frac{\eta_w}{H' * \rho_b} + \frac{\eta_a}{\rho_b} \right)$$

Since aesthetic odour concentration units are presented in mg/m3 rather than mg/L, and the soil standards are in ug/g, equation 7.2 is modified to:

$$C_s = \frac{C_{gas}}{1000} * \left(\frac{f_{oc} * K_{oc}}{H'} + \frac{\eta_w}{H' * \rho_b} + \frac{\eta_a}{\rho_b} \right)$$

This soil concentration corresponds to an infinite source of contaminant so that the gas concentration does not diminish with time and remains at the odour threshold.

A correction factor was applied to the equilibrium partition equation to address the observed difference of two to four times between the measured soil gas concentration and that predicted using the equilibrium partition equation (Hers, 2008). Specifically, considering that Henry's Law constants are much more reliable than the organic carbon partitioning coefficients, MOE addressed this discrepancy by multiplying the Koc values by two in the Physical Chemistry and Toxicology section of the spreadsheet model, thereby ensuring the correction was applied wherever the equation was used, i.e., S-IA, S-GW1, S-GW3, GW2, GW3, Soil-Odour and the separate-phase threshold.

2) Applying the five times Dilution Assumption

The assumed five times dilution of soil gas that occurs due to mixing with background air while smelling a handful of soil is implemented by multiplying the soil concentration obtained in the previous step by five.

3) Setting the Source Depletion Constraints

The source depletion concept, as discussed in Section 7.3.5, can be applied to the S-O pathway because, inherent to a gardening receptor, the soil is open to the atmosphere and therefore mass loss due to volatilization to the atmosphere can be assumed to occur.

Assuming that one year is a reasonably conservative time period between the collection of the soil samples and property residents gardening the soil, the following constraints on source depletion are applied for the S-O pathway:

the aesthetic standard must be met within one year
the allowable soil concentration cannot exceed 10 times the infinite-source, soil concentration.

4) Determine Initial Mass of Contaminant in Source Zone

$$\text{Initial Mass } (\mu g) = C_s\left(\frac{\mu g}{g}\right) * \rho_b\left(\frac{g}{cm^3}\right) * \text{volume of source zone}\left(m^3\right) * 10^6\left(\frac{cm^3}{m^3}\right)$$

where C_s is determined by Step 2

5) Determine Contaminant Mass Remaining after Volatilizing to Atmosphere

The Finite Source Jury model, presented in Section 7.3.6, is used to estimate the mass of contaminant lost to the atmosphere during the first week. The model estimates the mass flux to the atmosphere at the time of interest and therefore using the flux at t = 7 days conservatively represents the rate of mass loss for the first week.

$$J = C_0 * \sqrt{\frac{D_{Eff}}{\Pi * t}} * \left(1 - \exp\left(\frac{-d^2}{4 * D_{Eff} * t}\right)\right)$$

where:

J = contaminant flux at ground surface (g/cm^2-s)

C0 = uniform contaminant concentration at t = 0 (g/cm^3)

t = time (s)

d = thickness of contaminated soil (cm)

$$D_{Eff} = \text{effective diffusion coefficient } (cm^2/s) = \left(\frac{\dfrac{n_a^{10/3} * D_{air} * H' + n_w^{10/3} * D_{water}}{n^2}}{\left(\rho_b * K_{oc} * f_{oc} + n_w + n_a * H'\right)}\right)$$

To address the decrease of volatilization which might occur due to pore blockage during days of heavy rain or when the soil is covered by snow and ice the mass loss determined above was decreased by multiplying by (365 – number of “frost”days)/365. The number of “frost” days for the generic setting was set at 100, which is three months. Having a lower number of “frost”days means more contaminant can degas which allows the acceptable soil concentration to be higher.

This revised mass lost in first week is subtracted from the initial mass (Mass 1) to obtain Mass 2.

6) Determine the half life for Volatilization to Atmosphere.

The initial mass, Mass 1, and the mass remaining after one week, Mass 2, are entered into Equation 7.9, reproduced below, to generate the effective half life for this mode of source

depletion for each contaminant. To change t1/2 (week), into t1/2 (years), which is used to calculate the SD multipliers, t1/2 (week) is divided by 52.

$$t_{1/2}\text{ (years)} = \frac{-\ln 2 * 1\text{ week}}{\ln\frac{\text{Mass 2}}{\text{Mass 1}} * \frac{365.25}{7}}$$

7) Determine the Source Depletion Multipliers

Equation 7.12 from Section 7.3.5, reproduced below, determines the Source Depletion Multipliers (SDM) for the S-O pathway by putting C =1 and t = 1year.

$$C_0 = \frac{C}{\exp\left(\frac{-\ln 2 * t}{t_{1/2}}\right)} = \text{Source Depletion Multiplier}$$

Expressing the above in spreadsheet code

SDM = 1/exp(-LN2/$t_{1/2}$*1)

The SD multipliers which meet the constraints of not exceeding 10 and which deplete in one year to SDM = 1 are generated for each contaminant using the following IF statement:

IF (1 /(EXP(-LN(2)*1/t1/2)>10,10,1/(EXP(-LN(2)*1/t1/2))

The infinite source soil concentration determined in step 2 is then multiplied by the SDM.

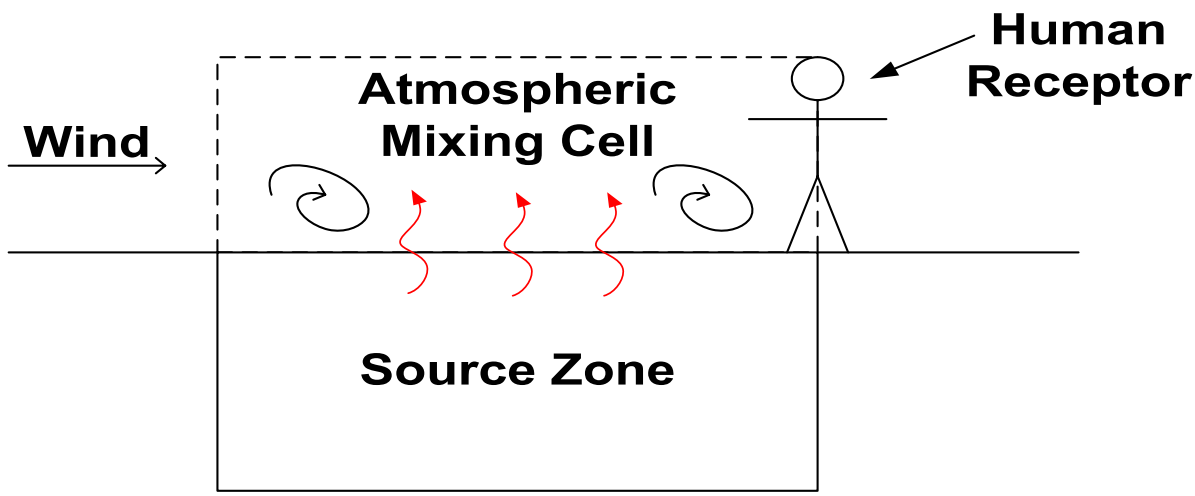
<u>7.10.3 Tier 2 Aspects and Considerations for S-O Pathway</u>

Tier 2 variables for this pathway are the number of frost days per year, foc and USSCS soil type. A map of Ontario is presented in the Tier 2 guidance document that demarcates the zones (from 50 to 170 days) for the number of frost days.

7.11 Deriving Soil Values Protective of Outdoor Air

The conceptual model of the Generic Setting for the S-OA pathway with the 200 cm. high mixing cell is shown in Figure 7.15.

Figure 7.15 – Soil-to-Outdoor Air Pathway: Conceptual Model of Generic Setting



7.11.1 Soil-to-Outdoor Air Pathway Description and Assumptions

This pathway does not drive any Tier 1 Generic Standard but is necessary in Tier 2 if the S-IA pathway is blocked so that the soil standard is still protective of outdoor air. A human receptor is exposed to contaminant vapour by breathing outdoor air while situated at the downwind edge of the source area. The assumptions used to generate the soil concentration for each contaminant that will not exceed the indoor air health-based standard for a human receptor breathing outdoor air are:

- One year is used as a conservative estimate of the time between collecting the soil samples for analysis during Phase 2 of the Environmental Site Assessment and the brownfield property going through the approvals process and starting to be used for its intended purpose.
- The acceptable air concentration is the lowest risk level determined for indoor air for the residential and commercial/industrial settings
- the soil volatilizes freely to the atmosphere as described by the Jury Reduced Solution Finite Source Volatilization Model; and
- the soil vapour is diluted with clean outdoor air moving at 410 cm/second in an atmospheric mixing cell, 200 cm high, before inhalation by human receptor.

7.11.2 Soil-to-Outdoor Air Contaminant Attenuation Modelling

Soil properties for the Soil-to-Outdoor Air pathway are presented in Section 7.2.1. While the source zone is assumed to extend down from ground surface to 200 cm., the foc value used is the vadose zone average so that the derived soil concentrations protect against any source depth.

A finite-source, vapour flux model combined with an atmospheric mixing cell were used to calculate the total soil concentration for each contaminant that will not result in an unacceptable outdoor air concentration to a human receptor at a redeveloped brownfield site. Soil concentrations vary with soil texture.

The calculation steps to the soil standard for the S-OA pathway are as follows:

1) Determine the vapour flux emitted from the soil into the atmosphere mixing cell that is necessary to raise the air concentration in the mixing cell to the human health standard.

J (g/cm2-sec) = Air standard (ug/m3)*Height(200 cm)*windspeed(410 cm/sec)*1e-12/Length(1300 cm) ….(Equation 7.25)

2) With the flux, J, now known, the Finite Source Jury model, presented in Section 7.3.6 and reproduced below, is rearranged to solve for the initial soil concentration that emits a flux after one year that results in the air standard. The Jury model estimates the mass flux to the atmosphere at the time of interest and therefore using the flux at t = 1 year conservatively estimates the air concentration that an outdoor worker would experience at a cleaned-up brownfield.

$$J = C_0 * \sqrt{\frac{D_{Eff}}{\Pi * t}} * \left(1 - \exp\left(\frac{-d^2}{4 * D_{Eff} * t}\right)\right)$$

where:
J = contaminant vapour flux leaving the ground surface (g/cm^2-s)

C0 = uniform contaminant concentration of soil at time of sampling (g/cm^3)

t = time (s)

d = thickness of contaminated soil (200 cm)

D_{Eff} = effective diffusion coefficient of soil (cm^2/s) = $\left(\frac{\frac{n_a^{10/3} * D_{air} * H' + n_w^{10/3} * D_{water}}{n^2}}{(\rho_b * K_{oc} * f_{oc} + n_w + n_a * H')}\right)$

3) The soil concentration of the contaminant is changed from g/cm3 to ug/g as follows:

Soil conc.(ug/g) = soil conc(g/cm3)*1,000,000(ug/g)/dry bulk density(g/cm3) ….(Equation 7.26)

7.11.3 Tier 2 Aspects and Considerations for S-OA Pathway

The S-OA pathway is affected in Tier 2 by USSCS soil type and foc.

7.12 Free Phase Threshold

Free phase, also known as separate phase, is a term that means the presence of NAPL.

Equation (7.1); that is,

$$C_s = C_{leachate}\left(K_{oc} * f_{oc} + \frac{\eta_w + \eta_a * H'}{\rho_b} \right)$$

is an equilibrium equation that is utilized extensively throughout the subsurface modelling for the development of the Generic Site Condition Standards. Its use assumes that there are three phases present; that is, air, water and foc (organic carbon fraction) bound material. In addition, the calculations of vapour intrusion for the indoor air pathways via J&E and the source depletion factors are done through determination of a total mass that is based on the sum of the three phases that are assumed to be present, and therefore the assumption that no free phase is present is inherent in the Generic Site Condition Standards. As such, it becomes necessary to limit the concentrations in the soil to the point at which free phase material could form. This is done through setting the *Cleachate* parameter in Equation (7.1) to the solubility of the pure compound that is being assessed. This calculation is done for each of coarse and medium/fine textured soils, and the resulting value is used as an upper limit to soil concentrations. Raoult's law was not used to estimate effective solubilities in mixtures since the Generic Site Condition Standards must deal with individual compounds. However, in the case of PHCs, consideration is made of the subfractions in order to develop the separate phase thresholds for F1, F2, F3 and F4.

The equations that have been used to develop Koc relationships were developed with the assumptions that van der Waals forces have a negligible effect on organic chemical adsorption onto soil particles. For large molecules, over 400 g/mole, these forces can overwhelm all other effects of chemical structure on adsorption, and the equations are no longer valid (Dragun, 1988, p 242). These large molecules can be effectively insoluble, and due to their low solubilities and the lack of ability of Koc values to account for adsorption onto the soil matrix properly, the free phase threshold calculation gives a number that is far too low to represent what could be held on the soil matrix. As a result, a different perspective is needed to develop a free threshold for these high molecular weight, low solubility substances.

Soil organic matter has a very complicated structure with extremely high surface area to volume ratio. As a result, large volumes of organic substances can sorb onto soil organic matter.

If the soil organic matter is viewed as a set of monomolecular sheets, similar to clay minerals, instead of as the immensely complicated structures that they are, a simplified but workable model for assessing adsorption potential for the purposes of the Generic Site Condition Standards can be envisioned. Each sheet could have a monomolecular layer of the contaminant on one surface, and there would still be a surface available for sorbtion of other molecules. The organic matter function of an exchange complex would still exist, although half of it would be removed by the substance on the other side. This might be viewed as a tolerable situation for brownfields scenarios. It would be extremely difficult to calculate the density of the organic molecules collapsed onto the matrix surfaces due to three dimensional configuration geometries; however, if it is assumed that the density of the organic substance collapsed on the surface is the same as that of the organic carbon itself, and there is no reason to believe that they would be a lot different, then a simple free phase ceiling limit for all large molecules for which van der Waals forces dominate adsorbtion process would be the weight of the organic matter fraction. Thus, a reasonable ceiling limit based on some understanding, although limited, as to why the free phase calculations do not work for these molecules, would be at the organic carbon fraction (foc) of the generic soil. In the spreadsheets, we have adopted the default foc of the CCME PHC CWS of 0.005, thus the free phase ceiling for these substances would be 0.005, or 0.5%, which is 5,000 ppm. (for coarse soils). It is noted that this foc value is higher than the values normally used by Ontario, but we are accepting the value under the assumption that it is accounting for both foc and clay mineral surfaces providing sorbtion sites.

As a result, we are recommending that a free phase threshold for coarse textured soils of 5,000 mg/kg be used for substances that have low solubility and a molecular weight of greater than 200 g/mole. Although it is known that van der Waal's forces overwhelm other forces at molecular weight of over about 400, the value of 200 has been chosen as an effect on the accuracy of the partitioning calculations occurs much earlier. Field work is indicating that the relationship may be influencing calculations for soil vapour partitioning at molecular weights as low as above 200 g/mole.

The failure of the partitioning model for high molecular weight substances is dependent upon the relationships between the Koc and solubility, as the model allows for substances with high solubilities to occupy significant portions of the organic carbon complex, but does not allow for substances of low solubility (e.g. PHC F4) to do so. As such, an algorithm can be developed which indicates when the Koc – solubility relationship is not allowing sufficient occupancy of the organic complex, provided that an assumption is made about the amount of organic contaminant that can occupy the organic matter complex; that is, the foc itself of 5,000 ug/g referred to above. This algorithm is essentially indicating that if the partitioning equation allows occupancy of the foc to the acceptable level, then there is no problem, but if it doesn't then, to account for the effect of Van der Waal's forces (i.e. when MW > = 200g/mole), the separate phase threshold can be moved up to the foc (5,000 mg/kg). The algorithm is as follows;

If MW >= 200 and Koc*foc*solubility*unit correction factor < foc*unit correction factor,

then
Separate phase threshold = foc (i.e. 5,000 mg/kg)

Where MW = molecular weight (g/mole)
Koc = organic carbon partitioning coefficient (mL/g)
Solubility = mg/L
ρ_b = soil dry bulk density (g/mL)
foc = mass fraction of organic carbon (mg_{oc}/mg_{soil})
density of water = 1.0 g/mL

Comments were received from some stakeholders regarding the calculation of free phase threshold after the proposed standards were posted for public comment. The feeling was expressed that the calculated values were too stringent given that the free phase threshold is used as a ceiling concentration when all effects based components are less stringent than the free phase threshold. Given no defined and calculated effects, it was felt that some leniency should be given in these situations where there is a benefit to cleaning up and re-using sites. After considering these arguments, MOE decided to have the free phase threshold calculation allow for a small amount of pore space to be occupied by the free phase material before the ceiling would kick in. It was determined that one percent pore volume, in addition to the previously described calculation of free phase, would be appropriate for use at contaminated sites. This volume would likely not be sufficient to interfere with water movement in the soil and should not pose a significant risk. However, even at this amount of free phase material, there exists the possibility that some soil functions, such as adsorption of other contaminants, and cation and anion exchange capacities, could be adversely affected at these levels. As a result, it was felt that values larger than 1% would be inappropriate for generic site condition standards due to the potential for such unknown effects, and requests for higher free phase thresholds would be best dealt with through the risk assessment process. The free phase threshold is therefore calculated to include the free phase material in one percent of the soil pore volume as well as the previously calculated value from the partitioning equations above.

7.13 Degradation of Chlorinated Aliphatic Compounds to Vinyl Chloride

The biodegradation of contaminants in the environment can effectively reduce their parent concentrations through the production of breakdown products. In general, the breakdown products are less toxic than the original contaminants (i.e., the parent compounds). However, the anaerobic biodegradation - through a reductive dechlorination step - of highly chlorinated compounds (e.g., PCE/TCE/DCE) to vinyl chloride (a known carcinogen) is a mechanism that does not follow this pattern. This reaction presents a unique challenge when setting Generic Site Condition Standards for the parent compounds.

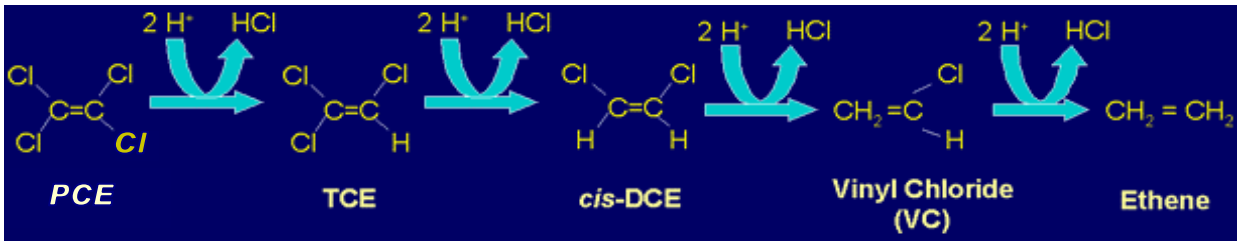
The chlorinated aliphatic parent compounds and degradation products that are being considered at this time are summarized as follows (Barrio-Lage et al. 1986):

Parent compound	Degradation product
• tetrachloroethylene (PCE)	• trichloroethylene (TCE) ↓
• trichloroethylene (TCE)	• 1,1-dichloroethylene (1,1-DCE) and/or • cis-1,2-dichloroethylene (cDCE) and/or • trans-1,2-dichloroethylene (transDCE) ↓
• 1,1-dichloroethylene (1,1-DCE)	• vinyl chloride (VC)
• cis-1,2-dichloroethylene (cDCE)	• chloroethane • vinyl chloride (VC)
• trans-1,2-dichloroethylene (transDCE)	• vinyl chloride (VC)

Note that there are three isomers of DCE. Biological production of DCE (from TCE) is almost purely cDCE, whereas manufactured DCE is mainly 1,1-DCE and transDCE (Waterloo, 1999).

Biodegradation of chlorinated ethenes is accomplished principally by reductive dechlorination. The reductive dechlorination reaction for tetrachloroethylene (PCE) can be conceptualized as follows:

Figure 7.15 Reductive Dechlorination of PCE



- Chlorine atoms on the ethylene molecule are replaced, in a sequential manner, with hydrogen atoms.
- PCE/TCE/cDCE /VC act as electron acceptors.
- H_2 acts as the electron donor; electron donors act as an energy source (Maymo-Gatell et al. 1997).
- Biodegradation rates of chlorinated compounds may be affected - including synergistic or antagonistic effects – by the bioavailability of organic compounds (Barnes et al. 1997).
- cDCE and transDCE decrease in concentration under anaerobic conditions; the cDCE decreases more rapidly. Both isomers also decrease under aerobic conditions but at much lower rates (Barnes et al. 1997).

- VC levels decrease under aerobic conditions and increase under anaerobic conditions (Barnes et al. 1997).

In the 1996 "Guideline for Use at Contaminated Sites in Ontario", the Ministry's approach to protecting human health from the degradation of chlorinated aliphatics to vinyl chloride was to apply the normally more restrictive criteria used to protect potable groundwater to the non-potable scenarios. Although this was possibly the first time any jurisdiction had attempted to account for degradation to vinyl chloride in setting Generic Site Condition Standards, the means chosen did not provide any protection for the potable pathway, and the means of protecting the non-potable groundwater scenarios, although reasonable under the circumstances, begs for a more scientific approach. In the current review, it was decided to examine other potential approaches and attempt to incorporate a more logical and more scientifically-based method of addressing the issue.

7.13.1 Emerging Science

Reductive dechlorination is a major mechanism for the biotic degradation of some polychlorinated ethylenes; chlorine atoms on the ethylene molecule are replaced, in a sequential manner, with hydrogen atoms (Maymo-Gatell et al. 1997). An emerging field in bioremediation is reductive dechlorination of PCE/TCE by various halo-respiring bacteria; it is a naturally occurring, strictly anaerobic process. Some organisms, including *Dehalococcoides ethenogenes* and other members of the family *Enterobacteriaceae*, use these chlorinated ethenes as an energy source in a metabolic reaction (Holliger et al. 1993, Sharman and MacCarty, 1996).

Some recent studies have indicated an apparent correlation between the presence of microbes in the *Dehalococcoides* group and complete reductive dechlorination to ethene (Hendrickson et al. 2002). Various strains within the group exhibit different abilities at converting VC to ethene (Major, D. 2003). Specifically, the only organism to date which has been demonstrated to further dechlorinate cDCE to ethene is *Dehalococcoides ethenogenes*; some claim that it is currently the most suitable biological indicator to assess dechlorination potential (Major et al. 2002, Fennel et al., 2001). A review of the literature reveals that others consider a consortium of organisms – not one single bacterium, operating on its own - as being necessary for, or capable of, biodegradation in the "real" environment (Nyer et al. 2003).

D. ethenogenes is not ubiquitous in the environment and its absence can lead to the accumulation of cDCE in anaerobic environments when electron donors are present (Hendrickson, 2002). cDCE also accumulates during the period when *D.ethenogenes* grows from low to higher cell densities. However, some evidence shows that bioaugmentation with a culture that contains various strains of *D.ethenogenes* can be used to promote dechlorination past cDCE to ethene at sites where *D.ethenogenes* is absent. The presence of this microbe does not necessarily imply that dechlorination will occur; the absence of this microbe, however, is associated with dechlorination stopping at cDCE (Major, D., 2003b). There is also some speculation that the introduction of bacterial cultures may cause short-term, localized spikes in dechlorination activity but, again, is not essential to total dechlorination of the site (Nyer et al., 2003).

Considering some emerging science indicating that degradation may stall at the cDCE phase, the focus of concern may be more appropriately placed on cDCE. The cDCE to VC portion of the reaction is slower than the VC to ethene step (Major, 2003a). Gibb's free energy rates for each transformation step support this observation. The Gibbs Free Energy is a thermodynamic quantity which can be used to determine if a reaction is spontaneous or not. Note that the energy release is dependent on the concentration of compounds. However, relative amounts can be observed with reference to a 2002 study (10), where the free energy (ΔG) for each reaction has been listed as follows:

$PCE + H_2 \rightarrow TCE + H^+ + Cl^-$
ΔG = -163.57 kJ/reaction
$TCE + H_2 \rightarrow cDCE + H^+ + Cl^-$
ΔG = -161.17 kJ/reaction
$cDCE + H_2 \rightarrow VC + H^+ + Cl^-$
ΔG = -141.17 kJ/reaction
$VC + H_2 \rightarrow ethene + H^+ + Cl^-$
ΔG = -154.87 kJ/reaction

More negative ΔG values correspond to greater energy release and indicate the possibility that the process may proceed but will not necessarily proceed spontaneously. The cDCE to VC step has the lowest energy release and is therefore not as favoured; it may also be why only specific microbes are involved in this reaction. These microbes prefer the next portion of the reaction, the VC to ethene step, as it is higher in energy. This thermodynamic property is distinct, however, from the *rate* of the reaction. Catalysts, like micro-organisms, lower activation energies and allow such thermodynamically favourable processes to proceed, but cannot cause a reaction that is not favoured in such a way to occur.

Maximum rates of reductive dechlorination in groundwater have been shown to be rapid, with approximated first-order rate constants for PCE, TCE, cDCE and VC between 0.6 and 2.5 h-1(Major et al., 2002).

Each site's redox potential and other site-specific geochemical parameters must be suitable to encourage dechlorination activity. Appropriate and sufficient electron activity, in conjunction with the necessary catalyst – such as *D.ethenogenes* – must be present for the process to proceed at a significant rate. Some evidence indicates that, under methogenic conditions, maintaining a site's sufficiently-reduced, redox conditions will lead to complete dechlorination without a substantial accumulation of vinyl chloride (Nyer et al., 2003).

Other parameters, such as variable solubilities and degradation rate potentials of each contaminant, affect real and perceived contaminant amounts. For example, DCE is more soluble than TCE in a "matrix-mediated equilibrium" and degrades more slowly. Lower K_{oc} values for cDCE lead to a greater mass of cDCE in the dissolved phase; cDCE and may appear to be more persistent or the reaction may appear to have slowed down (Nyer et al., 2003). As well, the rate of transformation from vinyl chloride to ethane can be significantly faster than that from cDCE to vinyl chloride, which may lead to the perception that cDCE can transform to ethene without any build-up of vinyl chloride.

Other findings demonstrate that either acetate or H_2 alone, acting as electron donors - using appropriate substrates and under appropriate conditions - can promote the complete dechlorination of chlorinated ethylenes to ethene (He et al., 2002). The maintenance of highly anaerobic and chemically reducing conditions can drive complete dechlorination, albeit with varying rates for different degradation products, and under many different redox and hydrogeologic conditions. Bio-oxidation or hydrolysis can also occur at the same time as reductive dehalogenation, also removing chlorine atoms, and further clouding the exact mechanistic steps involved in reductive dehalogenation. Isomers also undergo different transformations (Bouwer and McCarthy, 1983, Bouwer and McCarthy, 1983a).

This emerging science indicates that, under the right conditions, degradation may stall at cDCE, may result in the presence of VC, or may proceed past VC to ethene.

7.13.2 Application to the Development of Generic Effects-Based Criteria

Accurately predicting "generic" ratios of breakdown products in an Ontario context is difficult as there is wide variability in biodegradation rates reported in the literature; potentially, multiple discrete biological activities may be associated with one contaminated site (Major et al. 1991). As well, there is evidence that different metabolites are degraded through different mechanisms/conditions which may or may not be present at any given site (Hauschild et al. 1994). The conditions surrounding a monitoring well are not necessarily reflected in the entire site as the subsurface is a heterogeneous environment.

For the development of Generic Site Condition Standards in the Ontario context, it is not necessary that the solution used produce generic numbers that are both fully protective of all sites and allow, by themselves, for all sites to be cleaned up in an economically practical manner using the generic numbers, as there will always be some sites for which site specific risk assessment is needed. Therefore, the solution that is being targeted is one that protects the large majority of potential sites, with an acknowledgement that for some sites other assessment methods may be necessary. With this in mind, as well as suggestions from California and anecdotal evidence in Ontario that less that 10% of the concentration of an original parent chlorinated aliphatic compound ends up as vinyl chloride, MOE examined available Ontario data on concentrations of parent and daughter products of chlorinated aliphatic compounds at contaminated sites. The following table presents the results of that examination for groundwater from well locations that were nearest to the known or suspected source areas at the ten different contaminated sites for which useful data were available. The table compares concentrations of vinyl chloride to the sum of the other chlorinated aliphatics that were measured at each source location.

Table 7.1: Chlorinated Aliphatic Concentrations at Contaminant Source Areas (ug/L)

	TCA	PCE	TCE	DCE	VC*	Detection Limit if VC<DL	%VC**
Location 1							
imm. Down gradient			**3570**	**5410**	**500**	**<1000**	**5.57**
Location 2							
source area		**600**	**32000**	**280**	**25**	**<50**	**0.08**
near source		**580**	**140**	**300**	**50**		**4.90**
near source		**3400**	**9300**	**920**	**2**		**0.01**
Location 3							
Source area	**200000**		**1250**	**23200**	**3000**	**<6000**	**1.34**
Location 4							
Highest conc	**1500**	**33000**	**920**	**236**	**0.25**	**<0.5**	**0.00**
Location 5							
Source Area			**7510**	**18300**	**1530**		**5.93**
Location 6							
Assumed Source Area		**510**	**1100000**	**330**	**13**		**0.00**
Location 7							
Source Area – shallow		**173000**	**3530**	**0**	**0.25**	**<0.5**	**0.00**
Location 8							
30 m down gradient			**1600**	**10**	**0.1**	**<0.2**	**0.01**
Location 7							
presumed source area			**13300**	**233**	**10.8**		**0.08**
Location 8							
source area			**20,000**	**3.3**	**2.4**		**0.01**
Location 9a							
presumed source			**74000**	**30000**	**4100**		**3.94**
presumed source			**210000**	**72000**	**3900**		**1.38**
presumed source			**115000**	**36000**	**1950**		**1.29**
Location 9b							
presumed source			**64000**	**2750**	**109.5**		**0.16**
Location 9c							
probable source			**4100**	**2900**	**160**		**2.29**
Location 9d							
probable source			**19000**	**4500**	**210**		**0.89**
probable source			**62000**	**12000**	**310**		**0.42**
Location 9e							
Source			**780000**	**17000**	**4000**		**0.50**
Location 9f							
probable source			**1200**	**33100**	**140**		**0.41**
probable source			**8000**	**3100**	**360**		**3.24**
*** 1/2 DL used if <DL**							
**** %VC is calculated as (VC concentration x 100)/(sum of measured parent compounds)**							

The vinyl chloride concentrations were below 10% of the concentration of the potential parent products for all wells located at or near the source areas. This would appear to indicate that a 10% rule would be sufficiently protective, indeed, possibly overly protective. However, the argument can be made that the maximum vinyl chloride concentrations will occur downstream from the source area, as time (and as a result, distance) is required for the biodegradation to occur. An examination of the original data indicated that of the total of 85 wells for which data were available, 9 had vinyl chloride concentrations in excess of 10% of the measured TCE +DCE concentrations at that well. This would seem to imply that the 10% rule might be protective of about 90% of the sites where chlorinated aliphatics are identified as a problem. This in itself might be a reasonable degree of protection; however, a precise calculation would add the original amount of TCE or PCE that had resulted in the production of the VC that was measured back into the sum of the parent compounds, and also convert the DCE values back to their likely original TCE or PCE concentrations. When this calculation is done, the data indicate that the 10% rule covers 94% of the well data. In addition, the data for additional parent products such as 1,1-DCE, trans 1,2-DCE, and TCA were not provided, although they were stated to be present. These should be added into the summed totals. It is therefore highly likely that the calculated ratios would be significantly lower, and that the 10% rule would be protective of these sites.

It was therefore concluded that Generic Site Condition Standards could be set for the chlorinated ethylenes to account for degradation to vinyl chloride by not allowing the generic values to go above ten times those of vinyl chloride. This was applied to the GW1, GW2, and S-GW1 pathways.

7.14 Apparent Counter-intuitive Effects of Model and Parameter Choices

There are a number of situations where the standards that result from the model and parameter choices appear to conflict with the expected results. This section outlines some of these and explains why they happen.

1*) Medium/Fine textured soils having lower S-IA SCS's than coarse-textured soils.*

For some compounds, the relationship between the original S-IA component values for the two soil textures and the source depletion multipliers can result in the numeric criteria for the M/F soil being lower than that of the coarse soil. One example is the M/F and Coarse soil standards for Residential S-IA for Benzene, with the coarse soil value being 0.21 ug/g and the M/F, 0.17 ug/g. To investigate this specific result, an independent check was run using the USEPA's online version (March, 2001) of J&E and comparing those results with MOE's. After inputting MOE's default values for the building and soil properties, changing the acceptable indoor air concentration in the USEPA spreadsheet to 0.506 ug/m3, doubling the Koc to 331 cm3/g., and overriding the Q_{soil} calculation to yield 1.0 Lpm for the MF soil, the coarse soil value is 0.00211 ug/g and the M/F value is 0.0173 ug/g. These results duplicate MOE's penultimate values exactly and are not counter-intuitive in that the coarse value is lower than M/F's. The higher concentration for M/F soil means that more mass is present and therefore depleting that mass via the residential air-exchange rate takes longer than for the coarse soil, and therefore the effective depletion half life is longer. Using the source-depletion principles and equations

described in section 7.3.5, and using Figure 7.5, benzene's depletion half life for coarse soil is 0.18 years, with a corresponding SDM of 100, and the M/F's depletion half life is 1.28 years with a corresponding SDM of 10. Applying the SDMs of 100 and 10 yields MOE's final values.

2) *Very high GW3 and S-GW3 numbers for some compounds*

The application of a time cut-off of 300 years for the transport modelling of the generic GW3 pathway results in some highly-sorbed, strongly-retarded contaminants not fully breaking through to the surface water body 30 metres away. Since these falsely-low concentrations for these low-mobility compounds are assumed by MOE's method to be due to attenuation over that 30 m distance it results in artificially very high GW3 and S-GW3 numbers for those contaminants. In these cases, the GW3 and S-GW3 standards will be driven by other lower numbers, such as the free-phase threshold or the half solubility limit, or by another component.

In addition, higher-than-solubility concentrations can be generated by the MGRA model for groundwater and soil vapour. Since such concentrations are physically unattainable they can be considered as being a counter-intuitive aspect of the MGRA process and so is included here, as well as in the descriptions of the models in Section 7.3. MOE's MGRA model generates the starting concentration that is necessary to cause the acceptable impact at each pathway receptor and does so without limiting the increase to the coc's solubility. Since the starting concentration cannot be higher than solubility, any model-generated concentrations greater than this or their equivalent soil concentrations cannot generate a starting concentration which would cause the allowable impact on the receptor. As a consequence, if the standard is of this type, it is protective.

3) *The Effect of the Modelling –Time Specification in the GW3 Pathway*

If the GW3 value becomes lower when a greater travel distance is used in Tier 2 then the cause is due to the way the MGRA model measures the travel distance from the source centre while determining the travel time based on the source edge. This effect is described in Section 7.8.3, "Tier 2 Aspects and Considerations for GW3 Pathway".

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8 PHYSICAL-CHEMICAL PARAMETERS, DETECTION LIMITS, AND BACKGROUND CONCENTRATIONS

8.1 Physical-Chemical Parameters

There are a number of potential sources for physical-chemical parameters. A review was conducted of potential sources for MOE in 2003. The review listed parameter values used by a number of jurisdictions and recommended that MOE take the average value of these sources for the parameter as that to be used for development of the standards. SDB felt that the logic of taking the average is not appropriate for the purposes of this document. In some cases one value might be (and was) orders of magnitude higher than all the other values, in which case the chosen number would be over one order of magnitude higher than all the numbers except the one large one. In addition, some parameters clearly had the same original source for some of the different published compiled documents, and hence averaging of all values did not appear to be appropriate. MOE has instead chosen to take the data from a single well-respected source that documents the source references and that has a relatively complete database that is well - maintained. Since the Chemical Specific Factors section of the Oak Ridges National Laboratory's Risk Assessment Information System (ORNL RAIS) Database fulfills these requirements and is used as a major source of this information for risk assessments, it was chosen as the the source of this information for this standards setting process.

The following physical/chemical parameters were taken from the ORNL RAIS, (http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf):

Diffusivity in Air (D_i)
Diffusivity in Water (D_w)
Permeability constant (K_p)
Soil-Water Partition Coefficient (K_d)
Henry's Law Constant (H')
Molecular Weight (MW)
Organic Carbon Partition Coefficient. (Koc)
Log of Octanol-Water Partition Coefficient. (log Kow)
Water Solubility (S)
Vapour Pressure (VP)
Melting Point (MP)
Boiling Point (BP)

Properties for PHC fractions were not available from the above database. Subfraction values for PHCs were taken from those in the U.S. Total Petroleum Hydrocarbon Criteria Working Group publication "Selection of Representative TPH Fractions Based on Fate and Transport Considerations", 1997. Calculations for subsurface transport were all conducted on the sub-fractions, and the final component values determined by weighting the subfractions according to the ratios used by the CCME (2008a), as follows;

Table 8.1: PHC subfraction ratios (from Table B4 of CCME 2008a)

Fraction	Aliphatic	Aromatic
F1 - soil	55% C6-8, 36% C8-10	9% C8-10
- water for coarse soils	60.5% C6-8, 6.3% C8-10	33.2% C8-10
- air (vapour)	85.3% C6-8, 14.2% C8-10	0.4% C8-10
F2 – soil	36% C10-12, 44% C12-16	9% C10-12, 11% C12-16
– water for coase soils	2.4% C10-12, 0.2% C12-16	60.3% C10-12, 37.1% C12-16
- air (vapour)	76.7% C10-12, 20.6% C12-16	2.2% C10-12, 0.5% C12-16
F3 - soil	56% C16-21, 24%C21-34	14% C16-21, 6% C21-34
- air (vapour)	89.8% C16-21, 7.83%C21-34	2.37% C16-21, 0.01% C21-34
F4 – soil	80% C>34	20% C>34
-air (vapour)	0% C>34	0% C>34

Soil and water values are from CCME 2008a, air values are from Health Canada, 2009. Where CCME had no water values, soil values were used. Minor modifications may have been made to assure the fraction percentages add to 100%

The subfraction criteria were combined into a fraction component value using the following algorithm (from CCME 2008b);

$$CV_{fractioni} = 1/\sum(MF_{subfraction\ j} / CV_{subfractionj}) \qquad \text{Equation 8.1}$$

$CV_{fractioni}$ = component value for the fraction *i* (mg/kg)
$CV_{sub\text{-}fraction\ j}$ = component value (mg/kg) for each sub-fraction within fraction *i*
$MF_{sub\text{-}fraction\ j}$ = mass fraction of each sub-fraction within fraction *i*

It should be noted that CCME subfraction ratios for water for M/F soils are not used in the development of the Ontario standards since the aquifer is always assumed to be in coarse textured material.

PCBs provide a special case and challenge for determining the appropriate physical-chemical properties. Public comment on the Generic Site Condition Standards for PCBs indicated that the standards were far too stringent in that the S-IA component, and likely the S-GW3 component, appear to be assuming far more mobility than is known to happen in reality. A close look at the equations and the parameters used appears to indicate that the Henry's Law constant and the Koc may not have been appropriate for the PCBs that are causing the toxicity. As a result it was decided to utilize the USEPA RAGS value for Koc for PCBs instead of the ORNL value. This value of 309,000 cm^3/g (USEPA RAGS (Risk Assessment Guidance for Superfund Sites, Part 5, Chemical Specific Factors) (http://www.epa.gov/superfund/health/conmedia/soil/pdfs /part_5.pdf) as checked on February 5, 2008) appears to represent the known behaviour of PCB mixtures such as the Aroclor 1242 mixture used in the human health toxicity (inhalation TRV) assessment better than the old value of 44,800 cm3/g.

Henry's Law constants for individual congeners vary from 7.36 E-4 atm-m3/mol for mono to 1.8 E-8 for octa. The previously used value of 3.43 E-4 (from ORNL) is on the conservative end of the range and may not be representative of Aroclor mixtures.
USEPA RAGS does not provide a PCB Henry's Law constant, but it uses the following equation to calculate Henry's Law Constant when the measured values are not available:

$$HLC = (VP)(M)/(S) \qquad \text{(Equation 8.2)}$$

where
HLC = Henry's law constant (atm*m^3/mol)
VP = vapor pressure (atm)
M = molecular weight (g/mol)
S = solubility (mg/L or g/m^3).
The SSL equations require the dimensionless form of Henry's law constant, or H', which is calculated from HLC (atm-m3/mol) by multiplying by 41.

Using the values from the spreadsheet model,
VP = 8.63 e -5 mmHg = 1.14e-7 Atm
MW = 292 g/mol
Solubility = 0.277 g/m3

$$HLC = 1.14\text{ e-7} * 292 / 0.277 = 1.20\text{ e-4 atm-m3/mol} = 0.00493 \text{ (unitless)}$$

This value provides for internal consistency, and gives a slightly less conservative value than the old that is more in line with practical experience and observations regarding the mobility characteristics of PCBs. The value is still regarded as being conservative and protective.

Health Canada provided SDB with a spreadsheet (Health Canada, 2008) containing the results of a review of physical/chemical parameters. The review draws from a number of sources of information, including the ORNL database mentioned above. SDB decided to utilize the Health Canada database in situations where ORNL is lacking data.

Neither database contained Kocs for mercury or methyl mercury. A 1997 paper (Lyon et al. 1997) gave Kds for these substances. It was felt that use of minimum Kds from this paper would be appropriate for these contaminants for which there is known concern with respect to transport to surface waters. In this paper the worst case (minimum) soil water partition Kd for MHg is 20 L/kg (20 cm3/g). Since Kd=koc*foc, then equivalent Koc=Kd/0.005 = 4000. For HgII, the minimum Kd of 3300 equates to Koc= 3300/0.005 = 660,000.

Physical/chemical parameters are presented in Appendix B1.

8.2 Detection Limits

Analytical reporting limits (RLs) (formerly sometimes referred to as Method Detection Limits (MDLs)) were provided to Standards Development Branch by the Ontario Ministry of the Environment's Laboratory Service Branch (LSB) after consultation with a technical advisory committee that included representation from numerous analytical laboratories. The numbers provided represent the best reporting limits that a properly functioning private sector analytical laboratory can be reasonably expected to be able to achieve. Where LSB was unable to provide

a reporting limit, a practical quantitation limit (PQL) from Massachusetts (MADEP) was used. The reporting limits used are presented in Appendix B1.

8.3 Background Concentrations

8.3.1 Soils

In 1993 the Ontario Ministry of Environment and Energy published backround ranges of a large number of substances in Ontario soils (OMEE,1993). The overall range of a substance was called its "Ontario Typical Range" or OTR. The OTR_{98}, which is the 97.5th percentile of the distribution of a database of surface soils in Ontario that are not contaminated by point sources (see OMEE, 1993a) is used as the basis of the background soil standards. The public consultation process for the Guidelines in 1994 resulted in the recommendation that background numbers should take into account the natural occurring sampling variability. This is accounted for through adding two within site standard deviations of the replicated samples between the upper and lower confidence limits of the OTR_{98} (highest OTR_{98} value if there OTR values were different for different regions.) to the OTR_{98} to produce the background numbers in Table 1. However, this allowance for sampling variability is not permitted to increase a background number to beyond an effects-based number.

The Ministry of the Environment has conducted additional sampling for background metals concentrations since the sampling for the 1993 OTR document. An analysis of all the appropriate available background data from MOE records was conducted for the current review, and the OTR_{98}s recalculated wherever possible, using the same methodology as described in MOEE, 1993. This, as well as additional statistical information on the distributions, is presented below in Tables 8.2 and 8.3, and has been used in the generation of the new proposed standards. Background concentrations for organic substances remain the same as in the previous standards, and are detailed in OMEE, 1993. Although for the present update, MOE is using the same methodology that was used previously, consideration should be given in future updates to using geo-regional approaches and matching statistical methods if sufficient data exists at that time.

Numerous problems with beryllium concentrations in shales and soils derived from shales exceeding surface soil background concentrations have been reported to MOE. A 1998 MOE report titled "Investigation into Chemical Composition of Shales in Ontario"indicated beryllium concentrations to be elevated above normal surface soil background. As a result, an exception to the use of the OTR is being used for beryllium, as SDB is proposing to use 2.5 mg/kg as the background concentration for beryllium for all land use categrories.

Definitions, excluding common statistic terms, for Tables 8.2 and 8.3 are as follows:

OTR_{98} – 98th percentile of the data distribution
Region – MOE region (as per OMEE, 1993) to which column applies
LCL – lower confidence limit of the OTR_{98}
UCL – upper confidence limit of the OTR_{98}
Π - the confidence level (1-α) for the confidence limits around the OTR_{98}
$\bar{x}$CV - coefficient of variation about the OTR_{98}
N – number of sampling sites (number of samples could be as high as 3N)
IQR – Inter Quartile Range – A measure of dispersion equal to the 75th percentile – the 25th percentile
RL (µg / g) – analytical reporting limit

Table 8.2: Soil – 0ld Urban Parks

Table 8.2a: Ag, Al, As, B, Ba, Be, Ca, Cd, Cl and Co OTRs, Soil-Old Urban Parks

Variable	Ag	Al	As	B	Ba	Be	Ca	Cd	Cl	Co
OTR_{98}	0.33	26000	18	26	180	0.99	49000	1.2	130	17
OTR Units	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g
Region	All	All	All	All	All	All	All	All	All	All
LCL	0.22	24000	11	21	150	0.87	40000	0.81	21	15
UCL	0.5	28000	61	62	300	1.1	110000	2.6	410	22
Π	0.91	0.9	0.9	0.91	0.9	0.9	0.9	0.9	0.85	0.9
$\bar{x}$CV (%)	19	5	32	9.3	10	7.8	4.6	24	27	11
N	96	97	97	96	97	97	97	97	76	97
10th percentile	0.04	7600	1.4	2.6	31	0.5	3400	0.14	5	3.5
25th percentile	0.05	9400	2.4	4.6	44	0.5	5800	0.21	8.2	4.8
Median	0.078	12000	3.5	10	61	0.5	11000	0.32	12	5.9
75th percentile	0.15	17000	5.4	15	91	0.63	20000	0.44	23	8.4
IQR	0.099	7900	3	10	48	0.13	14000	0.24	15	3.6
90th percentile	0.21	22000	9.3	20	120	0.8	32000	0.68	37	13
Average	0.11	13000	5.5	11	74	0.59	15000	0.39	25	7.2
SD	0.085	5600	8	8.7	45	0.15	16000	0.34	52	3.9
Skewness	1.9	0.77	5.2	2.3	1.9	1.6	2.9	3.6	5.9	1.5
Kurtosis	4.7	-0.18	31	10	5.4	1.7	12	18	39	2.1
RL (µg / g)	0.05	200	0.2	0.5	0.5	0.5	100	0.05	0.5	0.2

Table 8.1b: Cr, Cu, F, Fe, Hg, K, Mg, Mn and Mo OTRs, Soil-Old Urban Parks

Variable	Cr	Cu	F	Fe	Hg	K	Mg	Mn	Mo
OTR_{98}	63	66	110	34000	0.27	4900	15000	1400	1.3
OTR Units	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g
Region	All	All	All	All	All	All	All	All	All
LCL	46	45	100	30000	0.15	4500	13000	980	0.5
UCL	83	100	150	71000	0.47	6600	23000	3200	2.2
Π	0.9	0.9	0.91	0.9	0.9	0.9	0.9	0.9	0.91
$\bar{x}$CV (%)	5.8	20	2.3	5.6	11	11	8	15	23
N	97	97	96	97	97	97	97	97	95
10th percentile	13	7.9	12	11000	0.029	690	2100	180	0.2
25th percentile	16	11	20	14000	0.043	1000	3100	250	0.2
Median	22	15	34	18000	0.065	1800	4500	410	0.33
75th percentile	30	25	66	23000	0.099	3000	8100	600	0.5
IQR	14	14	46	8300	0.057	2000	5000	350	0.3
90th percentile	39	38	94	29000	0.12	4300	11000	780	0.67
Average	25	21	44	19000	0.08	2100	6000	500	0.42
SD	13	16	33	8400	0.069	1400	3900	460	0.31
Skewness	1.9	2.4	0.91	2.5	3.3	0.88	1.4	3.9	2.9
Kurtosis	4.3	7.5	0.021	13	14	-0.003	2.4	19	12
RL (µg / g)	1	1	0.5	200	0.01	5	50	5	0.2

Table 8.2c: Na, Ni, TKN, P, Pb, S, Sb and Se OTRs, Soil-Old Urban Parks

Variable	Na	Na	Na	Ni	TKN	P	Pb	S	Sb	Se
OTR_{98}	170	180	1000	50	7	1.5	120	0.11	0.99	1.1
OTR Units	µg / g	µg / g	µg / g	µg / g	mg/g	mg/g	µg / g	%	µg / g	µg / g
Region	1	2	3,4,5,6	All	All	All	All	All	All	All
LCL	110	67	250	34	4.7	1.4	86	0.059	0.83	0.83
UCL	180	180	1200	77	17	2.1	420	0.14	2.6	2.6
Π	0.33	0.32	0.81	0.9	0.91	0.91	0.9	0.88	0.9	0.9
$\bar{x}$CV (%)	10	9.9	16	31	7.5	4.5	8.8	8.7	15	16
N	16	15	66	97	96	96	97	84	97	97
10th percentile	100	61	110	6.8	1.6	0.53	13	0.025	0.2	0.2
25th percentile	110	78	160	8.5	2.1	0.7	21	0.033	0.2	0.26
Median	140	95	190	12	2.8	0.82	32	0.045	0.22	0.37
75th percentile	150	130	270	19	3.5	1.1	49	0.059	0.33	0.5
IQR	42	53	120	10	1.4	0.38	28	0.026	0.13	0.25
90th percentile	170	160	460	28	4.5	1.3	66	0.078	0.56	0.71
Average	140	110	270	16	3.2	0.89	42	0.049	0.35	0.44
SD	28	40	220	12	2	0.32	49	0.023	0.36	0.34
Skewness	0.022	0.4	2.4	2.5	3.8	0.76	5.3	1.1	4.6	3.8
Kurtosis	-1.5	-1.1	6	7.7	20	1.2	35	1.7	24	20
RL (µg / g)	5	5	5	0.5	0.0001	0.00002	2	10	0.2	0.2

Table 8.2d: Sr, Ti, U, V and Zn OTRs, Soil-Old Urban Parks

Variable	Sr	Ti	U	V	Zn
OTR_{98}	77	4700	1.9	72	180
OTR Units	µg / g	µg / g	µg / g	µg / g	µg / g
Region	All	All	All	All	All
LCL	63	3500	1.6	57	150
UCL	130	6900	2.5	91	310
Π	0.9	0.88	0.91	0.9	0.9
$\bar{x}$CV (%)	6.8	7.4	15	7.6	14
N	97	85	96	97	97
10th percentile	15	1800	0.33	22	34
25th percentile	20	2400	0.5	26	49
Median	27	3000	0.79	32	66
75th percentile	36	3500	1.1	40	90
IQR	16	1100	0.61	14	41
90th percentile	53	3900	1.5	52	120
Average	31	3000	0.88	35	76
SD	18	960	0.47	14	46
Skewness	2.1	0.45	0.93	1.5	2.3
Kurtosis	6.5	2.4	0.79	2.8	8.1
RL (µg / g)	1	10	0.2	1	5

Table 8.3: Soil – Rural Parks

Table 8.3a: Ag, Al, As, B, Ba, Be, Ca, Cd, and Cl OTRs, Soil-Rural Parks

Variable	Ag	Ag	Al	As	B	Ba	Be	Ca	Cd	Cl
OTR_{98}	0.27	0.5	30000	11	30	170	1.1	54000	0.7	35
OTR Units	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g
Region	1,2,3,4,5	6	All	All	All	All	All	All	All	All
LCL	0.15	0.02	29000	9.8	28	150	0.97	39000	0.6	29
UCL	0.31	0.5	36000	30	48	210	1.2	64000	1	57
Π	0.89	0.4	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
$\bar{x}$CV (%)	18	46	8.4	16	9.1	13	5.3	6	11	0.24
n	87	20	110	110	110	110	110	110	110	110
10th percentile	0.045	0.02	6700	1.1	5.2	32	0.5	2100	0.097	0.5
25th percentile	0.068	0.02	10000	1.8	7.8	44	0.5	3600	0.16	4.7
median	0.11	0.03	14000	2.8	12	69	0.5	6400	0.21	8.8
75th percentile	0.15	0.072	18000	4.8	17	95	0.57	13000	0.32	16
IQR	0.082	0.052	7500	3	9.3	50	0.067	9700	0.16	11
90th percentile	0.2	0.5	25000	7.5	23	130	0.81	23000	0.5	25
average	0.12	0.11	15000	3.8	13	74	0.58	11000	0.27	12
SD	0.063	0.17	6600	3.6	7.8	40	0.16	12000	0.18	10
skewness	0.87	1.7	0.84	4	1.2	1.1	2.4	2.4	1.7	1.8
kurtosis	0.53	1.2	0.61	24	2.7	1.1	5.4	5.6	4	4.6
RL (µg / g)	0.05	0.05	200	0.2	0.5	0.5	0.5	100	0.05	0.5

Table 8.3b: Co, Cr, Cu, F, Fe, Hg, K, Mg, Mn and Mo OTRs, Soil-Rural Parks

Variable	Co	Cr	Cu	F	Fe	Hg	Hg	K	Mg	Mn	Mo
OTR_{98}	16	58	46	84	36000	0.13	0.13	6500	19000	1900	0.984
OTR Units	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g
Region	All	All	All	All	All	1,2,3,4,5	6	All	All	All	All
LCL	15	55	39	48	34000	0.075	0.019	5600	15000	1700	0.750
UCL	19	79	380	140	45000	0.24	0.14	9100	36000	4700	4.400
Π	0.88	0.88	0.88	0.88	0.88	0.89	0.4	0.88	0.88	0.88	0.881
$\bar{x}$CV (%)	6.9	7.4	18	13	3.3	8.8	13	7.3	17	0.27	0.096
N	110	110	110	110	110	87	20	110	110	110	104
10th percentile	3.6	13	6.5	3.6	11000	0.035	0.015	560	1500	160	0.200
25th percentile	5.2	17	9.2	9.2	16000	0.045	0.019	840	2500	240	0.200
Median	6.7	22	15	16	20000	0.058	0.031	1400	3900	520	0.200
75th percentile	9.3	30	21	24	24000	0.075	0.058	2700	6700	860	0.242
IQR	4	12	11	15	7800	0.031	0.039	1800	4300	620	0.042
90th percentile	13	39	34	32	30000	0.092	0.12	4500	11000	1300	0.537
Average	7.5	25	21	20	21000	0.063	0.048	2000	5600	660	0.321
SD	3.6	12	37	21	7000	0.033	0.041	1700	5300	620	0.449
Skewness	0.94	1.7	8.5	3.4	0.55	2.2	1	1.7	2.6	3.1	7.416
Kurtosis	0.5	3.5	78	15	0.54	8.5	-0.54	2.9	9.7	15	62.687
RL (µg / g)	0.2	1	1	0.5	200	0.01	0.01	5	50	5	0.2

Table 8.3c: Na, Ni, TKN, P, Pb, S and Sb OTRs, Soil-Rural Parks

Variable	Na	Ni	TKN	P	P	P	Pb	Pb	Pb	S	Sb
OTR_{98}	690	34	5.9	0.83	1.1	2.2	34	120	38	0.079	0.45
OTR Units	µg / g	µg / g	mg/g	mg/g	mg/g	mg/g	µg / g	µg / g	µg / g	%	µg / g
Region	All	All	All	1	2,3,5,6	4	1,3,4,5	2	6	All	All
LCL	590	29	4.6	0.55	0.83	0.75	24	23	10	0.076	0.43
UCL	1600	48	6.3	0.84	1.4	2.2	74	130	44	0.094	0.47
Π	0.88	0.88	0.88	0.35	0.84	0.35	0.83	0.35	0.4	0.88	0.88
$\bar{x}$CV (%)	5.6	4.6	17	3.1	7.4	11	8.8	25	9.2	12	50
N	110	110	110	17	72	17	70	17	20	110	110
10th percentile	75	5.5	1.1	0.47	0.28	0.66	14	17	6.5	0.017	0.2
25th percentile	110	8.4	1.8	0.55	0.42	0.75	17	23	9	0.027	0.2
Median	160	12	2.3	0.58	0.68	1.1	20	33	12	0.037	0.2
75th percentile	270	19	3	0.68	0.87	1.2	25	46	20	0.049	0.27
IQR	160	10	1.2	0.13	0.45	0.42	8	24	11	0.022	0.067
90th percentile	400	25	4	0.78	0.96	1.8	29	79	30	0.063	0.36
Average	220	14	2.5	0.59	0.65	1.1	22	42	16	0.039	0.25
SD	210	8.3	1.2	0.15	0.27	0.49	8.7	32	10	0.018	0.071
Skewness	3.7	1.4	1.1	-0.58	0.029	1.1	3.2	1.6	1.2	0.64	1.7
Kurtosis	19	2.4	1.4	0.53	-0.48	0.061	17	1.6	0.46	0.17	2.1
RL (µg / g)	5	0.5	0.0001	0.00002	0.00002	0.00002	2	2	2	10	0.2

Table 8.3d: Se, Sr, Ti, U, V and Zn OTRs, Soil-Rural Parks

Variable	Se	Sr	Ti	Ti	U	U	V	Zn
OTR_{98}	0.91	63	5500	4500	2.1	1.3	86	160
OTR Units	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g	µg / g
Region	All	All	1,2,3,4,5	6	1,2,3,4,5	6	All	All
LCL	0.77	47	3700	1600	1.3	0.5	75	120
UCL	2	150	7300	4600	9.7	1.5	170	240
Π	0.88	0.88	0.89	0.4	0.89	0.37	0.88	0.88
$\bar{x}$CV (%)	15	9.2	7.3	9.4	15	21	9	44
N	110	110	87	20	87	18	110	110
10th percentile	0.2	11	2400	980	0.6	0.42	24	25
25th percentile	0.27	16	2700	1500	0.74	0.46	29	42
Median	0.37	23	3200	2000	0.96	0.59	36	56
75th percentile	0.52	31	3700	3300	1.3	0.75	46	76
IQR	0.25	14	1000	1900	0.58	0.28	17	35
90th percentile	0.61	41	4600	4200	1.8	0.97	65	110
Average	0.42	26	3400	2400	1.2	0.66	41	64
SD	0.25	18	930	1300	1	0.3	20	38
Skewness	3.2	3.5	1.5	0.35	6.4	1.3	2.7	1.9
Kurtosis	15	19	3.1	-1.2	50	1.4	12	5.4
RL (µg / g)	0.2	1	10	10	0.2	0.2	1	5

Petroleum Hydrocarbons and BTEX

During consultation on the standards some stakeholders had expressed a lack of confidence in the accuracy of the OTR results for volatile organic compounds, particularly for BTEX. This concern, plus the need for background numbers for PHCs prompted the Ministry to conduct a study to determine the background concentrations of these compounds in conjunction with the Canadian Petroleum Producers Institute. The analytical methods used had very low detection limits suitable for an uncontaminated background sampling study, but which may not be practicly achievable in normal field work . The study was completed and the results made available in the spring of 2010 The results of this study are presented below.

Table 8.3e BTEX and PHCs Soil – Rural Parklands

Parameter	Benzene	Ethylbenzene	Toluene	Xylenes (total)	F1	[b]F2	F3	F4
[a]BTV(µg/g)	**0.005**	**0.005**	**0.025**	**0.007**	**17.24**		**240.2**	**119.1**
Region	All	All	All	All	All	All	All	All
Number of samples	90	90	90	90	90	90	90	90
Number distinct data	8	6	18	8	8	2	47	19
Number of detects	12	12	42	13	10	2	76	25
Reporting limit (µg/g)	0.002	0.002	0.002	0.002	10	10	10	10
% non-detects	87	87	53	86	89	98	16	72
Maximum detected	0.009	0.01	0.05	0.013	22		660	340
Minimum detected	0.002	0.002	0.002	0.002	10		12	10

[a]Background Threshold Value (BTV) – this value is based on the upper tolerance limit (UTL) calculated by Kaplan-Meier nonparametric method which represents the upper confidence limit (UCL) of the 97.5th percentile of the ranked data.

[b]BTV could not be calculated as there are only two data points over the detection limit.

Table 8.3f BTEX and PHCs in Soil – Old Urban Parklands

Parameter	Benzene	Ethylbenzene	Toluene	Xylenes (total)	F1	[b]F2	F3	F4
[a]BTV (µg/g)	**0.006**	**0.003**	**0.02**	**0.009**	**25**		**145**	**61**
Region	All	All	All	All	All	All	All	All
Number of samples	89	89	89	89	89	89	89	89
Number of distinct data	8	4	15	9	5	1	48	19
Number of detects	27	[c] 4	57	22	[c] 5	2		
Reporting Limit (µg/g)	0.002	0.002	0.002	0.002	10	10	10	10
% non-detects	70	82	36	75	94		19	71
Max Detected	0.009	0.005	0.036	0.018	58		380	140
Min Detected	0.002	0.002	0.002	0.002	11		11	10

[a]Background Threshold Value (BTV) – this value is based on the upper tolerance limit (UTL) calculated by Kaplan-Meier nonparametric method which represents the upper confidence limit (UCL) of the 97.5th percentile of the ranked data.

[b]BTV could not be calculated as there are only two data points over the detection limit.

[c]It should be noted that there very few detected values and the resulting calculations of BTV values may not be reliable enough to draw calculations.

8.3.2 Groundwater

Groundwater and sediment standards for the background approach were not provided in the 1996 Guidelines. These portions of the tables are therefore new and are now incorporated in the Tables of Site Condition Standards under O.Reg 153/04.

At the time that the background values were originally required for the regulation, there was insufficient groundwater background data available to develop actual background -based numbers. As a result, the background groundwater standards in Table 1 of the 2004 regulation were derived by utilizing the lowest of available Ontario effects-based groundwater numbers. The lowest value of the Provincial Water Quality Objectives (1999), the Ontario Drinking Water Quality Standard, and the GW2 component value (groundwater value that is protective of movement from soil to indoor air) was used as an upper limit. Method Detection Limits provided by MOE Laboratory Services Branch were used as lower limits, unless the number was being driven by an ODWQS, in which case the ODWQS was used. These values were checked against available measured groundwater data from the 1998 Drinking Water Surveillance Program (DWSP) and were considered to be generally achievable in site situations typical of background while providing a level of human health and ecosystem protection consistent with background conditions and protective of sensitive ecosystems.

Since the development of the original groundwater substitute background numbers, the DWSP data for 1997, 1999, 2000, 2001 and 2002 were made available, and data from the Provincial Groundwater Monitoring Information System (PGMIS) from 2002 to 2007 has become available. The background groundwater values that are being proposed for the 2008 standards are the 97.5 percentile (i.e. equivalent to OTR_{98}) of the PGMIS data after exclusion of data from known contaminated wells. The 97.5 %iles were generated using SAS and ProUCL4 software. The algorithms will generate a 97.5%ile value even when less than 97.5% of the data are above the detection limit; however, the software indicated that for the numbers of samples in the database, there needed to be at least 10 distinct values for the 97.5%ile number generated to be reliable. As such, if there were fewer than 10 numbers above the detection limit, the MDL itself was used as the 97.5 %ile value. Where PGMIS data were lacking, the DWSP 97.5 percentile was used instead. For parameters for which there are no PGMIS or DWSP data, the process described in the above paragraph is followed. Note that the component tables in the appendix do not include these substitute values in the Ontario GW background column, as they are not used as a minimum value for effects based standards development. A summary of the PGMIS data is presented in Table 8.4 below. This summary includes information for substances that are not included in the Tables of Site Condition Standards,. These are provided as assistance to individuals needing information on other substances.

Table 8.4 Summary of PGMIS Data for Background Groundwater Concentrations – NOTE units are in column 2

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
1,1,1-trichloroethane	µg/L	407	4	99.02	0.05	0.05	0.1	2	0.05	0.05	0.05
1,1,2,2-tetrachloroethane	µg/L	407	1	99.75	0.1	0.2	2	2	0.2	0.2	0.2
1,1,2-trichloroethane	µg/L	407	1	99.75	0.1	0.1	2	2	0.1	0.1	0.1
1,1-dichloroethane	µg/L	407	6	98.53	0.05	0.05	0.05	2	0.05	0.05	0.1
1,1-dichloroethene	µg/L	407	2	99.51	0.05	0.05	0.2	2	0.05	0.05	0.05
1,2,3,4-tetrachlorobenzene	µg/L	395	0	100.00	1	1					
1,2,3,5-tetrachlorobenzene	µg/L	395	0	100.00	2	2					
1,2,3-trichlorobenzene	µg/L	395	0	100.00	5	5					
1,2,4,5-tetrachlorobenzene	µg/L	395	0	100.00	1	1					
1,2,4-trichlorobenzene	µg/L	395	0	100.00	5	5					
1,2-dibromoethane	µg/L	407	1	99.75	0.1	0.1	2	2	0.1	0.1	0.1
1,2-dichlorobenzene	µg/L	407	2	99.51	0.05	0.05	0.05	2	0.05	0.05	0.05
1,2-dichloroethane	µg/L	407	1	99.75	0.05	0.1	2	2	0.1	0.1	0.1
1,2-dichloropropane	µg/L	407	3	99.26	0.05	0.05	0.05	2	0.05	0.05	0.05
1,3,5-trichlorobenzene	µg/L	395	0	100.00	5	5					
1,3-dichlorobenzene	µg/L	407	1	99.75	0.05	0.05	2	2	0.05	0.05	0.05
1,4-dichlorobenzene	µg/L	407	18	95.58	0.05	0.05	0.05	2	0.05	0.1	0.4
2,3,4,5-tetrachlorophenol	ng/L	401	1	99.75	20	20	23	23	20	20	20
2,3,4,6-tetrachlorophenol	ng/L	401	2	99.50	20	20	45	420	20	20	20
2,3,4-trichlorophenol	ng/L	401	0	100.00	100	100					
2,3,6-trichlorotoluene	ng/L	395	0	100.00	5	5					
2,4,5-T	ng/L	401	0	100.00	50	50					
2,4,5-trichlorophenol	ng/L	401	0	100.00	100	100					
2,4,5-trichlorotoluene	ng/L	395	0	100.00	5	5					
2,4,6-trichlorophenol	ng/L	401	4	99.00	20	20	36	82	20	20	20
2,4-D	ng/L	401	0	100.00	100	100					

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
2,4-DB	ng/L	401	0	100.00	200	200					
2,4-dichlorophenol	ng/L	401	0	100.00	2000	2000					
2,4-D-propionic acid	ng/L	401	1	99.75	100	100	260	260	100	100	100
2,6-dichlorobenzyl chloride	ng/L	395	0	100.00	10	10					
a-BHC (hexachlorocyclohexane)	ng/L	402	0	100.00	1	1					
a-Chlordane	ng/L	402	0	100.00	2	2					
Alachlor	ng/L	398	0	100.00	500	500					
Aldicarb	ng/L	416	0	100.00	2500	2500					
Aldrin	ng/L	402	0	100.00	1	1					
Aldrin+Dieldrin	ng/L	8	0	100.00	3	3					
Alkalinity; total fixed endpt	mg/L	349	349	0.00			11.8	1340	392	550	720
Aluminum	µg/L	419	414	1.19	0.1	120	0.1	1440	20.3	86.9	333
Ametryne	µg/L	398	0	100.00	50	50					
Aminomethylphosphonic acid	µg/L	401	1	99.75	5	5	15	15	5	5	5
Antimony	µg/L	419	411	1.91	0.05	7.3	0.05	35.9	0.92	1.46	5.69
Arsenic	µg/L	416	399	4.09	0.1	4	0.1	48.2	7.5	13	15.5
Atratone	ng/L	398	0	100.00	50	50					
Atrazine	ng/L	398	4	98.99	50	50	78	150	50	50	78
Atrazine+de-alkylatedatrazine	ng/L	398	3	99.25	200	200	210	360	200	200	200
Azinphos-methyl	µg/L	414	0	100.00	0.05	0.05					
Barban	ng/L	416	0	100.00	2000	2000					
Barium	µg/L	419	417	0.48	0.2	111	3.27	2220	415	609	799
b-BHC (hexachlorocyclohexane)	ng/L	402	0	100.00	2	2					
Bendiocarb	ng/L	416	0	100.00	1500	1500					
Benzene	µg/L	407	21	94.84	0.05	0.05	0.05	5.2	0.05	0.15	0.55
Beryllium	µg/L	419	28	93.32	0.05	0.08	0.05	0.55	0.06	0.07	0.12
Boron	µg/L	419	416	0.72	2	810	2	9410	923	1650	2870
Bromodichloromethane	µg/L	407	8	98.03	0.2	0.2	0.4	13	0.2	0.2	0.6

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
Bromoform	µg/L	407	2	99.51	0.5	0.5	0.5	2	0.5	0.5	0.5
Bromoxynil	ng/L	401	0	100.00	50	50					
Butachlor	ng/L	398	0	100.00	200	200					
Butylate	ng/L	416	0	100.00	2000	2000					
Cadmium	µg/L	419	35	91.65	0.05	0.39	0	0.41	0.07	0.11	0.3
Calcium	mg/L	417	417	0.00			3.4	1170	190	431	546
Carbaryl	ng/L	416	0	100.00	200	200					
Carbofuran	ng/L	416	0	100.00	2000	2000					
Carbon tetrachloride	µg/L	407	1	99.75	0.2	0.2	2	2	0.2	0.2	0.2
Carbon; dissolved inorganic	mg/L	418	417	0.24	0.2	0.2	3.3	1180	97.5	131	164
Carbon; dissolved organic	mg/L	420	414	1.43	0.1	0.5	0.2	154	6.45	9.8	34.7
Chlordane; total	ng/L	8	0	100.00	6	6					
Chloride	mg/L	419	419	0.00			0.3	11700	529	790	3170
Chlorobenzene	µg/L	407	1	99.75	0.05	0.05	2	2	0.05	0.05	0.05
Chlorobromuron	ng/L	411	0	100.00	2000	2000					
Chloroethene	µg/L	407	1	99.75	0	0.05	2	2	0.05	0.05	0.05
Chloroform	µg/L	407	49	87.96	0.1	0.1	0.1	273	0.5	2	18.4
Chlorotoluron	ng/L	411	0	100.00	2000	2000					
Chlorpropham	ng/L	416	0	100.00	2000	2000					
Chlorpyrifos	µg/L	414	0	100.00	0.1	0.1					
Chromium	µg/L	416	396	4.81	0.5	8.9	0.5	106	8.5	11.4	21.7
cis-1,2-dichloroethene	µg/L	407	3	99.26	0.05	0.05	0.05	2	0.05	0.05	0.05
Cobalt	µg/L	419	393	6.21	0.02	1.2	0.01	16.4	1.69	3.84	5.09
Conductivity	µS/cm	349	349	0.00			87	26200	2240	3160	13200
Copper	µg/L	419	214	48.93	0.5	3.4	0.5	39.1	2.9	4.3	5.9
Cyanazine	ng/L	398	0	100.00	100	100					
DDT; total	ng/L	8	0	100.00	17	17					
De-ethylated atrazine	ng/L	398	1	99.75	200	200	220	220	200	200	200
De-ethylated simazine	ng/L	398	0	100.00	200	200					

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
Diallate	ng/L	416	0	100.00	2000	2000					
Diazinon	µg/L	414	0	100.00	0.2	0.2					
Dibromochloromethane	µg/L	407	3	99.26	0.2	0.2	0.6	2.8	0.2	0.2	0.2
Dicamba	ng/L	401	0	100.00	50	50					
Dichloromethane	µg/L	407	9	97.79	0.2	0.5	0.2	30.5	0.5	0.5	1
Dichlorvos	µg/L	414	0	100.00	0.5	0.5					
Diclofop-methyl	ng/L	401	0	100.00	100	100					
Dieldrin	ng/L	402	0	100.00	2	2					
Difenoxuron	ng/L	411	0	100.00	2000	2000					
Dimethoate	µg/L	414	0	100.00	0.5	0.5					
Dinoseb	ng/L	401	0	100.00	20	20					
Diquat	µg/L	398	1	99.75	0.1	0.1	0.2	0.2	0.1	0.1	0.1
Diuron	ng/L	411	0	100.00	2000	2000					
Endosulphan I	ng/L	402	0	100.00	2	2					
Endosulphan II	ng/L	402	0	100.00	5	5					
Endosulphan sulphate	ng/L	402	0	100.00	5	5					
Endrin	ng/L	402	0	100.00	5	5					
Eptam	ng/L	416	0	100.00	2000	2000					
Ethion	µg/L	414	0	100.00	0.2	0.2					
Ethylbenzene	µg/L	407	16	96.07	0.05	0.05	0.05	2	0.05	0.1	0.2
Fluometuron	ng/L	411	0	100.00	2000	2000					
Fluoride	mg/L	420	415	1.19	0.01	0.01	0.02	3.67	1.695	2.09	2.61
g-BHC (hexachlorocyclohexane)	ng/L	402	1	99.75	1	1	5	5	1	1	1
g-Chlordane	ng/L	402	0	100.00	2	2					
Glyphosate	µg/L	401	1	99.75	2	2	2	2	2	2	2
Hardness	mg/L	411	411	0.00			17.5	6150	787	1380	2250
Heptachlor	ng/L	402	0	100.00	1	1					
Heptachlor epoxide	ng/L	402	0	100.00	2	2					
Heptachlor+Heptachlor Epoxide	ng/L	8	0	100.00	3	3					

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
Hexachlorobenzene	ng/L	395	1	99.75	1	1	9	9	1	1	1
Hexachlorobutadiene	ng/L	395	1	99.75	1	1	2	2	1	1	1
Hexachlorocyclopentadiene	ng/L	395	2	99.49	1	1	2	88	1	1	1
Hexachloroethane	µg/L	395	0	100.00	1	1					
Iron	µg/L	418	350	16.27	6	4700	6	28900	2430	4090	12400
Lead	µg/L	419	164	60.86	0.05	5	0.05	78.6	0.85	1.91	6.02
Linuron	ng/L	411	0	100.00	2000	2000					
m- and p-xylene	µg/L	118	23	80.51	0.05	0.05	0.05	11.4	0.15	2	2.7
Magnesium	mg/L	417	417	0.00			0.3	1020	74	134	255
Malathion	µg/L	414	0	100.00	0.5	0.5					
Manganese	µg/L	418	410	1.91	0.05	122	0.06	7800	276	717	1110
MCPA,4Cl2MePhenoxy-AceticAcid	ng/L	316	0	100.00	20	20					
MCPB,4Cl2MePhenoxy-ButyricAcid	ng/L	316	0	100.00	20	20					
MCPP,2-4Cl2MePhenoxy-PropAcid	ng/L	316	2	99.37	20	20	31	32	20	20	20
Methoxychlor	ng/L	402	0	100.00	5	5					
Methylparathion	µg/L	414	0	100.00	0.2	0.2					
Metobromuron	ng/L	411	0	100.00	2000	2000					
Metolachlor	ng/L	398	0	100.00	500	500					
Metoxuron	ng/L	411	0	100.00	2000	2000					
Metribuzin	ng/L	398	0	100.00	100	100					
Mevinphos	µg/L	414	0	100.00	0.2	0.2					
Mirex	ng/L	402	0	100.00	5	5					
Molybdenum	µg/L	419	400	4.53	0.05	6.5	0.05	83.4	14.7	22.7	41.4
Monolinuron	ng/L	411	0	100.00	2000	2000					
Monuron	ng/L	411	0	100.00	2000	2000					
m-xylene	µg/L	289	69	76.12	0.05	0.05	0.05	0.55	0.15	0.2	0.3
Neburon	ng/L	411	0	100.00	2000	2000					
Nickel	µg/L	419	345	17.66	0.2	5.3	0	68.5	8.8	14	17.8
Nitrogen; ammonia+ammonium	mg/L	351	149	57.55	0.05	0.05	0.05	109	1.71	3.95	5.86

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
Nitrogen; nitrate+nitrite	mg/L	351	158	54.99	0.05	0.05	0.05	32.2	7.12	11.5	15.8
Nitrogen; nitrite	mg/L	351	109	68.95	0.005	0.005	0.005	1.17	0.059	0.121	0.224
Nitrogen; total Kjeldahl	mg/L	420	356	15.24	0.02	0.05	0.03	132	3.525	5.65	11.6
Octachlorostyrene	ng/L	402	1	99.75	1	1	12	12	1	1	1
op-DDT	ng/L	402	0	100.00	5	5					
Oxychlordane	ng/L	402	0	100.00	2	2					
o-xylene	µg/L	407	28	93.12	0.05	0.05	0.05	2	0.05	0.1	0.3
Paraquat	µg/L	398	0	100.00	0.1	0.1					
Parathion	µg/L	414	0	100.00	0.1	0.1					
PCB; total	ng/L	402	13	96.77	20	20	20	124	20	26	60
Pentachlorobenzene	ng/L	395	1	99.75	1	1	2	2	1	1	1
Pentachlorophenol	ng/L	401	9	97.76	10	10	11	250	10	10	30
Permethrin	ng/L	254	24	90.55	100	100	100	100	100	100	100
pH	None	349	349	0.00			6.56	9.59	8.52	8.67	9.11
Phenolics; 4-AAP	µg/L	406	140	65.52	0.1	2	0.3	86.8	5.3	13.7	25.2
Phorate	µg/L	414	0	100.00	0.1	0.1					
Phosphorus; phosphate	mg/L	351	80	77.21	0.02	0.02	0.02	3.88	0.08	0.21	0.38
Phosphorus; total	mg/L	420	245	41.67	0.002	0.02	0.003	108	3.315	7.97	36.2
Picloram	ng/L	401	0	100.00	100	100					
Piperonyl Butoxide	ng/L	254	24	90.55	100	100	100	100	100	100	100
Potassium	mg/L	417	417	0.00			0.25	80.6	11.8	20.7	37.5
pp-DDD	ng/L	402	0	100.00	5	5					
pp-DDE	ng/L	402	1	99.75	2	2	4	4	2	2	2
pp-DDT	ng/L	402	0	100.00	5	5					
Prometone	ng/L	398	0	100.00	50	50					
Prometryne	ng/L	398	0	100.00	50	50					
Propazine	ng/L	398	0	100.00	50	50					
Propham	ng/L	416	0	100.00	2000	2000					
Propoxur	ng/L	416	0	100.00	2000	2000					

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
p-xylene	µg/L	289	0	100.00	0.05	0.05					
Pyrethrin 1	ng/L	254	24	90.55	100	100	100	100	100	100	100
Pyrethrin 2	ng/L	256	26	89.84	100	100	100	100	100	100	100
Reldan	µg/L	414	0	100.00	0.5	0.5					
Ronnel	µg/L	414	0	100.00	0.1	0.1					
Selenium	µg/L	416	99	76.20	1	8	1	83	2	5	7
Siduron	ng/L	411	0	100.00	2000	2000					
Silicon; reactive silicate	µg/L	420	419	0.24	0.02	0.02	0.18	66.5	10.03	11.6	20
Silver	µg/L	419	7	98.33	0.05	0.07	0	0.41	0.05	0.05	0.07
Silvex	ng/L	401	0	100.00	20	20					
Simazine	µg/L	398	3	99.25	50	50	54	96	50	50	50
Sodium	mg/L	417	417	0.00			0.8	4940	276	489	1470
Solids; dissolved	mg/L	418	418	0.00			57	22300	2110	3010	7640
Strontium	µg/L	419	417	0.48	2.8	4100	26.9	58500	13300	20200	35000
Styrene	µg/L	407	1	99.75	0.05	0.05	2	2	0.05	0.05	0.05
Sulphate	mg/L	420	397	5.48	0.5	0.5	0.6	5220	297	1070	1560
Temephos	µg/L	414	0	100.00	0.1	0.1					
Terbufos	µg/L	414	0	100.00	0.2	0.2					
Terbutryne	ng/L	398	0	100.00	200	200					
Tert-butyl methyl ether	µg/L	406	1	99.75	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Tetrachloroethene	µg/L	407	11	97.30	0.05	0.05	0.1	2	0.05	0.1	0.3
Thallium	µg/L	419	27	93.56	0.05	3.4	0.02	37.4	0.05	0.1	0.19
Titanium	µg/L	419	143	65.87	0.5	12.2	0.5	37	2.3	4.8	10.5
Toluene	µg/L	407	138	66.09	0.05	0.05	0.05	6.05	0.4	0.8	2.35
Toxaphene	ng/L	402	0	100.00	500	500					
trans-1,2-dichloroethene	µg/L	407	2	99.51	0.05	0.05	0.2	2	0.05	0.05	0.05
Triallate	ng/L	416	0	100.00	1500	1500					
Trichloroethene	µg/L	407	5	98.77	0.05	0.05	0.05	2	0.05	0.05	0.05
Trifluralin	ng/L	402	1	99.75	5	5	8	8	5	5	5

COC	Units	N	# Detected	% Non-Detects	Min Detection Limit	Max Detection Limit	Min Detected	Max Detected	95th%	97.5th%	99th%)
Trihalomethanes ; total	µg/L	406	20	95.07	0.5	0.5	0.5	274	0.5	2	18.5
Uranium	µg/L	419	329	21.48	0.05	3.1	0.05	38.2	5.09	8.89	10.8
Vanadium	µg/L	416	367	11.78	0.05	2.1	0.05	35.9	2.7	3.87	9.24
Zinc	µg/L	419	412	1.67	0.2	1700	0.2	21900	63.1	159	613

Table 8.5 Summary of DWSP Data for Background Groundwater Concentrations – NOTE - units in **µg/L unless otherwise stated**

COC	N	# Detected	% Non-Detects	Min Detection Limit (µg/L)	Max Detection Limit (µg/L)	Min Detected (µg/L)	Max Detected (µg/L)	95th% (µg/L)	97.5th% (µg/L)	99th% (µg/L)
1,1,1-trichloroethane	877	23	97.38	0.05	0.05	0.05	0.3	0.05	0.05	0.1
1,1,2,2-tetrachloroethane	878	0	100	0.1	0.1	n/a	n/a	0.1	0.1	0.1
1,1,2-trichloroethane	878	0	100	0.1	0.1	n/a	n/a	0.1	0.1	0.1
1,1-dichloroethane	878	4	99.54	0.05	0.05	0.1	0.25	0.05	0.05	0.05
1,1-dichloroethene	878	1	99.89	0.05	0.05	0.05	0.05	0.05	0.05	0.05
1,2,4-trichlorobenzene	42	0	100	0.005	0.005	n/a	n/a	0.005	0.005	0.005
1,2-dichlorobenzene	878	878	0	0.05	0.05	n/a	n/a	0.05	0.05	0.05
1,2-dichloroethane	878	1	99.89	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1,2-dichloropropane	878	10	98.86	0.05	0.05	0.35	2.1	0.05	0.05	0.373
1,3-dichlorobenzene	878	878	0	0.05	0.05	n/a	n/a	0.05	0.05	0.05
1,4-dichlorobenzene	878	876	0.23	0.05	0.05	0.05	0.15	0.05	0.05	0.05
2,4,5-trichlorophenol	29	0	0.1	0.1	0.1	n/a	n/a	0.1	0.1	0.1
2,4,6-trichlorophenol	29	1	96.55	0.02	0.02	0.042	0.042	0.020	0.027	0.036
a-Chlordane	42	42	0	0.002	2	n/a	n/a	0.002	0.002	0.002

COC	N	# Detected	% Non-Detects	Min Detection Limit (µg/L)	Max Detection Limit (µg/L)	Min Detected (µg/L)	Max Detected (µg/L)	95th% (µg/L)	97.5th% (µg/L)	99th% (µg/L)
Aldrin	42	0	100	0.001	0.001	n/a	n/a	0.001	0.001	0.001
Antimony	751	744	0.93	0.05	0.05	0.03	14.6	0.9	1.01	1.435
Anthracene	17	0	100	0.01	0.01	n/a	n/a	0.01	0.01	0.01
Arsenic	751	740	1.46	0.1	0.1	0.1	8.4	2.96	4.65	7.27
Barium	751	751	0	n/a	n/a	4.64	900	373.5	582.5	662.5
Benzene	922	3	99.68	0.05	0.05	0.05	0.15	0.05	0.05	0.05
Benzo(a)anthracene	17	0	100	0.02	0.02	n/a	n/a	0.02	0.02	0.02
Benzo(a)pyrene	17	0	100	0.001	0.005	n/a	n/a	0.005	0.005	0.005
Benzo(b)fluoranthene	17	0	10	0.01	0.01	n/a	n/a	0.01	0.01	0.01
Benzo(g,h,i) perylene	17	0	100	0.02	0.02	n/a	n/a	0.02	0.02	0.02
Benzo(k) fluoranthene	17	0	100	0.01	0.01	n/a	n/a	0.01	0.01	0.01
Beryllium	748	697	6.82	0.05	0.05	0.05	1.45	0.072	0.1126	0.223
Boron	751	748	0.40	2	2	2	925	235	420.5	481.5
Bromodichloromethane	872	4	99.54	0.2	0.2	0.2	6.2	0.2	0.2	0.2
Bromoform	873	2	99.77	0.5	0.5	1	7	0.5	0.5	0.5
Cadmium	751	721	3.99	0.05	0.05	0.05	0.58	0.1	0.132	0.185
Carbon tetrachloride	883	1	99.89	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Chlordane, alpha	42	0	100	0.002	0.002	n/a	n/a	0.002	0.002	0.002
Chlordane, gamma	42	0	100	0.002	0.002	n/a	n/a	0.002	0.002	0.002
Chloride	877	876	0.11	200	200	400	278 000	132 000	193 000	213 240
Chlorobenzene	883	0	100	0.05	0.05	n/a	n/a	0.05	0.05	0.05
Chloroform	867	32	96.31	0.1	0.1	0.1	44.6	0.1	0.1	0.1
Chromium, total	747	744	0.40	0.5	0.5	0.05	53.3	11.23	14.47	22.49
Chrysene	17	0	100	0.01	0.01	n/a	n/a	0.01	0.01	0.01
Cobalt	747	700	6.29	0.02	0.02	0.02	3.2	0.27	0.3435	0.6011
Copper	747	720	3.61	0.5	0.5	0.5	756	5.67	8.58	15.56
Cyanide, free	2	0	100	0.001	0.001	n/a	n/a	0.001	0.001	0.001
Dibenzo(a,h)antrhacene	17	0	100	0.02	0.02	n/a	n/a	0.02	0.02	0.02
1,2-dichlorobenzene (o-DCB)	878	0	100	0.05	0.05	n/a	n/a	0.05	0.05	0.05

COC	N	# Detected	% Non-Detects	Min Detection Limit (µg/L)	Max Detection Limit (µg/L)	Min Detected (µg/L)	Max Detected (µg/L)	95th% (µg/L)	97.5th% (µg/L)	99th% (µg/L)
1,3-dichlorobenzene (m-DCB)	878	0	100	0.05	0.05	n/a	n/a	0.05	0.05	0.05
1,4-dichlorobenzene (p-DCB)	878	2	99.77	0.052662	0.05	0.05106	0.05232	0.05	0.05	0.05
Dieldrin	42	0	100	0.002	0.002	n/a	n/a	0.002	0.002	0.002
Endosulphan I	42	0	100	0.002	0.002	n/a	n/a	0.002	0.002	0.002
Endosulphan II	42	0	100	0.005	0.005	n/a	n/a	0.005	0.005	0.005
Endosulphan sulphate	42	0	100	0.005	0.005	n/a	n/a	0.005	0.005	0.005
Endrin	42	0	100	0.005	0.005	n/a	n/a	0.005	0.005	0.005
Ethylbenzene	878	38	98.5	0.05	0.05	0.05	0.25	0.05	0.05	0.05
Ethylene Dibromide	878	0	100	0.1	0.1	n/a	n/a	0.1	0.1	0.1
Fluoranthene	17	0	100	0.01	0.01	n/a	n/a	0.01	0.01	0.01
Fluoride	881	880	0.11	0.01	0.01	0.02	2.38	1.76	2.08	2.184
g-BHC (hexachlorocyclohexane)	42	0	100	0.001	0.001	n/a	n/a	0.001	0.001	0.001
Heptachlor	42	0	100	0.001	0.001	n/a	n/a	0.001	0.001	0.001
Heptachlor epoxide	42	0	100	0.001	0.002	n/a	n/a	0.002	0.002	0.002
Hexachlorobenzene	42	0	100	0.001	0.001	n/a	n/a	0.001	0.001	0.001
Hexachlorobutadiene	42	0	100	0.001	0.001	n/a	n/a	0.001	0.001	0.001
Hexachloroethane	42	0	100	0.001	0.001	n/a	n/a	0.001	0.001	0.001
Indeno(1,2,3-cd)pyrene	17	0	100	0.02	0.02	n/a	n/a	0.02	0.02	0.02
Lead	745	705	5.4	0.05	0.05	0.05	12	0.4382	0.7204	1.4184
Mercury	31	0	100	0.02	0.02	n/a	n/a	0.02	0.02	0.02
Methylene Chloride	875	1	99.9	0.05	0.05	4	4	0.5	0.5	0.5
Molybdenum	747	747	0	n/a	n/a	0	14.8	4.64	5.978	7.4568
Nickel	746	683	8.4	0.2	0.2	0.2	12.7	3.883	4.8	5.865
Nitrates; total	892	864	23.32	5	5	6	12400	5180	8020	10510
Nitrite	892	492	44.84	1	1	2	267	20	50	100
Nitrogen; total Kjeldahl	889	863	2.92	200	200	300	2500	1024	1354	1540
Pentachlorophenol	29	0	100	0.01	0.01	n/a	n/a	0.01	0.01	0.01
Phenanthrene	17	0	100	0.01	0.01	n/a	n/a	0.01	0.01	0.01

COC	N	# Detected	% Non-Detects	Min Detection Limit (µg/L)	Max Detection Limit (µg/L)	Min Detected (µg/L)	Max Detected (µg/L)	95th% (µg/L)	97.5th% (µg/L)	99th% (µg/L)
Pyrene	17	0	100	0.01	0.01	n/a	n/a	0.01	0.01	0.01
Selenium	746	690	7.5	1	1	1	14	5	9.625	12.165
Silver	746	672	9.9	0.05	0.05	0.05	3.8	0.05	0.05	0.05
Sodium	883	882	0.11	200	200	1000	350 000	184 000	259 000	293 000
Styrene	878	65	92.60	0.05	0.05	0.4	0.05	0.05	0.15	0.2
Thallium	747	678	9.24	0.05	0.05	0.05	0.585	0.05	0.05	0.06
Tetrachloroethylene	878	3	99.66	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Toluene	877	840	4.2189	0.05	0.05	0.05	0.35	0.05	0.05	0.112
Trichloroethene	877	13	98.52	0.05	0.05	0.05	4.75	0.05	0.05	0.124
Vanadium	747	744	0.40	0.05	0.05	0.05	5.81	1.924	2.311	2.721
Vinyl Chloride	876	2	99.8	0.05	0.05	0.1	0.1	0.05	0.05	0.05
Zinc	747	745	0.28	0.2	0.2	0.2	159	15.44	42.06	115.5

8.3.3 Sediment

The background sediment standards in Table 1 are the same standards (Lowest Effect Levels) provided in Table E of the 1996 Guidelines and used for the Table 2 - 5 full depth generic and stratified site condition standards. These values are, with the sole exception of hexachlorobenzene, within an order of magnitude of the mean of measured background sediment where data are available in the 1993 Sediment Guidelines and, as such, are reasonably representative of an upper level of background. They are considered to provide a level of human health and ecosystem protection consistent with background and protective of sensitive ecosystems.

Although there are some background concentrations presented in the sediment quality guidelines document, they are mean values and do not represent upper limits of background. Use of mean values would be problematic in that up to half of uncontaminated sites in the Great Lakes basin could be expected to fail such criteria. These values would not be suitable for contaminated sites as they could force up to half of uncontaminated sites into risk assessment.

8.4 Chemical Specific Considerations

There are some chemicals for which special considerations have been made due to unusual circumstances. This section describes the situations where the final standards may not reflect the process as described in the rest of this document

1) **Lead** – As described in section 2, the direct soil contact values for human health for lead were taken directly from the 1993 multimedia assessment documentation. This documentation was very thorough, including a complete assessment of dietary intake, and a review of the values therein indicated that the numbers derived were still the most appropriate available at this time. Pending another multimedia assessment including a review of the most recently available toxicity information, it was decided to continue to utilize the previous assessment. Hence the values of 200 mg/kg and 1000 mg/kg were used for S1 and S2 respectively. In order to have values for industrial subsoils that did not default back to background, the value of 1,000mg/kg was also used as the S3 value.
2) **Sodium and Chloride** – The effects of sodium and chloride on plants and soil invertebrates are most appropriatesly covered by use of the parameters “electrical conductivity” and sodium adsorption ratio”. As a result, there is no need to have standards for sodium and chloride in surface soils, and the standard is set at Not Applicable (NA). However, for subsurface soils where the ecological component is removed, there are no component values left as EC and SAR have been removed. As a result, the subsurface values in Tables 4 and 5 are set as No Value (NV).
3) **Uranium** – The CCME has recently done an exhaustive report on uranium with considerable consulation, and with significant input from Ontario. As a result, it was decided that the CCME terrestrial ecological numbers as well as CCME human health direct contact numbers would be adopted directly.

4) **Boron** – Plant effects based numbers for boron are based on analysis using a hot water extract (HWSB) as opposed to a virtual total. Since plants are the most sensitive receptor, the standards where protection of plants is important are based on the hot water extract. However, for situations where plants are not important (e.g. subsurface soils) the virtual total (acid digest) value is used and the HWSB is not applicable.

8.5 References

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APPENDICES

APPENDIX A1: Tables of Site Condition Standards

APPENDIX A2: Summary Tables of Components for Soil Standards

APPENDIX A3: Summary Table of Components for Groundwater Standards

APPENDIX B1: Physical, Chemical and Toxicological Properties

APPENDIX B2: Ecological Toxicity Information

TABLE 1: Full Depth Background Site Condition Standards

Table 1	Soil (other than sediment) µg/g		Ground Water (µg/L)	Sediment (µg/g)
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All Types of Property Uses	All Types of Property Uses
Acenaphthene	0.05	0.072	4.1	NV
Acenaphthylene	0.093	0.093	1	NV
Acetone	0.5	0.5	2700	NV
Aldrin	0.05	0.05	0.01	0.002
Anthracene	0.05	0.16	0.1	0.22
Antimony	1	1.3	1.5	NV
Arsenic	11	18	13	6
Barium	210	220	610	NV
Benzene	0.02	0.02	0.5	NV
Benz[a]anthracene	0.095	0.36	0.2	0.32
Benzo[a]pyrene	0.05	0.3	0.01	0.37
Benzo[b]fluoranthene	0.3	0.47	0.1	NV
Benzo[ghi]perylene	0.2	0.68	0.2	0.17
Benzo[k]fluoranthene	0.05	0.48	0.1	0.24
Beryllium	2.5	2.5	0.5	NV
Biphenyl 1,1'-	0.05	0.05	0.5	NV
Bis(2-chloroethyl)ether	0.5	0.5	5	NV
Bis(2-chloroisopropyl)ether	0.5	0.5	120	NV
Bis(2-ethylhexyl)phthalate	5	5	10	NV
Boron (Hot Water Soluble)*	NA	NA	NA	NA
Boron (total)	36	36	1700	NV
Bromodichloromethane	0.05	0.05	2	NV
Bromoform	0.05	0.05	5	NV
Bromomethane	0.05	0.05	0.89	NV
Cadmium	1	1.2	0.5	0.6
Carbon Tetrachloride	0.05	0.05	0.2	NV
Chlordane	0.05	0.05	0.06	0.007
Chloroaniline p-	0.5	0.5	10	NV
Chlorobenzene	0.05	0.05	0.5	NV
Chloroform	0.05	0.05	2	NV
Chlorophenol, 2-	0.1	0.1	8.9	NV
Chromium Total	67	70	11	26
Chromium VI	0.66	0.66	25	NV
Chrysene	0.18	2.8	0.1	0.34
Cobalt	19	21	3.8	50
Copper	62	92	5	16
Cyanide (CN-)	0.051	0.051	5	0.1
Dibenz[a h]anthracene	0.1	0.1	0.2	0.06
Dibromochloromethane	0.05	0.05	2	NV
Dichlorobenzene, 1,2-	0.05	0.05	0.5	NV
Dichlorobenzene, 1,3-	0.05	0.05	0.5	NV
Dichlorobenzene, 1,4-	0.05	0.05	0.5	NV
Dichlorobenzidine, 3,3'-	1	1	0.5	NV
Dichlorodifluoromethane	0.05	0.05	590	NV
DDD	0.05	0.05	1.8	0.008
DDE	0.05	0.05	10	0.005
DDT	0.078	1.4	0.05	0.007
Dichloroethane, 1,1-	0.05	0.05	0.5	NV
Dichloroethane, 1,2-	0.05	0.05	0.5	NV
Dichloroethylene, 1,1-	0.05	0.05	0.5	NV
Dichloroethylene, 1,2-cis-	0.05	0.05	1.6	NV
Dichloroethylene, 1,2-trans-	0.05	0.05	1.6	NV
Dichlorophenol, 2,4-	0.1	0.1	20	NV
Dichloropropane, 1,2-	0.05	0.05	0.5	NV
Dichloropropene,1,3-	0.05	0.05	0.5	NV
Dieldrin	0.05	0.05	0.05	0.002

Table 1	Soil (other than sediment) µg/g		Ground Water (µg/L)	Sediment (µg/g)
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All Types of Property Uses	All Types of Property Uses
Diethyl Phthalate	0.5	0.5	30	NV
Dimethylphthalate	0.5	0.5	30	NV
Dimethylphenol, 2,4-	0.2	0.2	10	NV
Dinitrophenol, 2,4-	2	2	10	NV
Dinitrotoluene, 2,4 & 2,6-	0.5	0.5	5	NV
Dioxane, 1,4	0.2	0.2	50	NV
Dioxin/Furan (TEQ)	0.000007	0.000007	0.000015	NV
Endosulfan	0.04	0.04	0.05	NV
Endrin	0.04	0.04	0.05	0.003
Ethylbenzene	0.05	0.05	0.5	NV
Ethylene dibromide	0.05	0.05	0.2	NV
Fluoranthene	0.24	0.56	0.4	0.75
Fluorene	0.05	0.12	120	0.19
Heptachlor	0.05	0.05	0.01	NV
Heptachlor Epoxide	0.05	0.05	0.01	0.005
Hexachlorobenzene	0.01	0.01	0.01	0.02
Hexachlorobutadiene	0.01	0.01	0.01	NV
Hexachlorocyclohexane Gamma-	0.01	0.01	0.01	NV
Hexachloroethane	0.01	0.01	0.01	NV
Hexane (n)	0.05	0.05	5	NV
Indeno[1 2 3-cd]pyrene	0.11	0.23	0.2	0.2
Lead	45	120	1.9	31
Mercury	0.16	0.27	0.1	0.2
Methoxychlor	0.05	0.05	0.05	NV
Methyl Ethyl Ketone	0.5	0.5	400	NV
Methyl Isobutyl Ketone	0.5	0.5	640	NV
Methyl Mercury **	NV	NV	0.12	NV
Methyl tert-Butyl Ether (MTBE)	0.05	0.05	15	NV
Methylene Chloride	0.05	0.05	5	NV
Methlynaphthalene, 2-(1-) ***	0.05	0.59	2	NV
Molybdenum	2	2	23	NV
Naphthalene	0.05	0.09	7	NV
Nickel	37	82	14	16
Pentachlorophenol	0.1	0.1	0.5	NV
Petroleum Hydrocarbons F1****	17	25	420	NV
Petroleum Hydrocarbons F2	10	10	150	NV
Petroleum Hydrocarbons F3	240	240	500	NV
Petroleum Hydrocarbons F4	120	120	500	NV
Phenanthrene	0.19	0.69	0.1	0.56
Phenol	0.5	0.5	5	NV
Polychlorinated Biphenyls	0.3	0.3	0.2	0.07
Pyrene	0.19	1	0.2	0.49
Selenium	1.2	1.5	5	NV
Silver	0.5	0.5	0.3	0.5
Styrene	0.05	0.05	0.5	NV
Tetrachloroethane, 1,1,1,2-	0.05	0.05	1.1	NV
Tetrachloroethane, 1,1,2,2-	0.05	0.05	0.5	NV
Tetrachloroethylene	0.05	0.05	0.5	NV
Thallium	1	1	0.5	NV
Toluene	0.2	0.2	0.8	NV
Trichlorobenzene, 1,2,4-	0.05	0.05	0.5	NV
Trichloroethane, 1,1,1-	0.05	0.05	0.5	NV
Trichloroethane, 1,1,2-	0.05	0.05	0.5	NV
Trichloroethylene	0.05	0.05	0.5	NV
Trichlorofluoromethane	0.05	0.25	150	NV
Trichlorophenol, 2,4,5-	0.1	0.1	0.2	NV
Trichlorophenol, 2,4,6-	0.1	0.1	0.2	NV
Uranium	1.9	2.5	8.9	NV
Vanadium	86	86	3.9	NV
Vinyl Chloride	0.02	0.02	0.5	NV

Table 1	Soil (other than sediment) µg/g		Ground Water (µg/L)	Sediment (µg/g)
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All Types of Property Uses	All Types of Property Uses
Xylene Mixture	0.05	0.05	72	NV
Zinc	290	290	160	120
Electrical Conductivity (mS/cm)	0.47	0.57	NA	NA
Chloride	NA	NA	790000	NV
Sodium Adsorption Ratio	1	2.4	NA	NA
Sodium	NA	NA	490000	NV

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition

Table 2	Soil Standards (other than sediment) µg/g			Potable Ground Water µg/L
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Acenaphthene	(29) 7.9	(29) 7.9	(29) 21	4.1
Acenaphthylene	(0.17) 0.15	(0.17) 0.15	(0.17) 0.15	1
Acetone	(28) 16	(28) 16	(28) 16	2700
Aldrin	0.05	0.05	(0.11) 0.088	0.35
Anthracene	(0.74) 0.67	(0.74) 0.67	(0.74) 0.67	2.4
Antimony	7.5	7.5	(50) 40	6
Arsenic	11	18	18	25
Barium	390	390	670	1000
Benzene	(0.17) 0.21	(0.17) 0.21	(0.4) 0.32	5
Benz[a]anthracene	(0.63) 0.5	(0.63) 0.5	0.96	1
Benzo[a]pyrene	0.078	0.3	0.3	0.01
Benzo[b]fluoranthene	0.78	0.78	0.96	0.1
Benzo[ghi]perylene	(7.8) 6.6	(7.8) 6.6	9.6	0.2
Benzo[k]fluoranthene	0.78	0.78	0.96	0.1
Beryllium	(5) 4	(5) 4	(10) 8	4
Biphenyl 1,1'-	(1.1) 0.31	(1.1) 0.31	(210) 52	0.5
Bis(2-chloroethyl)ether	0.5	0.5	0.5	5
Bis(2-chloroisopropyl)ether	(1.8) 0.67	(1.8) 0.67	(13) 11	120
Bis(2-ethylhexyl)phthalate	5	5	(35) 28	10
Boron (Hot Water Soluble)*	1.5	1.5	2	NA
Boron (total)	120	120	120	5000
Bromodichloromethane	(1.9) 1.5	(1.9) 1.5	(1.9) 1.5	16
Bromoform	(0.26) 0.27	(0.26) 0.27	(1.7) 0.61	25
Bromomethane	0.05	0.05	0.05	0.89
Cadmium	1	1.2	1.9	2.7
Carbon Tetrachloride	(0.12) 0.05	(0.12) 0.05	(0.71) 0.21	(5) 0.79
Chlordane	0.05	0.05	0.05	7
Chloroaniline p-	(0.53) 0.5	(0.53) 0.5	(0.53) 0.5	10
Chlorobenzene	(2.7) 2.4	(2.7) 2.4	(2.7) 2.4	30
Chloroform	(0.18) 0.05	(0.18) 0.05	(0.18) 0.47	(22) 2.4
Chlorophenol, 2-	(2) 1.6	(2) 1.6	(3.9) 3.1	8.9
Chromium Total	160	160	160	50
Chromium VI	(10) 8	(10) 8	(10) 8	25
Chrysene	(7.8) 7	(7.8) 7	9.6	0.1
Cobalt	22	22	(100) 80	3.8
Copper	(180) 140	(180) 140	(300) 230	87
Cyanide (CN-)	0.051	0.051	0.051	66
Dibenz[a h]anthracene	0.1	0.1	0.1	0.2
Dibromochloromethane	(2.9) 2.3	(2.9) 2.3	(2.9) 2.3	25
Dichlorobenzene, 1,2-	(1.7) 1.2	(1.7) 1.2	(1.7) 1.2	3
Dichlorobenzene, 1,3-	(6) 4.8	(6) 4.8	(12) 9.6	59
Dichlorobenzene, 1,4-	(0.097) 0.083	(0.097) 0.083	(0.57) 0.2	1
Dichlorobenzidine, 3,3'-	1	1	1	0.5
Dichlorodifluoromethane	(25) 16	(25) 16	(25) 16	590
DDD	3.3	3.3	4.6	10
DDE	(0.33) 0.26	(0.33) 0.26	(0.65) 0.52	10
DDT	0.078	1.4	1.4	2.8
Dichloroethane, 1,1-	(0.6) 0.47	(0.6) 0.47	(0.6) 0.47	5
Dichloroethane, 1,2-	0.05	0.05	0.05	(5) 1.6
Dichloroethylene, 1,1-	0.05	0.05	(0.48) 0.064	(14) 1.6
Dichloroethylene, 1,2-cis-	(2.5) 1.9	(2.5) 1.9	(2.5) 1.9	(17) 1.6
Dichloroethylene, 1,2-trans-	(0.75) 0.084	(0.75) 0.084	(2.5) 1.3	(17) 1.6
Dichlorophenol, 2,4-	(0.27) 0.19	(0.27) 0.19	(0.27) 0.19	20
Dichloropropane, 1,2-	(0.085) 0.05	(0.085) 0.05	(0.68) 0.16	5
Dichloropropene,1,3-	(0.081) 0.05	(0.081) 0.05	(0.081) 0.059	0.5
Dieldrin	0.05	0.05	(0.11) 0.088	0.35

Table 2	Soil Standards (other than sediment) µg/g			Potable Ground Water µg/L
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Diethyl Phthalate	0.5	0.5	0.5	38
Dimethylphthalate	0.5	0.5	0.5	38
Dimethylphenol, 2,4-	(53) 38	(53) 38	(53) 38	59
Dinitrophenol, 2,4-	(2.9) 2	(2.9) 2	(2.9) 2	10
Dinitrotoluene, 2,4 & 2,6-	0.5	0.5	0.5	5
Dioxane, 1,4	0.2	1.8	1.8	50
Dioxin/Furan (TEQ)	0.000013	0.000013	0.000099	0.000015
Endosulfan	0.04	0.04	(0.38) 0.3	1.5
Endrin	0.04	0.04	0.04	0.48
Ethylbenzene	(1.6) 1.1	(1.6) 1.1	(1.6) 1.1	2.4
Ethylene dibromide	0.05	0.05	0.05	0.2
Fluoranthene	0.69	0.69	9.6	0.41
Fluorene	(69) 62	(69) 62	(69) 62	120
Heptachlor	0.15	0.15	0.19	1.5
Heptachlor Epoxide	0.05	0.05	0.05	0.048
Hexachlorobenzene	0.52	0.52	0.66	1
Hexachlorobutadiene	(0.014) 0.012	(0.014) 0.012	(0.095) 0.031	(0.6) 0.44
Hexachlorocyclohexane Gamma-	(0.063) 0.056	(0.063) 0.056	(0.063) 0.056	1.2
Hexachloroethane	(0.071) 0.089	(0.071) 0.089	(0.43) 0.21	2.1
Hexane (n)	(34) 2.8	(34) 2.8	(88) 46	(520) 51
Indeno[1 2 3-cd]pyrene	(0.48) 0.38	(0.48) 0.38	(0.95) 0.76	0.2
Lead	45	120	120	10
Mercury	(1.8) 0.25	(1.8) 0.27	(20) 3.9	(1) 0.29
Methoxychlor	0.13	0.13	1.6	6.5
Methyl Ethyl Ketone	(44) 16	(44) 16	(88) 70	1800
Methyl Isobutyl Ketone	(4.3) 1.7	(4.3) 1.7	(210) 31	640
Methyl Mercury **	(0.0094) 0.0084	(0.0094) 0.0084	(0.0094) 0.0084	0.15
Methyl tert-Butyl Ether (MTBE)	(1.4) 0.75	(1.4) 0.75	(2.3) 1.6	15
Methylene Chloride	(0.96) 0.1	(0.96) 0.1	(2) 1.6	50
Methlynaphthalene, 2-(1-) ***	(3.4) 0.99	(3.4) 0.99	(42) 30	3.2
Molybdenum	6.9	6.9	40	70
Naphthalene	(0.75) 0.6	(0.75) 0.6	(28) 9.6	11
Nickel	(130) 100	(130) 100	(340) 270	100
Pentachlorophenol	0.1	0.1	(3.3) 2.9	30
Petroleum Hydrocarbons F1****	(65) 55	(65) 55	(65) 55	750
Petroleum Hydrocarbons F2	(150) 98	(150) 98	(250) 230	150
Petroleum Hydrocarbons F3	(1300) 300	(1300) 300	(2500) 1700	500
Petroleum Hydrocarbons F4	(5600) 2800	(5600) 2800	(6600) 3300	500
Phenanthrene	(7.8) 6.2	(7.8) 6.2	(16) 12	1
Phenol	9.4	9.4	9.4	890
Polychlorinated Biphenyls	0.35	0.35	1.1	3
Pyrene	78	78	96	4.1
Selenium	2.4	2.4	5.5	10
Silver	(25) 20	(25) 20	(50) 40	1.5
Styrene	(2.2) 0.7	(2.2) 0.7	(43) 34	5.4
Tetrachloroethane, 1,1,1,2-	(0.05) 0.058	(0.05) 0.058	(0.11) 0.087	1.1
Tetrachloroethane, 1,1,2,2-	0.05	0.05	(0.094) 0.05	1
Tetrachloroethylene	(2.3) 0.28	(2.3) 0.28	(2.5) 1.9	(17) 1.6
Thallium	1	1	3.3	2
Toluene	(6) 2.3	(6) 2.3	(9) 6.4	24
Trichlorobenzene, 1,2,4-	(1.4) 0.36	(1.4) 0.36	(16) 3.2	70
Trichloroethane, 1,1,1-	(3.4) 0.38	(3.4) 0.38	(12) 6.1	200
Trichloroethane, 1,1,2-	0.05	0.05	(0.11) 0.05	(5) 4.7
Trichloroethylene	(0.52) 0.061	(0.52) 0.061	(0.61) 0.55	(5) 1.6
Trichlorofluoromethane	(5.8) 4	(5.8) 4	(5.8) 4	150
Trichlorophenol, 2,4,5-	(5.5) 4.4	(5.5) 4.4	(10) 9.1	8.9
Trichlorophenol, 2,4,6-	(2.9) 2.1	(2.9) 2.1	(2.9) 2.1	2
Uranium	23	23	33	20
Vanadium	86	86	86	6.2
Vinyl Chloride	(0.022) 0.02	(0.022) 0.02	(0.25) 0.032	(1.7) 0.5

Table 2	Soil Standards (other than sediment) µg/g			Potable Ground Water µg/L
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Xylene Mixture	(25) 3.1	(25) 3.1	(30) 26	300
Zinc	340	340	340	1100
Electrical Conductivity (mS/cm)	0.7	0.7	1.4	NA
Chloride	NA	NA	NA	790000
Sodium Adsorption Ratio	5	5	12	NA
Sodium	NA	NA	NA	490000

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

Table 3	Soil Standards (other than sediment) µg/g		Non- Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Acenaphthene	(58) 7.9	96	(1700) 600
Acenaphthylene	(0.17) 0.15	(0.17) 0.15	1.8
Acetone	(28) 16	(28) 16	130000
Aldrin	0.05	(0.11) 0.088	8.5
Anthracene	(0.74) 0.67	(0.74) 0.67	2.4
Antimony	7.5	(50) 40	20000
Arsenic	18	18	1900
Barium	390	670	29000
Benzene	(0.17) 0.21	(0.4) 0.32	(430) 44
Benz[a]anthracene	(0.63) 0.5	0.96	4.7
Benzo[a]pyrene	0.3	0.3	0.81
Benzo[b]fluoranthene	0.78	0.96	0.75
Benzo[ghi]perylene	(7.8) 6.6	9.6	0.2
Benzo[k]fluoranthene	0.78	0.96	0.4
Beryllium	(5) 4	(10) 8	67
Biphenyl 1,1'-	(1.1) 0.31	(210) 52	(2200) 1000
Bis(2-chloroethyl)ether	0.5	0.5	300000
Bis(2-chloroisopropyl)ether	(1.8) 0.67	(14) 11	20000
Bis(2-ethylhexyl)phthalate	5	(35) 28	140
Boron (Hot Water Soluble)*	1.5	2	NA
Boron (total)	120	120	45000
Bromodichloromethane	13	18	85000
Bromoform	(0.26) 0.27	(1.7) 0.61	(770) 380
Bromomethane	0.05	0.05	(56) 5.6
Cadmium	1.2	1.9	2.7
Carbon Tetrachloride	(0.12) 0.05	(1.5) 0.21	(8.4) 0.79
Chlordane	0.05	0.05	28
Chloroaniline p-	(0.53) 0.5	(0.53) 0.5	400
Chlorobenzene	(2.7) 2.4	(2.7) 2.4	630
Chloroform	(0.18) 0.05	(0.18) 0.47	(22) 2.4
Chlorophenol, 2-	(2) 1.6	(3.9) 3.1	3300
Chromium Total	160	160	810
Chromium VI	(10) 8	(10) 8	140
Chrysene	(7.8) 7	9.6	1
Cobalt	22	(100) 80	66
Copper	(180) 140	(300) 230	87
Cyanide (CN-)	0.051	0.051	66
Dibenz[a h]anthracene	0.1	0.1	0.52
Dibromochloromethane	9.4	13	82000
Dichlorobenzene, 1,2-	(4.3) 3.4	(8.5) 6.8	(9600) 4600
Dichlorobenzene, 1,3-	(6) 4.8	(12) 9.6	9600
Dichlorobenzene, 1,4-	(0.097) 0.083	(0.84) 0.2	(67) 8
Dichlorobenzidine, 3,3'-	1	1	640
Dichlorodifluoromethane	(25) 16	(25) 16	4400
DDD	3.3	4.6	45
DDE	(0.33) 0.26	(0.65) 0.52	20
DDT	1.4	1.4	2.8
Dichloroethane, 1,1-	(11) 3.5	(21) 17	(3100) 320
Dichloroethane, 1,2-	0.05	0.05	(12) 1.6
Dichloroethylene, 1,1-	0.05	(0.48) 0.064	(17) 1.6
Dichloroethylene, 1,2-cis-	(30) 3.4	(37) 55	(17) 1.6
Dichloroethylene, 1,2-trans-	(0.75) 0.084	(9.3) 1.3	(17) 1.6
Dichlorophenol, 2,4-	(2.1) 1.7	(4.2) 3.4	4600
Dichloropropane, 1,2-	(0.085) 0.05	(0.68) 0.16	(140) 16
Dichloropropene,1,3-	(0.083) 0.05	(0.21) 0.18	(45) 5.2
Dieldrin	0.05	(0.11) 0.088	0.75

Table 3	Soil Standards (other than sediment) µg/g		Non- Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Diethyl Phthalate	0.5	0.5	38
Dimethylphthalate	0.5	0.5	38
Dimethylphenol, 2,4-	(420) 390	(440) 390	39000
Dinitrophenol, 2,4-	38	(66) 59	11000
Dinitrotoluene, 2,4 & 2,6-	0.92	1.2	2900
Dioxane, 1,4	1.8	1.8	(7300000)1900000
Dioxin/Furan (TEQ)	0.000013	0.000099	(0.023) 0.014
Endosulfan	0.04	(0.38) 0.3	1.5
Endrin	0.04	0.04	0.48
Ethylbenzene	(15) 2	(19) 9.5	2300
Ethylene dibromide	0.05	0.05	(0.83) 0.25
Fluoranthene	0.69	9.6	130
Fluorene	(69) 62	(69) 62	400
Heptachlor	0.15	0.19	2.5
Heptachlor Epoxide	0.05	0.05	0.048
Hexachlorobenzene	0.52	0.66	3.1
Hexachlorobutadiene	(0.014) 0.012	(0.095) 0.031	(4.5) 0.44
Hexachlorocyclohexane Gamma-	(0.063) 0.056	(0.063) 0.056	1.2
Hexachloroethane	(0.071) 0.089	(0.43) 0.21	(200) 94
Hexane (n)	(34) 2.8	(88) 46	(520) 51
Indeno[1 2 3-cd]pyrene	(0.48) 0.38	(0.95) 0.76	0.2
Lead	120	120	25
Mercury	(1.8) 0.27	(20) 3.9	(2.8) 0.29
Methoxychlor	0.13	1.6	6.5
Methyl Ethyl Ketone	(44) 16	(88) 70	(1500000) 470000
Methyl Isobutyl Ketone	(4.3) 1.7	(210) 31	(580000) 140000
Methyl Mercury **	(0.0094) 0.0084	(0.0094) 0.0084	0.15
Methyl tert-Butyl Ether (MTBE)	(1.4) 0.75	(3.2) 11	(1400) 190
Methylene Chloride	(0.96) 0.1	(2) 1.6	(5500) 610
Methlynaphthalene, 2-(1-) ***	(3.4) 0.99	(85) 76	1800
Molybdenum	6.9	40	9200
Naphthalene	(0.75) 0.6	(28) 9.6	(6400) 1400
Nickel	(130) 100	(340) 270	490
Pentachlorophenol	0.1	(3.3) 2.9	62
Petroleum Hydrocarbons F1****	(65) 55	(65) 55	750
Petroleum Hydrocarbons F2	(150) 98	(250) 230	150
Petroleum Hydrocarbons F3	(1300) 300	(2500) 1700	500
Petroleum Hydrocarbons F4	(5600) 2800	(6600) 3300	500
Phenanthrene	(7.8) 6.2	(16) 12	580
Phenol	9.4	9.4	12000
Polychlorinated Biphenyls	0.35	1.1	(15) 7.8
Pyrene	78	96	68
Selenium	2.4	5.5	63
Silver	(25) 20	(50) 40	1.5
Styrene	(2.2) 0.7	(43) 34	(9100) 1300
Tetrachloroethane, 1,1,1,2-	(0.05) 0.058	(0.11) 0.087	(28) 3.3
Tetrachloroethane, 1,1,2,2-	0.05	(0.094) 0.05	(15) 3.2
Tetrachloroethylene	(2.3) 0.28	(21) 4.5	(17) 1.6
Thallium	1	3.3	510
Toluene	(6) 2.3	(78) 68	18000
Trichlorobenzene, 1,2,4-	(1.4) 0.36	(16) 3.2	(850) 180
Trichloroethane, 1,1,1-	(3.4) 0.38	(12) 6.1	(6700) 640
Trichloroethane, 1,1,2-	0.05	(0.11) 0.05	(30) 4.7
Trichloroethylene	(0.52) 0.061	(0.61) 0.91	(17) 1.6
Trichlorofluoromethane	(5.8) 4	(5.8) 4	2500
Trichlorophenol, 2,4,5-	(5.5) 4.4	10	1600
Trichlorophenol, 2,4,6-	(4.2) 3.8	(4.2) 3.8	230
Uranium	23	33	420
Vanadium	86	86	250
Vinyl Chloride	(0.022) 0.02	(0.25) 0.032	(1.7) 0.5

Table 3	Soil Standards (other than sediment) µg/g		Non- Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Xylene Mixture	(25) 3.1	(30) 26	4200
Zinc	340	340	1100
Electrical Conductivity (mS/cm)	0.7	1.4	#N/A
Chloride	NA	NA	2300000
Sodium Adsorption Ratio	5	12	NA
Sodium	NA	NA	2300000

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 4: Stratified Site Condition Standards in a Potable Ground Water Condition

Table 4	Soil Standards (other than sediment) µg/g				Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use		Industrial/ Commercial/Community Property Use		All Types of Property Use
	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	
Acenaphthene	(29) 7.9	(29) 7.9	(29) 21	(29) 21	4.1
Acenaphthylene	(0.17) 0.15	(0.17) 0.15	(0.17) 0.15	(0.17) 0.15	1
Acetone	(28) 16	(28) 16	(28) 16	(28) 16	2700
Aldrin	0.05	4.7	(0.11) 0.088	6.3	0.35
Anthracene	(0.74) 0.67	(0.74) 0.67	(0.74) 0.67	(0.74) 0.67	2.4
Antimony	7.5	63	(50) 40	63	6
Arsenic	18	18	18	47	25
Barium	390	(8600) 7700	670	(8600) 7700	1000
Benzene	(0.17) 0.21	(0.17) 0.21	(0.4) 0.32	(1.3) 0.92	5
Benz[a]anthracene	(0.63) 0.5	0.96	0.96	36	1
Benzo[a]pyrene	0.3	0.3	0.3	3.6	0.01
Benzo[b]fluoranthene	0.78	0.96	0.96	36	0.1
Benzo[ghi]perylene	(7.8) 6.6	9.6	9.6	360	0.2
Benzo[k]fluoranthene	0.78	0.96	0.96	36	0.1
Beryllium	(5) 4	60	(10) 8	60	4
Biphenyl 1,1'-	(1.1) 0.31	(83) 11	(210) 52	(210) 52	0.5
Bis(2-chloroethyl)ether	0.5	0.5	0.5	0.5	5
Bis(2-chloroisopropyl)ether	(1.8) 0.67	(13) 11	(13) 11	(13) 11	120
Bis(2-ethylhexyl)phthalate	5	(1200) 830	(35) 28	(1200) 830	10
Boron (Hot Water Soluble)*	1.5	NA	2	NA	NA
Boron (total)	NA	(7900) 5000	NA	(7900) 5000	5000
Bromodichloromethane	(1.9) 1.5	(1.9) 1.5	(1.9) 1.5	(1.9) 1.5	16
Bromoform	(0.26) 0.27	(0.26) 0.27	(1.7) 0.61	(2.7) 2	25
Bromomethane	0.05	0.05	0.05	0.05	0.89
Cadmium	1.2	7.9	1.9	7.9	2.7
Carbon Tetrachloride	(0.12) 0.05	(0.12) 0.05	(0.71) 0.21	(0.71) 0.43	(5) 0.79
Chlordane	0.05	0.8	0.05	30	7
Chloroaniline p-	(0.53) 0.5	(0.53) 0.5	(0.53) 0.5	(0.53) 0.5	10
Chlorobenzene	(2.7) 2.4	(2.7) 2.4	(2.7) 2.4	(2.7) 2.4	30
Chloroform	(0.18) 0.05	(0.18) 0.05	(0.18) 0.47	(0.19) 0.85	(22) 2.4
Chlorophenol, 2-	(2) 1.6	(5.1) 3.7	(3.9) 3.1	(5.1) 3.7	8.9
Chromium Total	160	(18000) 11000	160	(18000) 11000	50
Chromium VI	(10) 8	40	(10) 8	40	25
Chrysene	(7.8) 7	9.6	9.6	(28) 20	0.1
Cobalt	22	250	(100) 80	2500	3.8
Copper	(180) 140	5600	(300) 230	5600	87
Cyanide (CN-)	0.051	0.051	0.051	0.051	66
Dibenz[a h]anthracene	0.1	0.1	0.1	3.6	0.2
Dibromochloromethane	(2.9) 2.3	(2.9) 2.3	(2.9) 2.3	(2.9) 2.3	25
Dichlorobenzene, 1,2-	(1.7) 1.2	(1.7) 1.2	(1.7) 1.2	(1.7) 1.2	3
Dichlorobenzene, 1,3-	(6) 4.8	(34) 24	(12) 9.6	(34) 24	59
Dichlorobenzene, 1,4-	(0.097) 0.083	(0.097) 0.083	(0.57) 0.2	(0.57) 0.39	1
Dichlorobenzidine, 3,3'-	1	1	1	1	0.5
Dichlorodifluoromethane	(25) 16	(25) 16	(25) 16	(25) 16	590
DDD	3.3	4.6	4.6	110	10
DDE	(0.33) 0.26	3.2	(0.65) 0.52	110	10
DDT	1.4	3.2	1.4	110	2.8
Dichloroethane, 1,1-	(0.6) 0.47	(0.6) 0.47	(0.6) 0.47	(0.6) 0.47	5
Dichloroethane, 1,2-	0.05	0.05	0.05	(0.05) 0.055	(5) 1.6
Dichloroethylene, 1,1-	0.05	0.05	(0.48) 0.064	(0.53) 0.12	(14) 1.6
Dichloroethylene, 1,2-cis-	(2.5) 1.9	(2.5) 1.9	(2.5) 1.9	(2.5) 1.9	(17) 1.6
Dichloroethylene, 1,2-trans-	(0.75) 0.084	(0.75) 0.084	(2.5) 1.3	(2.5) 1.9	(17) 1.6
Dichlorophenol, 2,4-	(0.27) 0.19	(0.27) 0.19	(0.27) 0.19	(0.27) 0.19	20
Dichloropropane, 1,2-	(0.085) 0.05	(0.085) 0.05	(0.68) 0.16	(0.74) 0.33	5
Dichloropropene,1,3-	(0.081) 0.05	(0.081) 0.05	(0.081) 0.059	(0.081) 0.059	0.5
Dieldrin	0.05	(0.12) 0.11	(0.11) 0.088	(0.12) 0.11	0.35

Table 4	Soil Standards (other than sediment) µg/g				Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use		Industrial/ Commercial/Community Property Use		All Types of Property Use
	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	
Diethyl Phthalate	0.5	0.5	0.5	0.5	38
Dimethylphthalate	0.5	0.5	0.5	0.5	38
Dimethylphenol, 2,4-	(53) 38	(53) 38	(53) 38	(53) 38	59
Dinitrophenol, 2,4-	(2.9) 2	(2.9) 2	(2.9) 2	(2.9) 2	10
Dinitrotoluene, 2,4 & 2,6-	0.5	0.5	0.5	0.5	5
Dioxane, 1,4	1.8	(7.7) 7.5	1.8	(7.7) 7.5	50
Dioxin/Furan (TEQ)	0.000013	0.00051	0.000099	(0.0026) 0.0018	0.000015
Endosulfan	0.04	(0.51) 0.46	(0.38) 0.3	(0.51) 0.46	1.5
Endrin	0.04	(0.079) 0.071	0.04	(0.079) 0.071	0.48
Ethylbenzene	(1.6) 1.1	(1.6) 1.1	(1.6) 1.1	(1.6) 1.1	2.4
Ethylene dibromide	0.05	0.05	0.05	0.05	0.2
Fluoranthene	0.69	9.6	9.6	(34) 24	0.41
Fluorene	(69) 62	(69) 62	(69) 62	(69) 62	120
Heptachlor	0.15	0.19	0.19	(2) 1.8	1.5
Heptachlor Epoxide	0.05	0.05	0.05	0.05	0.048
Hexachlorobenzene	0.52	0.66	0.66	(4) 2.9	1
Hexachlorobutadiene	(0.014) 0.012	(0.014) 0.012	(0.095) 0.031	(0.11) 0.06	(0.6) 0.44
Hexachlorocyclohexane Gamma-	(0.063) 0.056	(0.063) 0.056	(0.063) 0.056	(0.063) 0.056	1.2
Hexachloroethane	(0.071) 0.089	(0.071) 0.089	(0.43) 0.21	(0.69) 0.49	2.1
Hexane (n)	(34) 2.8	(34) 2.8	(88) 46	(88) 54	(520) 51
Indeno[1 2 3-cd]pyrene	(0.48) 0.38	0.96	(0.95) 0.76	36	0.2
Lead	120	1000	120	1000	10
Mercury	(1.8) 0.27	(1.8) 0.27	(20) 3.9	(30) 13	(1) 0.29
Methoxychlor	0.13	1.6	1.6	1.6	6.5
Methyl Ethyl Ketone	(44) 16	(180) 16	(88) 70	(310) 150	1800
Methyl Isobutyl Ketone	(4.3) 1.7	(66) 6.6	(210) 31	(210) 64	640
Methyl Mercury **	(0.0094) 0.0084	(0.0094) 0.0084	(0.0094) 0.0084	(0.0094) 0.0084	0.15
Methyl tert-Butyl Ether (MTBE)	(1.4) 0.75	(1.4) 0.75	(2.3) 1.6	(2.3) 1.6	15
Methylene Chloride	(0.96) 0.1	(0.96) 0.1	(2) 1.6	(5.7) 3	50
Methlynaphthalene, 2-(1-) ***	(3.4) 0.99	(42) 30	(42) 30	(42) 30	3.2
Molybdenum	6.9	1200	40	1200	70
Naphthalene	(0.75) 0.6	(4.6) 0.65	(28) 9.6	(130) 93	11
Nickel	(130) 100	510	(340) 270	510	100
Pentachlorophenol	0.1	(3.3) 2.9	(3.3) 2.9	(3.3) 2.9	30
Petroleum Hydrocarbons F1****	(65) 55	(65) 55	(65) 55	(65) 55	750
Petroleum Hydrocarbons F2	(150) 98	(150) 98	(250) 230	(250) 230	150
Petroleum Hydrocarbons F3	(1300) 300	(7200) 5800	(2500) 1700	(7200) 5800	500
Petroleum Hydrocarbons F4	(5600) 2800	(8000) 6900	(6600) 3300	(8000) 6900	500
Phenanthrene	(7.8) 6.2	(24) 17	(16) 12	(24) 17	1
Phenol	9.4	(53) 46	9.4	(53) 46	890
Polychlorinated Biphenyls	0.35	2.7	1.1	4.1	3
Pyrene	78	96	96	(330) 240	4.1
Selenium	2.4	1200	5.5	1200	10
Silver	(25) 20	490	(50) 40	490	1.5
Styrene	(2.2) 0.7	(19) 16	(43) 34	(66) 47	5.4
Tetrachloroethane, 1,1,1,2-	(0.05) 0.058	(0.05) 0.058	(0.11) 0.087	(0.14) 0.15	1.1
Tetrachloroethane, 1,1,2,2-	0.05	0.05	(0.094) 0.05	(0.11) 0.05	1
Tetrachloroethylene	(2.3) 0.28	(2.3) 0.28	(2.5) 1.9	(2.5) 1.9	(17) 1.6
Thallium	1	3.3	3.3	33	2
Toluene	(6) 2.3	(9) 6.2	(9) 6.4	(9) 6.4	24
Trichlorobenzene, 1,2,4-	(1.4) 0.36	(1.4) 0.36	(16) 3.2	(22) 10	70
Trichloroethane, 1,1,1-	(3.4) 0.38	(3.4) 0.38	(12) 6.1	(12) 9.8	200
Trichloroethane, 1,1,2-	0.05	0.05	(0.11) 0.05	(0.13) 0.068	(5) 4.7
Trichloroethylene	(0.52) 0.061	(0.52) 0.061	(0.61) 0.55	(0.69) 0.55	(5) 1.6
Trichlorofluoromethane	(5.8) 4	(5.8) 4	(5.8) 4	(5.8) 4	150
Trichlorophenol, 2,4,5-	(5.5) 4.4	(13) 9.1	(10) 9.1	(13) 9.1	8.9
Trichlorophenol, 2,4,6-	(2.9) 2.1	(2.9) 2.1	(2.9) 2.1	(2.9) 2.1	2
Uranium	23	300	33	300	20
Vanadium	86	160	86	160	6.2
Vinyl Chloride	(0.022) 0.02	(0.022) 0.02	(0.25) 0.032	(0.25) 0.057	(1.7) 0.5

Table 4	Soil Standards (other than sediment) µg/g				Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use		Industrial/ Commercial/Community Property Use		All Types of Property Use
	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	
Xylene Mixture	(25) 3.1	(25) 3.1	(30) 26	(30) 26	300
Zinc	340	(24000) 15000	340	(24000) 15000	1100
Electrical Conductivity (mS/cm)	0.7	NA	1.4	NA	N/A
Chloride	NA	NV	NA	NV	790000
Sodium Adsorption Ratio	5	NA	12	NA	N/A
Sodium	NA	NV	NA	NV	490000

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 5: Stratified Site Condition Standards in a Non-Potable Ground Water Condition

Table 5	Soil Standards (other than sediment) µg/g				Non-Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use		Industrial/ Commercial/Community Property Use		All Types of Property Use
	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	
Acenaphthene	(58) 7.9	(58) 7.9	96	(620) 330	(1700) 600
Acenaphthylene	(0.17) 0.15	(0.17) 0.15	(0.17) 0.15	(0.17) 0.15	1.8
Acetone	(28) 16	(28) 16	(28) 16	(28) 16	130000
Aldrin	0.05	4.7	(0.11) 0.088	6.3	8.5
Anthracene	(0.74) 0.67	(0.74) 0.67	(0.74) 0.67	(0.74) 0.67	2.4
Antimony	7.5	63	(50) 40	63	20000
Arsenic	18	18	18	47	1900
Barium	390	(8600) 7700	670	(8600) 7700	29000
Benzene	(0.17) 0.21	(0.17) 0.21	(0.4) 0.32	(4.4) 6.1	(430) 44
Benz[a]anthracene	(0.63) 0.5	0.96	0.96	36	4.7
Benzo[a]pyrene	0.3	0.3	0.3	3.6	0.81
Benzo[b]fluoranthene	0.78	0.96	0.96	36	0.75
Benzo[ghi]perylene	(7.8) 6.6	9.6	9.6	360	0.2
Benzo[k]fluoranthene	0.78	0.96	0.96	36	0.4
Beryllium	(5) 4	60	(10) 8	60	67
Biphenyl 1,1'-	(1.1) 0.31	(83) 11	(210) 52	(210) 52	(2200) 1000
Bis(2-chloroethyl)ether	0.5	0.5	0.5	16	300000
Bis(2-chloroisopropyl)ether	(1.8) 0.67	(14) 11	(14) 11	(14) 11	20000
Bis(2-ethylhexyl)phthalate	5	(8300) 7100	(35) 28	(8300) 7100	140
Boron (Hot Water Soluble)*	1.5	NA	2	NA	NA
Boron (total)	NA	(7900) 5000	NA	(7900) 5000	45000
Bromodichloromethane	13	18	18	(63) 50	85000
Bromoform	(0.26) 0.27	(0.26) 0.27	(1.7) 0.61	(2.7) 2	(770) 380
Bromomethane	0.05	0.05	0.05	0.05	(56) 5.6
Cadmium	1.2	7.9	1.9	7.9	2.7
Carbon Tetrachloride	(0.12) 0.05	(0.12) 0.05	(1.5) 0.21	(1.7) 0.43	(8.4) 0.79
Chlordane	0.05	0.8	0.05	30	28
Chloroaniline p-	(0.53) 0.5	(0.53) 0.5	(0.53) 0.5	(0.53) 0.5	400
Chlorobenzene	(2.7) 2.4	(2.7) 2.4	(2.7) 2.4	(2.7) 2.4	630
Chloroform	(0.18) 0.05	(0.18) 0.05	(0.18) 0.47	(0.19) 0.85	(22) 2.4
Chlorophenol, 2-	(2) 1.6	(23) 21	(3.9) 3.1	(23) 21	3300
Chromium Total	160	(18000) 11000	160	(18000) 11000	810
Chromium VI	(10) 8	40	(10) 8	40	140
Chrysene	(7.8) 7	9.6	9.6	360	1
Cobalt	22	250	(100) 80	2500	66
Copper	(180) 140	5600	(300) 230	5600	87
Cyanide (CN-)	0.051	0.051	0.051	0.051	66
Dibenz[a h]anthracene	0.1	0.1	0.1	3.6	0.52
Dibromochloromethane	9.4	13	13	(61) 48	82000
Dichlorobenzene, 1,2-	(4.3) 3.4	(52) 35	(8.5) 6.8	(68) 60	(9600) 4600
Dichlorobenzene, 1,3-	(6) 4.8	(67) 59	(12) 9.6	(67) 59	9600
Dichlorobenzene, 1,4-	(0.097) 0.083	(0.097) 0.083	(0.84) 0.2	(0.97) 0.39	(67) 8
Dichlorobenzidine, 3,3'-	1	1	1	25	640
Dichlorodifluoromethane	(25) 16	(25) 16	(25) 16	(25) 16	4400
DDD	3.3	4.6	4.6	110	45
DDE	(0.33) 0.26	3.2	(0.65) 0.52	110	20
DDT	1.4	3.2	1.4	110	2.8
Dichloroethane, 1,1-	(11) 3.5	(31) 3.5	(21) 17	(45) 120	(3100) 320
Dichloroethane, 1,2-	0.05	0.05	0.05	(0.05) 0.055	(12) 1.6
Dichloroethylene, 1,1-	0.05	0.05	(0.48) 0.064	(0.53) 0.12	(17) 1.6
Dichloroethylene, 1,2-cis-	(30) 3.4	(30) 3.4	(37) 55	(43) 110	(17) 1.6
Dichloroethylene, 1,2-trans-	(0.75) 0.084	(0.75) 0.084	(9.3) 1.3	(11) 2.9	(17) 1.6
Dichlorophenol, 2,4-	(2.1) 1.7	(52) 46	(4.2) 3.4	(52) 46	4600
Dichloropropane, 1,2-	(0.085) 0.05	(0.085) 0.05	(0.68) 0.16	(0.75) 0.33	(140) 16
Dichloropropene,1,3-	(0.083) 0.05	(0.083) 0.05	(0.21) 0.18	(0.24) 0.34	(45) 5.2
Dieldrin	0.05	(0.12) 0.11	(0.11) 0.088	(0.12) 0.11	0.75

Table 5	Soil Standards (other than sediment) µg/g				Non-Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use		Industrial/ Commercial/Community Property Use		All Types of Property Use
	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	
Diethyl Phthalate	0.5	0.5	0.5	0.5	38
Dimethylphthalate	0.5	0.5	0.5	0.5	38
Dimethylphenol, 2,4-	(420) 390	(440) 390	(440) 390	(440) 390	39000
Dinitrophenol, 2,4-	38	(66) 59	(66) 59	(66) 59	11000
Dinitrotoluene, 2,4 & 2,6-	0.92	1.2	1.2	(17) 15	2900
Dioxane, 1,4	1.8	100	1.8	(1500) 810	7300000) 1900000
Dioxin/Furan (TEQ)	0.000013	0.00051	0.000099	0.0044	(0.023) 0.014
Endosulfan	0.04	(0.51) 0.46	(0.38) 0.3	(0.51) 0.46	1.5
Endrin	0.04	(0.079) 0.071	0.04	(0.079) 0.071	0.48
Ethylbenzene	(15) 2	(16) 2	(19) 9.5	(19) 17	2300
Ethylene dibromide	0.05	0.05	0.05	0.05	(0.83) 0.25
Fluoranthene	0.69	9.6	9.6	360	130
Fluorene	(69) 62	(69) 62	(69) 62	(69) 62	400
Heptachlor	0.15	0.19	0.19	(2) 1.8	2.5
Heptachlor Epoxide	0.05	0.05	0.05	0.05	0.048
Hexachlorobenzene	0.52	0.66	0.66	(15) 14	3.1
Hexachlorobutadiene	(0.014) 0.012	(0.014) 0.012	(0.095) 0.031	(0.11) 0.06	(4.5) 0.44
Hexachlorocyclohexane Gamma-	(0.063) 0.056	(0.063) 0.056	(0.063) 0.056	(0.063) 0.056	1.2
Hexachloroethane	(0.071) 0.089	(0.071) 0.089	(0.43) 0.21	1.7	(200) 94
Hexane (n)	(34) 2.8	(34) 2.8	(88) 46	(88) 54	(520) 51
Indeno[1 2 3-cd]pyrene	(0.48) 0.38	0.96	(0.95) 0.76	36	0.2
Lead	120	1000	120	1000	25
Mercury	(1.8) 0.27	(1.8) 0.27	(20) 3.9	(30) 13	(2.8) 0.29
Methoxychlor	0.13	1.6	1.6	1.6	6.5
Methyl Ethyl Ketone	(44) 16	(180) 16	(88) 70	(380) 150	(1500000) 470000
Methyl Isobutyl Ketone	(4.3) 1.7	(66) 6.6	(210) 31	(210) 64	(580000) 140000
Methyl Mercury **	(0.0094) 0.0084	(0.0094) 0.0084	(0.0094) 0.0084	(0.0094) 0.0084	0.15
Methyl tert-Butyl Ether (MTBE)	(1.4) 0.75	(1.4) 0.75	(3.2) 11	(3.4) 14	(1400) 190
Methylene Chloride	(0.96) 0.1	(0.96) 0.1	(2) 1.6	(9.8) 3	(5500) 610
Methlynaphthalene, 2-(1-) ***	(3.4) 0.99	(85) 34	(85) 76	(85) 76	1800
Molybdenum	6.9	1200	40	1200	9200
Naphthalene	(0.75) 0.6	(4.6) 0.65	(28) 9.6	(220) 200	(6400) 1400
Nickel	(130) 100	510	(340) 270	510	490
Pentachlorophenol	0.1	(3.3) 2.9	(3.3) 2.9	(3.3) 2.9	62
Petroleum Hydrocarbons F1****	(65) 55	(65) 55	(65) 55	(65) 55	750
Petroleum Hydrocarbons F2	(150) 98	(150) 98	(250) 230	(250) 230	150
Petroleum Hydrocarbons F3	(1300) 300	(7200) 5800	(2500) 1700	(7200) 5800	500
Petroleum Hydrocarbons F4	(5600) 2800	(8000) 6900	(6600) 3300	(8000) 6900	500
Phenanthrene	(7.8) 6.2	(300) 270	(16) 12	(300) 270	580
Phenol	9.4	(53) 46	9.4	(53) 46	12000
Polychlorinated Biphenyls	0.35	2.7	1.1	4.1	(15) 7.8
Pyrene	78	96	96	(2900) 2600	68
Selenium	2.4	1200	5.5	1200	63
Silver	(25) 20	490	(50) 40	490	1.5
Styrene	(2.2) 0.7	(19) 16	(43) 34	(75) 66	(9100) 1300
Tetrachloroethane, 1,1,1,2-	(0.05) 0.058	(0.05) 0.058	(0.11) 0.087	(0.14) 0.24	(28) 3.3
Tetrachloroethane, 1,1,2,2-	0.05	0.05	(0.094) 0.05	(0.11) 0.05	(15) 3.2
Tetrachloroethylene	(2.3) 0.28	(2.3) 0.28	(21) 4.5	(21) 9.5	(17) 1.6
Thallium	1	3.3	3.3	33	510
Toluene	(6) 2.3	(50) 6.2	(78) 68	(78) 68	18000
Trichlorobenzene, 1,2,4-	(1.4) 0.36	(1.4) 0.36	(16) 3.2	(22) 10	(850) 180
Trichloroethane, 1,1,1-	(3.4) 0.38	(3.4) 0.38	(12) 6.1	(12) 9.8	(6700) 640
Trichloroethane, 1,1,2-	0.05	0.05	(0.11) 0.05	(0.13) 0.068	(30) 4.7
Trichloroethylene	(0.52) 0.061	(0.52) 0.061	(0.61) 0.91	(0.69) 1.8	(17) 1.6
Trichlorofluoromethane	(5.8) 4	(5.8) 4	(5.8) 4	(5.8) 4	2500
Trichlorophenol, 2,4,5-	(5.5) 4.4	(30) 27	10	(30) 27	1600
Trichlorophenol, 2,4,6-	(4.2) 3.8	(4.2) 3.8	(4.2) 3.8	(4.2) 3.8	230
Uranium	23	300	33	300	420
Vanadium	86	160	86	160	250
Vinyl Chloride	(0.022) 0.02	(0.022) 0.02	(0.25) 0.032	(0.28) 0.057	(1.7) 0.5

Table 5	Soil Standards (other than sediment) µg/g				Non-Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use		Industrial/ Commercial/Community Property Use		All Types of Property Use
	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	
Xylene Mixture	(25) 3.1	(25) 3.1	(30) 26	(30) 26	4200
Zinc	340	(24000) 15000	340	(24000) 15000	1100
Electrical Conductivity (mS/cm)	0.7	NA	1.4	NA	#N/A
Chloride	NA	NV	NA	NV	2300000
Sodium Adsorption Ratio	5	NA	12	NA	NA
Sodium	NA	NV	NA	NV	2300000

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 6: Generic Site Condition Standards for Shallow Soils in a Potable Ground Water Condition

Table 6	Soil Standards (other than sediment) µg/g			Potable Ground Water µg/L
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Acenaphthene	(29) 7.9	(29) 7.9	(29) 21	4.1
Acenaphthylene	(0.17) 0.15	(0.17) 0.15	(0.17) 0.15	1
Acetone	(28) 16	(28) 16	(28) 16	2700
Aldrin	0.05	0.05	(0.11) 0.088	0.35
Anthracene	(0.74) 0.67	(0.74) 0.67	(0.74) 0.67	1
Antimony	7.5	7.5	(50) 40	6
Arsenic	11	18	18	25
Barium	390	390	670	1000
Benzene	(0.17) 0.21	(0.17) 0.21	(0.4) 0.32	0.5
Benz[a]anthracene	(0.63) 0.5	(0.63) 0.5	0.96	1
Benzo[a]pyrene	0.078	0.3	0.3	0.01
Benzo[b]fluoranthene	0.78	0.78	0.96	0.1
Benzo[ghi]perylene	(7.8) 6.6	(7.8) 6.6	9.6	0.2
Benzo[k]fluoranthene	0.78	0.78	0.96	0.1
Beryllium	(5) 4	(5) 4	(10) 8	4
Biphenyl 1,1'-	(1.1) 0.31	(1.1) 0.31	(210) 52	0.5
Bis(2-chloroethyl)ether	0.5	0.5	0.5	5
Bis(2-chloroisopropyl)ether	(1.8) 0.67	(1.8) 0.67	(13) 11	120
Bis(2-ethylhexyl)phthalate	5	5	(35) 28	10
Boron (Hot Water Soluble)*	1.5	1.5	2	NA
Boron (total)	120	120	120	5000
Bromodichloromethane	(1.9) 1.5	(1.9) 1.5	(1.9) 1.5	16
Bromoform	(0.26) 0.27	(0.26) 0.27	(1.7) 0.61	5
Bromomethane	0.05	0.05	0.05	0.89
Cadmium	1	1.2	1.9	2.1
Carbon Tetrachloride	(0.12) 0.05	(0.12) 0.05	(0.71) 0.21	0.2
Chlordane	0.05	0.05	0.05	0.06
Chloroaniline p-	(0.53) 0.5	(0.53) 0.5	(0.53) 0.5	10
Chlorobenzene	(2.7) 2.4	(2.7) 2.4	(2.7) 2.4	30
Chloroform	(0.18) 0.05	(0.18) 0.05	(0.18) 0.47	2
Chlorophenol, 2-	(2) 1.6	(2) 1.6	(3.9) 3.1	8.9
Chromium Total	160	160	160	50
Chromium VI	(10) 8	(10) 8	(10) 8	25
Chrysene	(7.8) 7	(7.8) 7	9.6	0.1
Cobalt	22	22	(100) 80	3.8
Copper	(180) 140	(180) 140	(300) 230	69
Cyanide (CN-)	0.051	0.051	0.051	52
Dibenz[a h]anthracene	0.1	0.1	0.1	0.2
Dibromochloromethane	(2.9) 2.3	(2.9) 2.3	(2.9) 2.3	25
Dichlorobenzene, 1,2-	(1.7) 1.2	(1.7) 1.2	(1.7) 1.2	3
Dichlorobenzene, 1,3-	(6) 4.8	(6) 4.8	(12) 9.6	59
Dichlorobenzene, 1,4-	(0.097) 0.083	(0.097) 0.083	(0.57) 0.2	0.5
Dichlorobenzidine, 3,3'-	1	1	1	0.5
Dichlorodifluoromethane	(25) 16	(25) 16	(25) 16	590
DDD	3.3	3.3	4.6	1.8
DDE	(0.33) 0.26	(0.33) 0.26	(0.65) 0.52	10
DDT	0.078	1.4	1.4	0.05
Dichloroethane, 1,1-	(0.6) 0.47	(0.6) 0.47	(0.6) 0.47	5
Dichloroethane, 1,2-	0.05	0.05	0.05	0.5
Dichloroethylene, 1,1-	0.05	0.05	(0.48) 0.064	0.5
Dichloroethylene, 1,2-cis-	(2.5) 1.9	(2.5) 1.9	(2.5) 1.9	1.6
Dichloroethylene, 1,2-trans-	(0.75) 0.084	(0.75) 0.084	(2.5) 1.3	1.6
Dichlorophenol, 2,4-	(0.27) 0.19	(0.27) 0.19	(0.27) 0.19	20
Dichloropropane, 1,2-	(0.085) 0.05	(0.085) 0.05	(0.68) 0.16	0.58
Dichloropropene,1,3-	(0.081) 0.05	(0.081) 0.05	(0.081) 0.059	0.5
Dieldrin	0.05	0.05	(0.11) 0.088	0.35

Table 6	Soil Standards (other than sediment) µg/g			Potable Ground Water µg/L
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Diethyl Phthalate	0.5	0.5	0.5	30
Dimethylphthalate	0.5	0.5	0.5	30
Dimethylphenol, 2,4-	(53) 38	(53) 38	(53) 38	59
Dinitrophenol, 2,4-	(2.9) 2	(2.9) 2	(2.9) 2	10
Dinitrotoluene, 2,4 & 2,6-	0.5	0.5	0.5	5
Dioxane, 1,4	0.2	1.8	1.8	50
Dioxin/Furan (TEQ)	0.000013	0.000013	0.000099	0.000015
Endosulfan	0.04	0.04	(0.38) 0.3	0.56
Endrin	0.04	0.04	0.04	0.36
Ethylbenzene	(1.6) 1.1	(1.6) 1.1	(1.6) 1.1	2.4
Ethylene dibromide	0.05	0.05	0.05	0.2
Fluoranthene	0.69	0.69	9.6	0.41
Fluorene	(69) 62	(69) 62	(69) 62	120
Heptachlor	0.15	0.15	0.19	0.038
Heptachlor Epoxide	0.05	0.05	0.05	0.038
Hexachlorobenzene	0.52	0.52	0.66	1
Hexachlorobutadiene	(0.014) 0.012	(0.014) 0.012	(0.095) 0.031	0.012
Hexachlorocyclohexane Gamma-	(0.063) 0.056	(0.063) 0.056	(0.063) 0.056	0.95
Hexachloroethane	(0.071) 0.089	(0.071) 0.089	(0.43) 0.21	0.17
Hexane (n)	(34) 2.8	(34) 2.8	(88) 46	5
Indeno[1 2 3-cd]pyrene	(0.48) 0.38	(0.48) 0.38	(0.95) 0.76	0.2
Lead	45	120	120	10
Mercury	(1.8) 0.25	(1.8) 0.27	(20) 3.9	0.1
Methoxychlor	0.13	0.13	1.6	0.3
Methyl Ethyl Ketone	(44) 16	(44) 16	(88) 70	1800
Methyl Isobutyl Ketone	(4.3) 1.7	(4.3) 1.7	(210) 31	640
Methyl Mercury **	(0.0094) 0.0084	(0.0094) 0.0084	(0.0094) 0.0084	0.12
Methyl tert-Butyl Ether (MTBE)	(1.4) 0.75	(1.4) 0.75	(2.3) 1.6	15
Methylene Chloride	(0.96) 0.1	(0.96) 0.1	(2) 1.6	26
Methlynaphthalene, 2-(1-) ***	(3.4) 0.99	(3.4) 0.99	(42) 30	3.2
Molybdenum	6.9	6.9	40	70
Naphthalene	(0.75) 0.6	(0.75) 0.6	(28) 9.6	7
Nickel	(130) 100	(130) 100	(340) 270	100
Pentachlorophenol	0.1	0.1	(3.3) 2.9	30
Petroleum Hydrocarbons F1****	(65) 55	(65) 55	(65) 55	420
Petroleum Hydrocarbons F2	(150) 98	(150) 98	(250) 230	150
Petroleum Hydrocarbons F3	(1300) 300	(1300) 300	(2500) 1700	500
Petroleum Hydrocarbons F4	(5600) 2800	(5600) 2800	(6600) 3300	500
Phenanthrene	(7.8) 6.2	(7.8) 6.2	(16) 12	1
Phenol	9.4	9.4	9.4	890
Polychlorinated Biphenyls	0.35	0.35	1.1	0.2
Pyrene	78	78	96	4.1
Selenium	2.4	2.4	5.5	10
Silver	(25) 20	(25) 20	(50) 40	1.2
Styrene	(2.2) 0.7	(2.2) 0.7	(43) 34	5.4
Tetrachloroethane, 1,1,1,2-	(0.05) 0.058	(0.05) 0.058	(0.11) 0.087	1.1
Tetrachloroethane, 1,1,2,2-	0.05	0.05	(0.094) 0.05	0.5
Tetrachloroethylene	(2.3) 0.28	(2.3) 0.28	(2.5) 1.9	0.5
Thallium	1	1	3.3	2
Toluene	(6) 2.3	(6) 2.3	(9) 6.4	24
Trichlorobenzene, 1,2,4-	(1.4) 0.36	(1.4) 0.36	(16) 3.2	3
Trichloroethane, 1,1,1-	(3.4) 0.38	(3.4) 0.38	(12) 6.1	23
Trichloroethane, 1,1,2-	0.05	0.05	(0.11) 0.05	0.5
Trichloroethylene	(0.52) 0.061	(0.52) 0.061	(0.61) 0.55	0.5
Trichlorofluoromethane	(5.8) 4	(5.8) 4	(5.8) 4	150
Trichlorophenol, 2,4,5-	(5.5) 4.4	(5.5) 4.4	(10) 9.1	8.9
Trichlorophenol, 2,4,6-	(2.9) 2.1	(2.9) 2.1	(2.9) 2.1	2
Uranium	23	23	33	20
Vanadium	86	86	86	6.2
Vinyl Chloride	(0.022) 0.02	(0.022) 0.02	(0.25) 0.032	0.5

Table 6	Soil Standards (other than sediment) µg/g			Potable Ground Water µg/L
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Xylene Mixture	(25) 3.1	(25) 3.1	(30) 26	72
Zinc	340	340	340	890
Electrical Conductivity (mS/cm)	0.7	0.7	1.4	NA
Chloride	NA	NA	NA	790000
Sodium Adsorption Ratio	5	5	12	NA
Sodium	NA	NA	NA	490000

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 7: Generic Site Condition Standards for Shallow Soils in a Non-Potable Ground Water Condition

Table 7	Soil Standards (other than sediment) µg/g		Non- Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Acenaphthene	(58) 7.9	96	17
Acenaphthylene	(0.17) 0.15	(0.17) 0.15	1
Acetone	(28) 16	(28) 16	100000
Aldrin	0.05	(0.11) 0.088	3
Anthracene	(0.74) 0.67	(0.74) 0.67	1
Antimony	7.5	(50) 40	16000
Arsenic	18	18	1500
Barium	390	670	23000
Benzene	(0.17) 0.21	(0.4) 0.32	0.5
Benz[a]anthracene	(0.63) 0.5	0.96	1.8
Benzo[a]pyrene	0.3	0.3	0.81
Benzo[b]fluoranthene	0.78	0.96	0.75
Benzo[ghi]perylene	(7.8) 6.6	9.6	0.2
Benzo[k]fluoranthene	0.78	0.96	0.4
Beryllium	(5) 4	(10) 8	53
Biphenyl 1,1'-	(1.1) 0.31	(210) 52	(1700) 1000
Bis(2-chloroethyl)ether	0.5	0.5	240000
Bis(2-chloroisopropyl)ether	(1.8) 0.67	(14) 11	20000
Bis(2-ethylhexyl)phthalate	5	(35) 28	30
Boron (Hot Water Soluble)*	1.5	2	NA
Boron (total)	120	120	36000
Bromodichloromethane	13	18	67000
Bromoform	(0.26) 0.27	(1.7) 0.61	5
Bromomethane	0.05	0.05	0.89
Cadmium	1.2	1.9	2.1
Carbon Tetrachloride	(0.12) 0.05	(1.5) 0.21	0.2
Chlordane	0.05	0.05	0.06
Chloroaniline p-	(0.53) 0.5	(0.53) 0.5	320
Chlorobenzene	(2.7) 2.4	(2.7) 2.4	140
Chloroform	(0.18) 0.05	(0.18) 0.47	2
Chlorophenol, 2-	(2) 1.6	(3.9) 3.1	2600
Chromium Total	160	160	640
Chromium VI	(10) 8	(10) 8	110
Chrysene	(7.8) 7	9.6	0.7
Cobalt	22	(100) 80	52
Copper	(180) 140	(300) 230	69
Cyanide (CN-)	0.051	0.051	52
Dibenz[a h]anthracene	0.1	0.1	0.4
Dibromochloromethane	9.4	13	65000
Dichlorobenzene, 1,2-	(4.3) 3.4	(8.5) 6.8	150
Dichlorobenzene, 1,3-	(6) 4.8	(12) 9.6	7600
Dichlorobenzene, 1,4-	(0.097) 0.083	(0.84) 0.2	0.5
Dichlorobenzidine, 3,3'-	1	1	500
Dichlorodifluoromethane	(25) 16	(25) 16	3500
DDD	3.3	4.6	1.8
DDE	(0.33) 0.26	(0.65) 0.52	17
DDT	1.4	1.4	0.05
Dichloroethane, 1,1-	(11) 3.5	(21) 17	11
Dichloroethane, 1,2-	0.05	0.05	0.5
Dichloroethylene, 1,1-	0.05	(0.48) 0.064	0.5
Dichloroethylene, 1,2-cis-	(30) 3.4	(37) 55	1.6
Dichloroethylene, 1,2-trans-	(0.75) 0.084	(9.3) 1.3	1.6
Dichlorophenol, 2,4-	(2.1) 1.7	(4.2) 3.4	3700
Dichloropropane, 1,2-	(0.085) 0.05	(0.68) 0.16	0.58
Dichloropropene,1,3-	(0.083) 0.05	(0.21) 0.18	0.5
Dieldrin	0.05	(0.11) 0.088	0.56

Table 7	Soil Standards (other than sediment) µg/g		Non- Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Diethyl Phthalate	0.5	0.5	30
Dimethylphthalate	0.5	0.5	30
Dimethylphenol, 2,4-	(420) 390	(440) 390	31000
Dinitrophenol, 2,4-	38	(66) 59	9000
Dinitrotoluene, 2,4 & 2,6-	0.92	1.2	2300
Dioxane, 1,4	1.8	1.8	190000
Dioxin/Furan (TEQ)	0.000013	0.000099	0.0001
Endosulfan	0.04	(0.38) 0.3	0.56
Endrin	0.04	0.04	0.36
Ethylbenzene	(15) 2	(19) 9.5	54
Ethylene dibromide	0.05	0.05	0.2
Fluoranthene	0.69	9.6	44
Fluorene	(69) 62	(69) 62	290
Heptachlor	0.15	0.19	0.038
Heptachlor Epoxide	0.05	0.05	0.038
Hexachlorobenzene	0.52	0.66	3.1
Hexachlorobutadiene	(0.014) 0.012	(0.095) 0.031	0.012
Hexachlorocyclohexane Gamma-	(0.063) 0.056	(0.063) 0.056	0.95
Hexachloroethane	(0.071) 0.089	(0.43) 0.21	0.17
Hexane (n)	(34) 2.8	(88) 46	5
Indeno[1 2 3-cd]pyrene	(0.48) 0.38	(0.95) 0.76	0.2
Lead	120	120	20
Mercury	(1.8) 0.27	(20) 3.9	0.1
Methoxychlor	0.13	1.6	0.3
Methyl Ethyl Ketone	(44) 16	(88) 70	21000
Methyl Isobutyl Ketone	(4.3) 1.7	(210) 31	5200
Methyl Mercury **	(0.0094) 0.0084	(0.0094) 0.0084	0.12
Methyl tert-Butyl Ether (MTBE)	(1.4) 0.75	(3.2) 11	15
Methylene Chloride	(0.96) 0.1	(2) 1.6	26
Methlynaphthalene, 2-(1-) ***	(3.4) 0.99	(85) 76	1500
Molybdenum	6.9	40	7300
Naphthalene	(0.75) 0.6	(28) 9.6	7
Nickel	(130) 100	(340) 270	390
Pentachlorophenol	0.1	(3.3) 2.9	50
Petroleum Hydrocarbons F1****	(65) 55	(65) 55	420
Petroleum Hydrocarbons F2	(150) 98	(250) 230	150
Petroleum Hydrocarbons F3	(1300) 300	(2500) 1700	500
Petroleum Hydrocarbons F4	(5600) 2800	(6600) 3300	500
Phenanthrene	(7.8) 6.2	(16) 12	380
Phenol	9.4	9.4	9600
Polychlorinated Biphenyls	0.35	1.1	0.2
Pyrene	78	96	5.7
Selenium	2.4	5.5	50
Silver	(25) 20	(50) 40	1.2
Styrene	(2.2) 0.7	(43) 34	43
Tetrachloroethane, 1,1,1,2-	(0.05) 0.058	(0.11) 0.087	1.1
Tetrachloroethane, 1,1,2,2-	0.05	(0.094) 0.05	0.5
Tetrachloroethylene	(2.3) 0.28	(21) 4.5	0.5
Thallium	1	3.3	400
Toluene	(6) 2.3	(78) 68	320
Trichlorobenzene, 1,2,4-	(1.4) 0.36	(16) 3.2	3
Trichloroethane, 1,1,1-	(3.4) 0.38	(12) 6.1	23
Trichloroethane, 1,1,2-	0.05	(0.11) 0.05	0.5
Trichloroethylene	(0.52) 0.061	(0.61) 0.91	0.5
Trichlorofluoromethane	(5.8) 4	(5.8) 4	2000
Trichlorophenol, 2,4,5-	(5.5) 4.4	10	1300
Trichlorophenol, 2,4,6-	(4.2) 3.8	(4.2) 3.8	180
Uranium	23	33	330
Vanadium	86	86	200
Vinyl Chloride	(0.022) 0.02	(0.25) 0.032	0.5

Table 7	Soil Standards (other than sediment) µg/g		Non- Potable Ground Water µg/L
Contaminant	Residential/ Parkland/Institutional Property Use	Industrial/ Commercial/Community Property Use	All Types of Property Use
Xylene Mixture	(25) 3.1	(30) 26	72
Zinc	340	340	890
Electrical Conductivity (mS/cm)	0.7	1.4	NA
Chloride	NA	NA	1800000
Sodium Adsorption Ratio	5	12	NA
Sodium	NA	NA	1800000

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 8 - Generic Site Condition Standards for Use within 30 m of a Water Body in a Potable Ground Water Condition

Table 8	Soil (other than sediment) µg/g		Ground Water (µg/L)	Sediment µg/g
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All types of Property Use	All Types of Property Use
Acenaphthene	0.05	0.072	4.1	NV
Acenaphthylene	0.093	0.093	1	NV
Acetone	0.5	0.5	2700	NV
Aldrin	0.05	0.05	0.35	0.002
Anthracene	0.22	0.22	1	0.22
Antimony	1	1.3	6	NV
Arsenic	11	18	25	6
Barium	210	220	1000	NV
Benzene	0.02	0.02	5	NV
Benz[a]anthracene	0.32	0.36	1	0.32
Benzo[a]pyrene	0.078	0.3	0.01	0.37
Benzo[b]fluoranthene	0.3	0.47	0.1	NV
Benzo[ghi]perylene	0.2	0.68	0.2	0.17
Benzo[k]fluoranthene	0.24	0.48	0.1	0.24
Beryllium	2.5	2.5	4	NV
Biphenyl 1,1'-	0.05	0.05	0.5	NV
Bis(2-chloroethyl)ether	0.5	0.5	5	NV
Bis(2-chloroisopropyl)ether	0.5	0.5	120	NV
Bis(2-ethylhexyl)phthalate	5	5	10	NV
Boron (Hot Water Soluble)*	1.5	1.5	NA	NA
Boron (total)	36	36	5000	NV
Bromodichloromethane	0.05	0.05	16	NV
Bromoform	0.05	0.05	25	NV
Bromomethane	0.05	0.05	0.89	NV
Cadmium	1	1.2	2.1	0.6
Carbon Tetrachloride	0.05	0.05	0.79	NV
Chlordane	0.05	0.05	0.06	0.007
Chloroaniline p-	0.5	0.5	10	NV
Chlorobenzene	0.05	0.05	30	NV
Chloroform	0.05	0.05	2.4	NV
Chlorophenol, 2-	0.1	0.1	8.9	NV
Chromium Total	67	70	50	26
Chromium VI	0.66	0.66	25	NV
Chrysene	0.34	2.8	0.1	0.34
Cobalt	22	22	3.8	50
Copper	62	92	69	16
Cyanide (CN-)	0.051	0.051	52	0.1
Dibenz[a h]anthracene	0.1	0.1	0.2	0.06
Dibromochloromethane	0.05	0.05	25	NV
Dichlorobenzene, 1,2-	0.05	0.05	3	NV
Dichlorobenzene, 1,3-	0.05	0.05	59	NV
Dichlorobenzene, 1,4-	0.05	0.05	1	NV
Dichlorobenzidine, 3,3'-	1	1	0.5	NV
Dichlorodifluoromethane	0.05	0.05	590	NV
DDD	0.05	0.05	1.8	0.008
DDE	0.05	0.05	10	0.005
DDT	0.078	1.4	0.05	0.007
Dichloroethane, 1,1-	0.05	0.05	5	NV
Dichloroethane, 1,2-	0.05	0.05	1.6	NV
Dichloroethylene, 1,1-	0.05	0.05	1.6	NV
Dichloroethylene, 1,2-cis-	0.05	0.05	1.6	NV
Dichloroethylene, 1,2-trans-	0.05	0.05	1.6	NV
Dichlorophenol, 2,4-	0.1	0.1	20	NV
Dichloropropane, 1,2-	0.05	0.05	5	NV
Dichloropropene,1,3-	0.05	0.05	0.5	NV
Dieldrin	0.05	0.05	0.35	0.002

Table 8	Soil (other than sediment) µg/g		Ground Water (µg/L)	Sediment µg/g
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All types of Property Use	All Types of Property Use
Diethyl Phthalate	0.5	0.5	30	NV
Dimethylphthalate	0.5	0.5	30	NV
Dimethylphenol, 2,4-	0.2	0.2	59	NV
Dinitrophenol, 2,4-	2	2	10	NV
Dinitrotoluene, 2,4 & 2,6-	0.5	0.5	5	NV
Dioxane, 1,4	0.2	0.2	50	NV
Dioxin/Furan (TEQ)	0.000007	0.000007	0.000015	NV
Endosulfan	0.04	0.04	0.56	NV
Endrin	0.04	0.04	0.36	0.003
Ethylbenzene	0.05	0.05	2.4	NV
Ethylene dibromide	0.05	0.05	0.2	NV
Fluoranthene	0.69	0.69	0.41	0.75
Fluorene	0.19	0.19	120	0.19
Heptachlor	0.05	0.05	0.038	NV
Heptachlor Epoxide	0.05	0.05	0.038	0.005
Hexachlorobenzene	0.02	0.02	1	0.02
Hexachlorobutadiene	0.01	0.01	0.44	NV
Hexachlorocyclohexane Gamma-	0.01	0.01	0.95	NV
Hexachloroethane	0.01	0.01	2.1	NV
Hexane (n)	0.05	0.05	51	NV
Indeno[1 2 3-cd]pyrene	0.2	0.23	0.2	0.2
Lead	45	120	10	31
Mercury	0.2	0.27	0.29	0.2
Methoxychlor	0.05	0.05	0.3	NV
Methyl Ethyl Ketone	0.5	0.5	1800	NV
Methyl Isobutyl Ketone	0.5	0.5	640	NV
Methyl Mercury **	NV	NV	0.12	NV
Methyl tert-Butyl Ether (MTBE)	0.05	0.05	15	NV
Methylene Chloride	0.05	0.05	50	NV
Methlynaphthalene, 2-(1-) ***	0.05	0.59	3.2	NV
Molybdenum	2	2	70	NV
Naphthalene	0.05	0.09	11	NV
Nickel	37	82	100	16
Pentachlorophenol	0.1	0.1	30	NV
Petroleum Hydrocarbons F1****	17	25	420	NV
Petroleum Hydrocarbons F2	10	10	150	NV
Petroleum Hydrocarbons F3	240	240	500	NV
Petroleum Hydrocarbons F4	120	120	500	NV
Phenanthrene	0.56	0.69	1	0.56
Phenol	0.5	0.5	890	NV
Polychlorinated Biphenyls	0.3	0.3	0.2	0.07
Pyrene	0.49	1	4.1	0.49
Selenium	1.2	1.5	10	NV
Silver	0.5	0.5	1.2	0.5
Styrene	0.05	0.05	5.4	NV
Tetrachloroethane, 1,1,1,2-	0.05	0.05	1.1	NV
Tetrachloroethane, 1,1,2,2-	0.05	0.05	1	NV
Tetrachloroethylene	0.05	0.05	1.6	NV
Thallium	1	1	2	NV
Toluene	0.2	0.2	22	NV
Trichlorobenzene, 1,2,4-	0.05	0.05	70	NV
Trichloroethane, 1,1,1-	0.05	0.05	200	NV
Trichloroethane, 1,1,2-	0.05	0.05	4.7	NV
Trichloroethylene	0.05	0.05	1.6	NV
Trichlorofluoromethane	0.05	0.25	150	NV
Trichlorophenol, 2,4,5-	0.1	0.1	8.9	NV
Trichlorophenol, 2,4,6-	0.1	0.1	2	NV
Uranium	1.9	2.5	20	NV
Vanadium	86	86	6.2	NV
Vinyl Chloride	0.02	0.02	0.5	NV

Table 8	Soil (other than sediment) µg/g		Ground Water (µg/L)	Sediment µg/g
Contaminant	Agricultural or Other Property Use	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All types of Property Use	All Types of Property Use
Xylene Mixture	0.05	0.05	300	NV
Zinc	290	290	890	120
Electrical Conductivity (mS/cm)	0.7	0.7	NA	NA
Chloride	NA	NA	790000	NV
Sodium Adsorption Ratio	5	5	NA	NA
Sodium	NA	NA	490000	NV

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

TABLE 9 - Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Ground Water Condition

Table 9	Soil (other than sediment) µg/g	Ground Water (µg/L)	Sediment µg/g
Contaminant	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All Types of Property Use	All Types of Property Use
Acenaphthene	0.072	600	NV
Acenaphthylene	0.093	1.4	NV
Acetone	0.5	100000	NV
Aldrin	0.05	3	0.002
Anthracene	0.22	1	0.22
Antimony	1.3	16000	NV
Arsenic	18	1500	6
Barium	220	23000	NV
Benzene	0.02	44	NV
Benz[a]anthracene	0.36	1.8	0.32
Benzo[a]pyrene	0.3	0.81	0.37
Benzo[b]fluoranthene	0.47	0.75	NV
Benzo[ghi]perylene	0.68	0.2	0.17
Benzo[k]fluoranthene	0.48	0.4	0.24
Beryllium	2.5	53	NV
Biphenyl 1,1'-	0.05	1700	NV
Bis(2-chloroethyl)ether	0.5	240000	NV
Bis(2-chloroisopropyl)ether	0.5	20000	NV
Bis(2-ethylhexyl)phthalate	5	30	NV
Boron (Hot Water Soluble)*	1.5	NA	NA
Boron (total)	36	36000	NV
Bromodichloromethane	0.05	67000	NV
Bromoform	0.05	380	NV
Bromomethane	0.05	5.6	NV
Cadmium	1.2	2.1	0.6
Carbon Tetrachloride	0.05	0.79	NV
Chlordane	0.05	0.06	0.007
Chloroaniline p-	0.5	320	NV
Chlorobenzene	0.05	500	NV
Chloroform	0.05	2.4	NV
Chlorophenol, 2-	0.1	2600	NV
Chromium Total	70	640	26
Chromium VI	0.66	110	NV
Chrysene	2.8	0.7	0.34
Cobalt	22	52	50
Copper	92	69	16
Cyanide (CN-)	0.051	52	0.1
Dibenz[a h]anthracene	0.1	0.4	0.06
Dibromochloromethane	0.05	65000	NV
Dichlorobenzene, 1,2-	0.05	4600	NV
Dichlorobenzene, 1,3-	0.05	7600	NV
Dichlorobenzene, 1,4-	0.05	8	NV
Dichlorobenzidine, 3,3'-	1	500	NV
Dichlorodifluoromethane	0.05	3500	NV
DDD	0.05	1.8	0.008
DDE	0.05	17	0.005
DDT	1.4	0.05	0.007
Dichloroethane, 1,1-	0.05	320	NV
Dichloroethane, 1,2-	0.05	1.6	NV
Dichloroethylene, 1,1-	0.05	1.6	NV
Dichloroethylene, 1,2-cis-	0.05	1.6	NV
Dichloroethylene, 1,2-trans-	0.05	1.6	NV
Dichlorophenol, 2,4-	0.1	3700	NV
Dichloropropane, 1,2-	0.05	16	NV
Dichloropropene,1,3-	0.05	5.2	NV
Dieldrin	0.05	0.56	0.002

Table 9	Soil (other than sediment) µg/g	Ground Water (µg/L)	Sediment µg/g
Contaminant	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All Types of Property Use	All Types of Property Use
Diethyl Phthalate	0.5	30	NV
Dimethylphthalate	0.5	30	NV
Dimethylphenol, 2,4-	0.2	31000	NV
Dinitrophenol, 2,4-	2	9000	NV
Dinitrotoluene, 2,4 & 2,6-	0.5	2300	NV
Dioxane, 1,4	0.2	1900000	NV
Dioxin/Furan (TEQ)	0.000007	0.0001	NV
Endosulfan	0.04	0.56	NV
Endrin	0.04	0.36	0.003
Ethylbenzene	0.05	1800	NV
Ethylene dibromide	0.05	0.25	NV
Fluoranthene	0.69	73	0.75
Fluorene	0.19	290	0.19
Heptachlor	0.05	0.038	NV
Heptachlor Epoxide	0.05	0.038	0.005
Hexachlorobenzene	0.02	3.1	0.02
Hexachlorobutadiene	0.01	0.44	NV
Hexachlorocyclohexane Gamma-	0.01	0.95	NV
Hexachloroethane	0.01	94	NV
Hexane (n)	0.05	51	NV
Indeno[1 2 3-cd]pyrene	0.23	0.2	0.2
Lead	120	20	31
Mercury	0.27	0.29	0.2
Methoxychlor	0.05	0.3	NV
Methyl Ethyl Ketone	0.5	470000	NV
Methyl Isobutyl Ketone	0.5	140000	NV
Methyl Mercury **	NV	0.12	NV
Methyl tert-Butyl Ether (MTBE)	0.05	190	NV
Methylene Chloride	0.05	610	NV
Methlynaphthalene, 2-(1-) ***	0.59	1500	NV
Molybdenum	2	7300	NV
Naphthalene	0.09	1400	NV
Nickel	82	390	16
Pentachlorophenol	0.1	50	NV
Petroleum Hydrocarbons F1****	25	420	NV
Petroleum Hydrocarbons F2	10	150	NV
Petroleum Hydrocarbons F3	240	500	NV
Petroleum Hydrocarbons F4	120	500	NV
Phenanthrene	0.69	380	0.56
Phenol	0.5	9600	NV
Polychlorinated Biphenyls	0.3	0.2	0.07
Pyrene	1	5.7	0.49
Selenium	1.5	50	NV
Silver	0.5	1.2	0.5
Styrene	0.05	1300	NV
Tetrachloroethane, 1,1,1,2-	0.05	3.3	NV
Tetrachloroethane, 1,1,2,2-	0.05	3.2	NV
Tetrachloroethylene	0.05	1.6	NV
Thallium	1	400	NV
Toluene	0.2	14000	NV
Trichlorobenzene, 1,2,4-	0.05	180	NV
Trichloroethane, 1,1,1-	0.05	640	NV
Trichloroethane, 1,1,2-	0.05	4.7	NV
Trichloroethylene	0.05	1.6	NV
Trichlorofluoromethane	0.25	2000	NV
Trichlorophenol, 2,4,5-	0.1	1300	NV
Trichlorophenol, 2,4,6-	0.1	180	NV
Uranium	2.5	330	NV
Vanadium	86	200	NV
Vinyl Chloride	0.02	0.5	NV

Table 9	Soil (other than sediment) µg/g	Ground Water (µg/L)	Sediment µg/g
Contaminant	Residential/ Parkland/Institutional/ Industrial/Commercial/ Community Property Use	All Types of Property Use	All Types of Property Use
Xylene Mixture	0.05	3300	NV
Zinc	290	890	120
Electrical Conductivity (mS/cm)	0.7	NA	NA
Chloride	NA	1800000	NV
Sodium Adsorption Ratio	5	NA	NA
Sodium	NA	1800000	NV

Notes

( ) Standard in bracket applies to medium and fine textured soils

N/V= No value derived. N/A = Not applicable

* The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), since plant protection for soils below the root zone is not a significant concern.

**Analysis for methyl mercury only applies when mercury (total) standard is exceeded

*** The methyl naphthalene standards are appliable to both 1-methyl naphthallene and 2- methyl naphthalene , with the provision that if both are detected the sum of the two must not exceed the standard.

**** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Agricultural Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Acenaphthene	0.05		0.05		6600	78	21	560	7.9	3900	1300	2800	100
Acenaphthylene	0.05		0.093			7.8	2.3	0.15	0.45		96	2900	
Acetone	0.5		0.5		32	19000	320	16	720	4300	120000	92000	140
Aldrin	0.05		0.05	0.044	0.0024	0.56	31	150000		260000		5000	5200
Anthracene	0.05		0.05	2.5	38000	5400	15000	0.67				2700	
Antimony	1		1	20	25	7.5						8000	
Arsenic	1		11	20	51	0.95						12000	
Barium	5		210	750	390	3800						7700	
Benzene	0.02		0.02	25	370	9.3	0.92	14	0.21	820	17	5000	63
Benz[a]anthracene	0.05		0.095	0.5		0.78	190	5.1E+11	65		330	7600	
Benzo[a]pyrene	0.05		0.05	20	1600	0.078	6.6	3.8E+13	820		170	7600	
Benzo[b]fluoranthene	0.05		0.3			0.78	67	7.7E+13	5500		2000	7600	
Benzo[ghi]perylene	0.1		0.2	6.6		7.8	2200	1.2E+13				7600	
Benzo[k]fluoranthene	0.05		0.05	7.6		0.78	66	2.5E+13	6700		2100	7600	
Beryllium	2		2.5	4	13	38						3900	
Biphenyl 1,1'-	0.05		0.05			710	590	190		11		2600	0.31
Bis(2-chloroethyl)ether	0.5		0.5			0.32	0.0014	92		69		6400	1.9
Bis(2-chloroisopropyl)ether	0.5		0.5			840	12	120		18		11	0.67
Bis(2-ethylhexyl)phthalate	5		5	14	0.8	1100	830	2.5E+09				7100	
Boron (Hot Water Soluble)*	0.5		0.5	1.5								5000	
Boron (total)	5		36		120	4300						5000	
Bromodichloromethane	0.05		0.05			13	1.5	50				5500	
Bromoform	0.05		0.05			100	2.3	21	0.27	220	91	11000	5.4
Bromomethane	0.05		0.05			6.3	0.097	1.4	0.00034	27	68	7300	6
Cadmium	1		1	12	1.9	0.69						18000	
Carbon Tetrachloride	0.05		0.05	5.8	7.6	15	0.51	2.3	0.013	470	30	3900	120
Chlordane	0.05		0.05	1.1	0.0085	0.59	510	180	7.6	5700	210	8400	110
Chloroaniline p-	0.5		0.5	20		38	0.66	0.45				6100	
Chlorobenzene	0.05		0.05	6		1300	8	2.4	91	78	8900	3700	3.7
Chloroform	0.05		0.05	34	81	26	2.3	9.5	0.032	1400	8.9	6600	260
Chlorophenol, 2-	0.1		0.1	1.6		63	3.7	21				130000	
Chromium Total	5		67	310	160	28000						11000	
Chromium VI	0.2		0.66	8	910	160							
Chrysene	0.05		0.18	7		7.8	20	3.6E+11	1900		6600	7700	
Cobalt	2		19	40	180	22						19000	
Copper	5		62	140	280	600							
Cyanide (CN-)	0.05		0.051	0.9	0.11	380	22	0.022				240000	
Dibenz[a h]anthracene	0.1		0.1			0.078	22	2.4E+13	33000		430	7600	
Dibromochloromethane	0.05		0.05			9.4	2.3	48				10000	
Dichlorobenzene, 1,2-	0.05		0.05	3.4		6300	1.2	60	35	160	9200	3100	6.1
Dichlorobenzene, 1,3-	0.05		0.05	4.8		420	24	59				3300	
Dichlorobenzene, 1,4-	0.05		0.05	3.6		47	0.4	59	0.083	22	18	3000	0.85
Dichlorobenzidine, 3,3'-	1		1			0.52	0.16	66				5000	
Dichlorodifluoromethane	0.05		0.05	40		4200	150	16				710	
DDD	0.05		0.05	6.8		3.3	1300	34000000				5000	
DDE	0.05		0.05	0.26		2.3	1300	310000000				5000	
DDT	0.05		0.078	1	0.0011	2.3	1800	730000000				5000	
Dichloroethane, 1,1-	0.05		0.05	8.4		840	0.47	1600	3.5	130	1500	4800	24
Dichloroethane, 1,2-	0.05		0.05	48	29	8.7	0.48	180	0.025	640	1.4	5300	45
Dichloroethylene, 1,1-	0.05		0.05	50	43	1000	1.3	11	0.004	180	1300	3900	44
Dichloroethylene, 1,2-cis-	0.05		0.05		84	630	1.9	130	3.4		1300	4600	
Dichloroethylene, 1,2-trans-	0.05		0.05		84	420	1.9	220	0.084	34	700	4600	8.5
Dichlorophenol, 2,4-	0.1		0.1	1.7		63	0.19	46				33000	

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Agricultural Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Dichloropropane, 1,2-	0.05		0.05	25		22	0.54	76	0.01	4.5	27	2100	0.34
Dichloropropene,1,3-	0.05		0.05	25		8.7	0.059	3.8	0.027	17	9	5000	1.2
Dieldrin	0.05		0.05	0.044	0.00096	0.94	3.1	0.11				8700	
Diethyl Phthalate	0.5		0.5	11	85	94000	2200	0.07				7600	
Dimethylphthalate	0.5		0.5	17		94000	1400	0.023				1800	
Dimethylphenol, 2,4-	0.2		0.2			420	38	390				57000	
Dinitrophenol, 2,4-	2		2			38	2	59				13000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			0.92	0.015	15				3800	
Dioxane, 1,4	0.2		0.2		0.17	72	7.5	810	180		57000	82000	
Dioxin/Furan (TEQ)		5.4E-07	7E-06		0.000013	0.000048	0.0018	780	0.0028		0.11	7000	
Endosulfan	0.04		0.04	0.15	0.023	38	110	0.46				8700	
Endrin	0.04		0.04	0.019	0.0011	4.7	18	0.071				5000	
Ethylbenzene	0.05		0.05	55	90	2100	1.1	17	2	100	7600	2700	5.2
Ethylene dibromide	0.05		0.05			0.22	0.0048	86	0.0014	1600	0.099	2000	51
Fluoranthene	0.05		0.24	50	0.69	7.8	24	40000	250		2500	7600	
Fluorene	0.05		0.05			720	1100	62				2800	
Heptachlor	0.05		0.05	0.2	3.9	0.15	66	1.8		19000		8300	370
Heptachlor Epoxide	0.05		0.05			0.11	6.6	0.0035		8800		5000	180
Hexachlorobenzene	0.01		0.01	100		0.52	2.9	14				9300	
Hexachlorobutadiene	0.01		0.01			7.1	0.52	1.6	0.012	210	2.8	8300	8.6
Hexachlorocyclohexane Gamma-	0.01		0.01	5.9		0.25	11	0.056				5000	
Hexachloroethane	0.01		0.01			21	0.49	22	0.089	51	54	9400	0.46
Hexane (n)	0.05		0.05					54	2.8		130000	1500	
Indeno[1 2 3-cd]pyrene	0.1		0.11	0.38		0.78	220	8.6E+13	46000		4000	7600	
Lead	10		45	250	32	200						24000	
Mercury	0.1		0.16	10	20	9.8	550	1.2E+14	0.25		36	34000	
Methoxychlor	0.05		0.05		0.13	0.38	32000	3.9				8000	
Methyl Ethyl Ketone	0.5		0.5	35	5700	13000	160	230	16	750	44000	26000	26
Methyl Isobutyl Ketone	0.5		0.5			21000	440	150	6.6	39	23000	5100	1.7
Methyl Mercury **				0.8	0.034	2	1	0.0084				1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	25		440	1.6	220	0.75		170	8000	
Methylene Chloride	0.05		0.05	0.78	230	110	4.8	7.4	0.1	670	2200	6400	150
Methlynaphthalene, 2-(1-) ***	0.05		0.05			72	30	76		34		3600	0.99
Molybdenum	2		2	40	6.9	110						22000	
Naphthalene	0.05		0.05	0.6	380	360	93	200	0.65	150	270	2800	4.5
Nickel	5		37	100	5000	330							
Pentachlorophenol	0.1		0.1	17	0.013	3.6	86	2.9				9200	
Petroleum Hydrocarbons F1****	10		17	210		6900	4100	55	130		26000	1700	
Petroleum Hydrocarbons F2	10		10	150		3100	4300	230	98		25000	2700	
Petroleum Hydrocarbons F3	50		240	300		5800	20000					5800	
Petroleum Hydrocarbons F4	50		120	2800		6100	1600000					6900	
Phenanthrene	0.05		0.19	6.2	2700		17	270				2300	
Phenol	0.5		0.5	17	9.4	5400	240	46	940	34000	16000	230000	970
Polychlorinated Biphenyls	0.3		0.3	33	1.1	0.35	770	9.9E+11	3.1		120	5000	
Pyrene	0.05		0.19		4700	78	240	2600	1900		23000	7700	
Selenium	1		1.2	10	2.4	110							
Silver	0.5		0.5	20		77						22000	
Styrene	0.05		0.05	17		2500	47	66	16	18	3400	3500	0.7
Tetrachloroethane, 1,1,1,2-	0.05		0.05			30	0.15	37	0.058		5.1	4400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05			4	0.14	48	0.0045	2400	1.6	6700	86
Tetrachloroethylene	0.05		0.05	3.8	4.5	290	1.9	18	0.28	320	2300	3700	61
Thallium	1		1	1.4	3.9	0.29						22000	
Toluene	0.2		0.2	150	140	1700	6.4	68	6.2	35	34000	3300	2.3

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Agricultural Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Trichlorobenzene, 1,2,4-	0.05		0.05	13		210	45	43	0.36	1100	290	3400	32
Trichloroethane, 1,1,1-	0.05		0.05	18	820	42000	20	9.8	0.38	1000	12000	3700	250
Trichloroethane, 1,1,2-	0.05		0.05	80		14	0.54	120	0.03		2.9	3900	
Trichloroethylene	0.05		0.05	100	8.1	31	0.55	300	0.061	480	24	4100	91
Trichlorofluoromethane	0.05		0.05	16		6300	20	4				4400	
Trichlorophenol, 2,4,5-	0.1		0.1	4.4		56	9.1	27				14000	
Trichlorophenol, 2,4,6-	0.1		0.1	4.4		56	2.1	3.8				13000	
Uranium	1		1.9	500	33	23						40000	
Vanadium	10		86	200	18	39						7100	
Vinyl Chloride	0.02		0.02	3.4	6.8	0.57	0.19	270	0.0021	1000	14	6100	230
Xylene Mixture	0.05		0.05	95	96	4200	120	26	3.1	580	4900	2300	35
Zinc	30		290	400	340	5600						15000	
Electrical Conductivity (mS/cm)			0.47	0.7									
Chloride	5		52				52000	220				3000	
Sodium Adsorption Ratio			1	5									
Sodium	50		430										

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Acenaphthene	0.05		0.072		6600	78	21	560	7.9	3900	1300	2800	100
Acenaphthylene	0.05		0.093			7.8	2.3	0.15	0.45		96	2900	
Acetone	0.5		0.5		56	19000	320	16	720	4300	120000	92000	140
Aldrin	0.05		0.05	0.044	0.0024	0.56	31	150000		260000		5000	5200
Anthracene	0.05		0.16	2.5	38000	5400	15000	0.67				2700	
Antimony	1		1.3	20	25	7.5						8000	
Arsenic	1		18	20	51	0.95						12000	
Barium	5		220	750	390	3800						7700	
Benzene	0.02		0.02	25	370	9.3	0.92	14	0.21	820	17	5000	63
Benz[a]anthracene	0.05		0.36	0.5		0.78	190	5.1E+11	65		330	7600	
Benzo[a]pyrene	0.05		0.3	20	1600	0.078	6.6	3.8E+13	820		170	7600	
Benzo[b]fluoranthene	0.05		0.47			0.78	67	7.7E+13	5500		2000	7600	
Benzo[ghi]perylene	0.1		0.68	6.6		7.8	2200	1.2E+13				7600	
Benzo[k]fluoranthene	0.05		0.48	7.6		0.78	66	2.5E+13	6700		2100	7600	
Beryllium	2		2.5	4	13	38						3900	
Biphenyl 1,1'-	0.05		0.05			710	590	190		11		2600	0.31
Bis(2-chloroethyl)ether	0.5		0.5			0.32	0.0014	92		69		6400	1.9
Bis(2-chloroisopropyl)ether	0.5		0.5			840	12	120		18		11	0.67
Bis(2-ethylhexyl)phthalate	5		5	14	0.8	1100	830	2.5E+09				7100	
Boron (Hot Water Soluble)*	0.5		0.5	1.5								5000	
Boron (total)	5		36		120	4300						5000	
Bromodichloromethane	0.05		0.05			13	1.5	50				5500	
Bromoform	0.05		0.05			100	2.3	21	0.27	220	91	11000	5.4
Bromomethane	0.05		0.05			6.3	0.097	1.4	0.00034	27	68	7300	6
Cadmium	1		1.2	12	1.9	0.69						18000	
Carbon Tetrachloride	0.05		0.05	5.8	7.6	15	0.51	2.3	0.013	470	30	3900	120
Chlordane	0.05		0.05	1.1	0.0085	0.59	510	180	7.6	5700	210	8400	110
Chloroaniline p-	0.5		0.5	20		38	0.66	0.45				6100	
Chlorobenzene	0.05		0.05	6		1300	8	2.4	91	78	8900	3700	3.7
Chloroform	0.05		0.05	34	81	26	2.3	9.5	0.032	1400	8.9	6600	260
Chlorophenol, 2-	0.1		0.1	1.6		63	3.7	21				130000	
Chromium Total	5		70	310	160	28000						11000	
Chromium VI	0.2		0.66	8	910	160							
Chrysene	0.05		2.8	7		7.8	20	3.6E+11	1900		6600	7700	
Cobalt	2		21	40	180	22						19000	
Copper	5		92	140	770	600							
Cyanide (CN-)	0.05		0.051	0.9	0.11	380	22	0.022				240000	
Dibenz[a h]anthracene	0.1		0.1			0.078	22	2.4E+13	33000		430	7600	
Dibromochloromethane	0.05		0.05			9.4	2.3	48				10000	
Dichlorobenzene, 1,2-	0.05		0.05	3.4		6300	1.2	60	35	160	9200	3100	6.1
Dichlorobenzene, 1,3-	0.05		0.05	4.8		420	24	59				3300	
Dichlorobenzene, 1,4-	0.05		0.05	3.6		47	0.4	59	0.083	22	18	3000	0.85
Dichlorobenzidine, 3,3'-	1		1			0.52	0.16	66				5000	
Dichlorodifluoromethane	0.05		0.05	40		4200	150	16				710	
DDD	0.05		0.05	6.8		3.3	1300	34000000				5000	
DDE	0.05		0.05	0.26		2.3	1300	310000000				5000	
DDT	0.05		1.4	1	0.0011	2.3	1800	730000000				5000	
Dichloroethane, 1,1-	0.05		0.05	8.4		840	0.47	1600	3.5	130	1500	4800	24
Dichloroethane, 1,2-	0.05		0.05	48	29	8.7	0.48	180	0.025	640	1.4	5300	45
Dichloroethylene, 1,1-	0.05		0.05	50	43	1000	1.3	11	0.004	180	1300	3900	44
Dichloroethylene, 1,2-cis-	0.05		0.05		84	630	1.9	130	3.4		1300	4600	
Dichloroethylene, 1,2-trans-	0.05		0.05		84	420	1.9	220	0.084	34	700	4600	8.5
Dichlorophenol, 2,4-	0.1		0.1	1.7		63	0.19	46				33000	

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Dichloropropane, 1,2-	0.05		0.05	25		22	0.54	76	0.01	4.5	27	2100	0.34
Dichloropropene,1,3-	0.05		0.05	25		8.7	0.059	3.8	0.027	17	9	5000	1.2
Dieldrin	0.05		0.05	0.044	0.00096	0.94	3.1	0.11				8700	
Diethyl Phthalate	0.5		0.5	11	85	94000	2200	0.07				7600	
Dimethylphthalate	0.5		0.5	17		94000	1400	0.023				1800	
Dimethylphenol, 2,4-	0.2		0.2			420	38	390				57000	
Dinitrophenol, 2,4-	2		2			38	2	59				13000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			0.92	0.015	15				3800	
Dioxane, 1,4	0.2		0.2		1.8	72	7.5	810	180		57000	82000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000013	0.000048	0.0018	780	0.0028		0.11	7000	
Endosulfan	0.04		0.04	0.15	0.023	38	110	0.46				8700	
Endrin	0.04		0.04	0.019	0.0011	4.7	18	0.071				5000	
Ethylbenzene	0.05		0.05	55	90	2100	1.1	17	2	100	7600	2700	5.2
Ethylene dibromide	0.05		0.05			0.22	0.0048	86	0.0014	1600	0.099	2000	51
Fluoranthene	0.05		0.56	50	0.69	7.8	24	40000	250		2500	7600	
Fluorene	0.05		0.12			720	1100	62				2800	
Heptachlor	0.05		0.05	0.2	3.9	0.15	66	1.8		19000		8300	370
Heptachlor Epoxide	0.05		0.05			0.11	6.6	0.0035		8800		5000	180
Hexachlorobenzene	0.01		0.01	100		0.52	2.9	14				9300	
Hexachlorobutadiene	0.01		0.01			7.1	0.52	1.6	0.012	210	2.8	8300	8.6
Hexachlorocyclohexane Gamma-	0.01		0.01	5.9		0.25	11	0.056				5000	
Hexachloroethane	0.01		0.01			21	0.49	22	0.089	51	54	9400	0.46
Hexane (n)	0.05		0.05					54	2.8		130000	1500	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.38		0.78	220	8.6E+13	46000		4000	7600	
Lead	10		120	250	32	200						24000	
Mercury	0.1		0.27	10	20	9.8	550	1.2E+14	0.25		36	34000	
Methoxychlor	0.05		0.05		0.13	0.38	32000	3.9				8000	
Methyl Ethyl Ketone	0.5		0.5	35	9900	13000	160	230	16	750	44000	26000	26
Methyl Isobutyl Ketone	0.5		0.5			21000	440	150	6.6	39	23000	5100	1.7
Methyl Mercury **				0.8	0.034	2	1	0.0084				1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	25		440	1.6	220	0.75		170	8000	
Methylene Chloride	0.05		0.05	0.78	350	110	4.8	7.4	0.1	670	2200	6400	150
Methlynaphthalene, 2-(1-) ***	0.05		0.59			72	30	76		34		3600	0.99
Molybdenum	2		2	40	6.9	110						22000	
Naphthalene	0.05		0.09	0.6	380	360	93	200	0.65	150	270	2800	4.5
Nickel	5		82	100	5000	330							
Pentachlorophenol	0.1		0.1	17	0.013	3.6	86	2.9				9200	
Petroleum Hydrocarbons F1****	10		25	210		6900	4100	55	130		26000	1700	
Petroleum Hydrocarbons F2	10		10	150		3100	4300	230	98		25000	2700	
Petroleum Hydrocarbons F3	50		240	300		5800	20000					5800	
Petroleum Hydrocarbons F4	50		120	2800		6100	1600000					6900	
Phenanthrene	0.05		0.69	6.2	2700		17	270				2300	
Phenol	0.5		0.5	17	9.4	5400	240	46	940	34000	16000	230000	970
Polychlorinated Biphenyls	0.3		0.3	33	1.1	0.35	770	9.9E+11	3.1		120	5000	
Pyrene	0.05		1		4700	78	240	2600	1900		23000	7700	
Selenium	1		1.5	10	2.4	110							
Silver	0.5		0.5	20		77						22000	
Styrene	0.05		0.05	17		2500	47	66	16	18	3400	3500	0.7
Tetrachloroethane, 1,1,1,2-	0.05		0.05			30	0.15	37	0.058		5.1	4400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05			4	0.14	48	0.0045	2400	1.6	6700	86
Tetrachloroethylene	0.05		0.05	3.8	4.5	290	1.9	18	0.28	320	2300	3700	61
Thallium	1		1	1.4	3.9	0.29						22000	
Toluene	0.2		0.2	150	140	1700	6.4	68	6.2	35	34000	3300	2.3

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Trichlorobenzene, 1,2,4-	0.05		0.05	13		210	45	43	0.36	1100	290	3400	32
Trichloroethane, 1,1,1-	0.05		0.05	18	820	42000	20	9.8	0.38	1000	12000	3700	250
Trichloroethane, 1,1,2-	0.05		0.05	80		14	0.54	120	0.03		2.9	3900	
Trichloroethylene	0.05		0.05	100	8.1	31	0.55	300	0.061	480	24	4100	91
Trichlorofluoromethane	0.05		0.25	16		6300	20	4				4400	
Trichlorophenol, 2,4,5-	0.1		0.1	4.4		56	9.1	27				14000	
Trichlorophenol, 2,4,6-	0.1		0.1	4.4		56	2.1	3.8				13000	
Uranium	1		2.5	500	33	23						40000	
Vanadium	10		86	200	18	39						7100	
Vinyl Chloride	0.02		0.02	3.4	12	0.57	0.19	270	0.0021	1000	14	6100	230
Xylene Mixture	0.05		0.05	95	96	4200	120	26	3.1	580	4900	2300	35
Zinc	30		290	400	340	5600						15000	
Electrical Conductivity (mS/cm)			0.57	0.7									
Chloride	5		210				52000	220				3000	
Sodium Adsorption Ratio			2.4	5									
Sodium	50		1300										

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Acenaphthene	0.05		0.072		46000	96	3600	21	560	120	18000	1300	2800
Acenaphthylene	0.05		0.093			9.6	360	2.3	0.15	6.6		96	2900
Acetone	0.5		0.5		56	200000	660000	320	16	1900	20000	120000	92000
Aldrin	0.05		0.05	0.088	1200	4.7	6.3	31	150000		1200000		5000
Anthracene	0.05		0.16	32	470000	42000	420000	15000	0.67				2700
Antimony	1		1.3	40	1500	63	63						8000
Arsenic	1		18	40	330	1.3	47						12000
Barium	5		220	1500	670	32000	8600						7700
Benzene	0.02		0.02	180	6800	13	480	0.92	14	0.32	3800	17	5000
Benz[a]anthracene	0.05		0.36	1		0.96	36	190	5.1E+11	970		330	7600
Benzo[a]pyrene	0.05		0.3	72	46000	0.096	3.6	6.6	3.8E+13	12000		170	7600
Benzo[b]fluoranthene	0.05		0.47			0.96	36	67	7.7E+13	81000		2000	7600
Benzo[ghi]perylene	0.1		0.68	13		9.6	360	2200	1.2E+13				7600
Benzo[k]fluoranthene	0.05		0.48	15		0.96	36	66	2.5E+13	99000		2100	7600
Beryllium	2		2.5	8	780	320	60						3900
Biphenyl 1,1'-	0.05		0.05			6000	6000	590	190		52		2600
Bis(2-chloroethyl)ether	0.5		0.5			0.44	16	0.0014	92		320		6400
Bis(2-chloroisopropyl)ether	0.5		0.5			8800	8800	12	120		82		11
Bis(2-ethylhexyl)phthalate	5		5	28	140000	9500	16000	830	2.5E+09				7100
Boron (Hot Water Soluble)*	0.5		0.5	2									5000
Boron (total)	5		36		120	24000	24000						5000
Bromodichloromethane	0.05		0.05			18	660	1.5	50				5500
Bromoform	0.05		0.05			140	5200	2.3	21	0.61	980	91	11000
Bromomethane	0.05		0.05			66	660	0.097	1.4	0.0016	130	68	7300
Cadmium	1		1.2	24	1.9	7.9	7.9						18000
Carbon Tetrachloride	0.05		0.05	12	880	150	1500	0.51	2.3	0.21	2200	30	3900
Chlordane	0.05		0.05	2.2	0.0085	0.8	30	510	180	110	26000	210	8400
Chloroaniline p-	0.5		0.5	40		320	320	0.66	0.45				6100
Chlorobenzene	0.05		0.05	12		13000	42000	8	2.4	130	360	8900	3700
Chloroform	0.05		0.05	68	830	35	1300	2.3	9.5	0.47	6800	8.9	6600
Chlorophenol, 2-	0.1		0.1	3.1		660	660	3.7	21				130000
Chromium Total	5		70	500	160	240000	240000						11000
Chromium VI	0.2		0.66	8	8500	1300	40						
Chrysene	0.05		2.8	14		9.6	360	20	3.6E+11	28000		6600	7700
Cobalt	2		21	80	180	250	2500						19000
Copper	5		92	230	3100	5600	5600						
Cyanide (CN-)	0.05		0.051	8	0.11	3200	7900	22	0.022				240000
Dibenz[a h]anthracene	0.1		0.1			0.096	3.6	22	2.4E+13	480000		430	7600
Dibromochloromethane	0.05		0.05			13	490	2.3	48				10000
Dichlorobenzene, 1,2-	0.05		0.05	6.8		66000	130000	1.2	60	110	770	9200	3100
Dichlorobenzene, 1,3-	0.05		0.05	9.6		4400	4400	24	59				3300
Dichlorobenzene, 1,4-	0.05		0.05	7.2		65	2400	0.4	59	0.2	100	18	3000
Dichlorobenzidine, 3,3'-	1		1			0.66	25	0.16	66				5000
Dichlorodifluoromethane	0.05		0.05	80		44000	44000	150	16				710
DDD	0.05		0.05	14		4.6	110	1300	34000000				5000
DDE	0.05		0.05	0.52		3.2	110	1300	310000000				5000
DDT	0.05		1.4	6.3	0.0012	3.2	110	1800	730000000				5000
Dichloroethane, 1,1-	0.05		0.05	17		8800	88000	0.47	1600	56	590	1500	4800
Dichloroethane, 1,2-	0.05		0.05	96	29	12	450	0.48	180	0.038	3000	1.4	5300
Dichloroethylene, 1,1-	0.05		0.05	100	760	11000	11000	1.3	11	0.064	860	1300	3900
Dichloroethylene, 1,2-cis-	0.05		0.05		940	6600	66000	1.9	130	55		1300	4600
Dichloroethylene, 1,2-trans-	0.05		0.05		940	4400	44000	1.9	220	1.3	160	700	4600
Dichlorophenol, 2,4-	0.1		0.1	3.4		660	660	0.19	46				33000

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Dichloropropane, 1,2-	0.05		0.05	50		31	1100	0.54	76	0.16	21	27	2100
Dichloropropene,1,3-	0.05		0.05	50		12	450	0.059	3.8	0.18	78	9	5000
Dieldrin	0.05		0.05	0.088	240	7.9	16	3.1	0.11				8700
Diethyl Phthalate	0.5		0.5	21	1000000	790000	1300000	2200	0.07				7600
Dimethylphthalate	0.5		0.5	34		790000	790000	1400	0.023				1800
Dimethylphenol, 2,4-	0.2		0.2			4400	44000	38	390				57000
Dinitrophenol, 2,4-	2		2			320	3200	2	59				13000
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			1.2	43	0.015	15				3800
Dioxane, 1,4	0.2		0.2		1.8	100	3700	7.5	810	1800		57000	82000
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000099	0.00051	0.0044	0.0018	780	0.043		0.11	7000
Endosulfan	0.04		0.04	0.3	1.2	320	790	110	0.46				8700
Endrin	0.04		0.04	0.038	0.0011	39	320	18	0.071				5000
Ethylbenzene	0.05		0.05	300	38000	22000	22000	1.1	17	9.5	470	7600	2700
Ethylene dibromide	0.05		0.05			0.31	11	0.0048	86	0.0015	7100	0.099	2000
Fluoranthene	0.05		0.56	180	120000	9.6	360	24	40000	3700		2500	7600
Fluorene	0.05		0.12			5600	56000	1100	62				2800
Heptachlor	0.05		0.05	0.4	1100	0.19	2.3	66	1.8		87000		8300
Heptachlor Epoxide	0.05		0.05			0.14	5.3	6.6	0.0035		40000		5000
Hexachlorobenzene	0.01		0.01	200		0.66	16	2.9	14				9300
Hexachlorobutadiene	0.01		0.01			14	75	0.52	1.6	0.031	980	2.8	8300
Hexachlorocyclohexane Gamma-	0.01		0.01	12		2.5	2.5	11	0.056				5000
Hexachloroethane	0.01		0.01			79	2200	0.49	22	0.21	220	54	9400
Hexane (n)	0.05		0.05				21000000		54	46		130000	1500
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.76		0.96	36	220	8.6E+13	670000		4000	7600
Lead	10		120	1100	32	1000	1000						24000
Mercury	0.1		0.27	50	20	67	670	550	1.2E+14	3.9		36	34000
Methoxychlor	0.05		0.05		4100	1.6	1.6	32000	3.9				8000
Methyl Ethyl Ketone	0.5		0.5	70	9900	64000	64000	160	230	74	3500	44000	26000
Methyl Isobutyl Ketone	0.5		0.5			110000	110000	440	150	31	180	23000	5100
Methyl Mercury **				1.6	0.034	9.2	9.2	1	0.0084				1300000
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	50		610	23000	1.6	220	11		170	8000
Methylene Chloride	0.05		0.05	1.6	400	150	5500	4.8	7.4	1.6	3100	2200	6400
Methlynaphthalene, 2-(1-) ***	0.05		0.59			560	560	30	76		160		3600
Molybdenum	2		2	40	74	1200	1200						22000
Naphthalene	0.05		0.09	22	1300	2800	28000	93	200	9.6	710	270	2800
Nickel	5		82	270	5400	2200	510						
Pentachlorophenol	0.1		0.1	31	2000	4.1	50	86	2.9				9200
Petroleum Hydrocarbons F1****	10		25	320		47000	100000	4100	55	580		26000	1700
Petroleum Hydrocarbons F2	10		10	260		22000	48000	4300	230	380		25000	2700
Petroleum Hydrocarbons F3	50		240	1700		40000	260000	20000					5800
Petroleum Hydrocarbons F4	50		120	3300		42000	400000	1600000					6900
Phenanthrene	0.05		0.69	12	36000			17	270				2300
Phenol	0.5		0.5	40	9.4	42000	42000	240	46	15000	160000	16000	230000
Polychlorinated Biphenyls	0.3		0.3	33	1.1	2.7	4.1	770	9.9E+11	45		120	5000
Pyrene	0.05		1		99000	96	3600	240	2600	28000		23000	7700
Selenium	1		1.5	10	5.5	1200	1200						
Silver	0.5		0.5	40		490	490						22000
Styrene	0.05		0.05	34		26000	26000	47	66	42	83	3400	3500
Tetrachloroethane, 1,1,1,2-	0.05		0.05			42	1600	0.15	37	0.087		5.1	4400
Tetrachloroethane, 1,1,2,2-	0.05		0.05			5.5	210	0.14	48	0.019	11000	1.6	6700
Tetrachloroethylene	0.05		0.05	34	310	3100	31000	1.9	18	4.5	1500	2300	3700
Thallium	1		1	3.6	47	3.3	33						22000
Toluene	0.2		0.2	500	14000	18000	180000	6.4	68	99	170	34000	3300

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Trichlorobenzene, 1,2,4-	0.05		0.05	30		2200	22000	45	43	3.2	5300	290	3400
Trichloroethane, 1,1,1-	0.05		0.05	35	39000	440000	1500000	20	9.8	6.1	4700	12000	3700
Trichloroethane, 1,1,2-	0.05		0.05	160		19	720	0.54	120	0.042		2.9	3900
Trichloroethylene	0.05		0.05	200	390	85	160	0.55	300	0.91	2200	24	4100
Trichlorofluoromethane	0.05		0.25	32		66000	66000	20	4				4400
Trichlorophenol, 2,4,5-	0.1		0.1	10		470	470	9.1	27				14000
Trichlorophenol, 2,4,6-	0.1		0.1	10		72	470	2.1	3.8				13000
Uranium	1		2.5	2000	33	300	300						40000
Vanadium	10		86	200	18	160	160						7100
Vinyl Chloride	0.02		0.02	6.8	12	0.79	29	0.19	270	0.032	4800	14	6100
Xylene Mixture	0.05		0.05	350	47000	44000	88000	120	26	50	2700	4900	2300
Zinc	30		290	600	340	47000	47000						15000
Electrical Conductivity (mS/cm)			0.57	1.4									
Chloride	5		210					52000	220				3000
Sodium Adsorption Ratio			2.4	12									
Sodium	50		1300										

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Agricultural Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Acenaphthene	0.05		0.05		6600	78	29	620	58	29000	1300	4300	360
Acenaphthylene	0.05		0.093			7.8	3.2	0.17	3.3		96	4000	
Acetone	0.5		0.5		32	19000	440	28	1200	54000	120000	140000	290
Aldrin	0.05		0.05	0.055	0.0024	0.56	43	170000		1500000		5000	18000
Anthracene	0.05		0.05	3.1	38000	5400	21000	0.74				4300	
Antimony	1		1	25	25	7.5						13000	
Arsenic	1		11	25	51	0.95						19000	
Barium	5		210	1000	390	3800						12000	
Benzene	0.02		0.02	60	370	9.3	1.3	16	0.17	6700	17	6200	150
Benz[a]anthracene	0.05		0.095	0.63		0.78	270	5.6E+11	490		330	9200	
Benzo[a]pyrene	0.05		0.05	25	1600	0.078	9.2	4.2E+13	6100		170	9200	
Benzo[b]fluoranthene	0.05		0.3			0.78	94	8.6E+13	37000		2000	9200	
Benzo[ghi]perylene	0.1		0.2	8.3		7.8	3100	1.4E+13				9200	
Benzo[k]fluoranthene	0.05		0.05	9.5		0.78	92	2.8E+13	45000		2100	9200	
Beryllium	2		2.5	5	13	38						6200	
Biphenyl 1,1'-	0.05		0.05			710	830	210		83		3900	1.1
Bis(2-chloroethyl)ether	0.5		0.5			0.32	0.0014	130		660		8800	5.6
Bis(2-chloroisopropyl)ether	0.5		0.5			840	13	160		150		14	1.8
Bis(2-ethylhexyl)phthalate	5		5	17	0.8	1100	1200	2.8E+09				8300	
Boron (Hot Water Soluble)*	0.5		0.5	1.5								7900	
Boron (total)	5		36		120	4300						7900	
Bromodichloromethane	0.05		0.05			13	1.9	63				8100	
Bromoform	0.05		0.05			100	2.9	27	0.26	1500	91	15000	16
Bromomethane	0.05		0.05			6.3	0.1	2	0.0034	270	68	10000	18
Cadmium	1		1	12	1.9	0.69						29000	
Carbon Tetrachloride	0.05		0.05	7.3	7.6	15	0.71	3	0.12	4300	30	6000	370
Chlordane	0.05		0.05	1.4	0.0085	0.59	710	200	43	33000	210	10000	390
Chloroaniline p-	0.5		0.5	25		38	0.89	0.53				8100	
Chlorobenzene	0.05		0.05	7.5		1300	11	2.7	53	620	8900	5100	11
Chloroform	0.05		0.05	43	81	26	3	12	0.18	13000	8.9	9000	450
Chlorophenol, 2-	0.1		0.1	2		63	5.1	23				130000	
Chromium Total	5		67	390	160	28000						18000	
Chromium VI	0.2		0.66	10	910	160							
Chrysene	0.05		0.18	8.8		7.8	28	4E+11	13000		6600	9300	
Cobalt	2		19	50	180	22						30000	
Copper	5		62	180	280	600							
Cyanide (CN-)	0.05		0.051	1.1	0.11	380	23	0.03				290000	
Dibenz[a h]anthracene	0.1		0.1			0.078	31	2.7E+13	170000		430	9200	
Dibromochloromethane	0.05		0.05			9.4	2.9	61				13000	
Dichlorobenzene, 1,2-	0.05		0.05	4.3		6300	1.7	68	52	1300	9200	4800	19
Dichlorobenzene, 1,3-	0.05		0.05	6		420	34	67				4900	
Dichlorobenzene, 1,4-	0.05		0.05	4.5		47	0.57	67	0.097	170	18	4600	2.6
Dichlorobenzidine, 3,3'-	1		1			0.52	0.22	74				5000	
Dichlorodifluoromethane	0.05		0.05	50		4200	280	25				1000	
DDD	0.05		0.05	8.5		3.3	1800	38000000				5000	
DDE	0.05		0.05	0.33		2.3	1800	350000000				5000	
DDT	0.05		0.078	1.3	0.0011	2.3	2600	810000000				5000	
Dichloroethane, 1,1-	0.05		0.05	11		840	0.6	2000	31	1100	1500	6600	41
Dichloroethane, 1,2-	0.05		0.05	60	29	8.7	0.62	220	0.013	5700	1.4	7100	110
Dichloroethylene, 1,1-	0.05		0.05	63	43	1000	1.8	15	0.038	1800	1300	5800	140
Dichloroethylene, 1,2-cis-	0.05		0.05		84	630	2.5	160	30		1300	6400	
Dichloroethylene, 1,2-trans-	0.05		0.05		84	420	2.5	280	0.75	300	700	6500	18
Dichlorophenol, 2,4-	0.1		0.1	2.1		63	0.27	52				33000	

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Agricultural Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Dichloropropane, 1,2-	0.05		0.05	31		22	0.74	91	0.085	38	27	2300	0.81
Dichloropropene,1,3-	0.05		0.05	31		8.7	0.081	4.5	0.083	140	9	6600	2.8
Dieldrin	0.05		0.05	0.055	0.00096	0.94	4.3	0.12				11000	
Diethyl Phthalate	0.5		0.5	13	85	94000	3100	0.081				9100	
Dimethylphthalate	0.5		0.5	21		94000	1800	0.029				2000	
Dimethylphenol, 2,4-	0.2		0.2			420	53	440				57000	
Dinitrophenol, 2,4-	2		2			38	2.9	66				14000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			0.92	0.021	17				5400	
Dioxane, 1,4	0.2		0.2		0.17	72	7.7	1500	1400		57000	130000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000013	0.000048	0.0026	870	0.017		0.11	8200	
Endosulfan	0.04		0.04	0.19	0.023	38	150	0.51				11000	
Endrin	0.04		0.04	0.024	0.0011	4.7	25	0.079				5000	
Ethylbenzene	0.05		0.05	120	90	2100	1.6	19	16	800	7600	3800	15
Ethylene dibromide	0.05		0.05			0.22	0.0062	110	0.00054	11000	0.099	2200	150
Fluoranthene	0.05		0.24	63	0.69	7.8	34	45000	1700		2500	9200	
Fluorene	0.05		0.05			720	1600	69				4200	
Heptachlor	0.05		0.05	0.25	3.9	0.15	92	2		110000		10000	1300
Heptachlor Epoxide	0.05		0.05			0.11	9.3	0.0039		52000		5000	620
Hexachlorobenzene	0.01		0.01	130		0.52	4	15				12000	
Hexachlorobutadiene	0.01		0.01			7.1	0.73	1.8	0.014	1600	2.8	10000	26
Hexachlorocyclohexane Gamma-	0.01		0.01	7.4		0.25	16	0.063				5000	
Hexachloroethane	0.01		0.01			21	0.69	25	0.071	160	54	12000	1.5
Hexane (n)	0.05		0.05					88	34		130000	2400	
Indeno[1 2 3-cd]pyrene	0.1		0.11	0.48		0.78	310	9.5E+13	300000		4000	9200	
Lead	10		45	310	32	200						38000	
Mercury	0.1		0.16	15	20	9.8	770	1.3E+14	1.8		36	50000	
Methoxychlor	0.05		0.05		0.13	0.38	45000	4.3				9700	
Methyl Ethyl Ketone	0.5		0.5	44	5700	13000	310	380	180	8700	44000	38000	60
Methyl Isobutyl Ketone	0.5		0.5			21000	380	210	66	400	23000	7100	4.3
Methyl Mercury **				1	0.034	2	1.4	0.0094				1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	31		440	2.3	350	1.4		170	12000	
Methylene Chloride	0.05		0.05	0.98	230	110	5.7	9.8	0.96	6300	2200	8400	230
Methlynaphthalene, 2-(1-) ***	0.05		0.05			72	42	85		260		5200	3.4
Molybdenum	2		2	40	6.9	110						34000	
Naphthalene	0.05		0.05	0.75	380	360	130	220	4.6	1200	270	4000	15
Nickel	5		37	130	5000	330							
Pentachlorophenol	0.1		0.1	21	0.013	3.6	120	3.3				12000	
Petroleum Hydrocarbons F1****	10		17	210		6900	5800	65	240		26000	2600	
Petroleum Hydrocarbons F2	10		10	150		3100	6000	250	150		25000	3900	
Petroleum Hydrocarbons F3	50		240	1300		5800	28000					7200	
Petroleum Hydrocarbons F4	50		120	5600		6100	2300000					8000	
Phenanthrene	0.05		0.19	7.8	2700		24	300				3500	
Phenol	0.5		0.5	22	9.4	5400	330	53	7500	280000	16000	240000	3400
Polychlorinated Biphenyls	0.3		0.3	41	1.1	0.35	1100	1.1E+12	19		120	5000	
Pyrene	0.05		0.19		4700	78	330	2900	13000		23000	9300	
Selenium	1		1.2	13	2.4	110							
Silver	0.5		0.5	25		77						35000	
Styrene	0.05		0.05	22		2500	66	75	19	140	3400	4700	2.2
Tetrachloroethane, 1,1,1,2-	0.05		0.05			30	0.2	43	0.046		5.1	6400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05			4	0.19	56	0.0096	20000	1.6	8800	270
Tetrachloroethylene	0.05		0.05	4.8	4.5	290	2.5	21	2.3	2700	2300	5700	100
Thallium	1		1	1.8	3.9	0.29						34000	
Toluene	0.2		0.2	220	140	1700	9	78	50	290	34000	4400	6

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Agricultural Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Trichlorobenzene, 1,2,4-	0.05		0.05	16		210	63	48	1.4	8200	290	5300	110
Trichloroethane, 1,1,1-	0.05		0.05	22	820	42000	27	12	3.4	9000	12000	5500	640
Trichloroethane, 1,1,2-	0.05		0.05	100		14	0.73	150	0.018		2.9	5700	
Trichloroethylene	0.05		0.05	130	8.1	31	0.76	360	0.52	4100	24	6000	160
Trichlorofluoromethane	0.05		0.05	20		6300	33	5.8				6600	
Trichlorophenol, 2,4,5-	0.1		0.1	5.5		56	13	30				14000	
Trichlorophenol, 2,4,6-	0.1		0.1	5.5		56	2.9	4.2				15000	
Uranium	1		1.9	500	33	23						64000	
Vanadium	10		86	250	18	39						11000	
Vinyl Chloride	0.02		0.02	4.3	6.8	0.57	0.25	380	0.022	10000	14	8400	670
Xylene Mixture	0.05		0.05	55	96	4200	170	30	25	4600	4900	3400	93
Zinc	30		290	500	340	5600						24000	
Electrical Conductivity (mS/cm)			0.47	0.7									
Chloride	5		52				35000	430				5100	
Sodium Adsorption Ratio			1	5									
Sodium	50		430										

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Acenaphthene	0.05		0.072		6600	78	29	620	58	29000	1300	4300	360
Acenaphthylene	0.05		0.093			7.8	3.2	0.17	3.3		96	4000	
Acetone	0.5		0.5		56	19000	440	28	1200	54000	120000	140000	290
Aldrin	0.05		0.05	0.055	0.0024	0.56	43	170000		1500000		5000	18000
Anthracene	0.05		0.16	3.1	38000	5400	21000	0.74				4300	
Antimony	1		1.3	25	25	7.5						13000	
Arsenic	1		18	25	51	0.95						19000	
Barium	5		220	1000	390	3800						12000	
Benzene	0.02		0.02	60	370	9.3	1.3	16	0.17	6700	17	6200	150
Benz[a]anthracene	0.05		0.36	0.63		0.78	270	5.6E+11	490		330	9200	
Benzo[a]pyrene	0.05		0.3	25	1600	0.078	9.2	4.2E+13	6100		170	9200	
Benzo[b]fluoranthene	0.05		0.47			0.78	94	8.6E+13	37000		2000	9200	
Benzo[ghi]perylene	0.1		0.68	8.3		7.8	3100	1.4E+13				9200	
Benzo[k]fluoranthene	0.05		0.48	9.5		0.78	92	2.8E+13	45000		2100	9200	
Beryllium	2		2.5	5	13	38						6200	
Biphenyl 1,1'-	0.05		0.05			710	830	210		83		3900	1.1
Bis(2-chloroethyl)ether	0.5		0.5			0.32	0.0014	130		660		8800	5.6
Bis(2-chloroisopropyl)ether	0.5		0.5			840	13	160		150		14	1.8
Bis(2-ethylhexyl)phthalate	5		5	17	0.8	1100	1200	2.8E+09				8300	
Boron (Hot Water Soluble)*	0.5		0.5	1.5								7900	
Boron (total)	5		36		120	4300						7900	
Bromodichloromethane	0.05		0.05			13	1.9	63				8100	
Bromoform	0.05		0.05			100	2.9	27	0.26	1500	91	15000	16
Bromomethane	0.05		0.05			6.3	0.1	2	0.0034	270	68	10000	18
Cadmium	1		1.2	12	1.9	0.69						29000	
Carbon Tetrachloride	0.05		0.05	7.3	7.6	15	0.71	3	0.12	4300	30	6000	370
Chlordane	0.05		0.05	1.4	0.0085	0.59	710	200	43	33000	210	10000	390
Chloroaniline p-	0.5		0.5	25		38	0.89	0.53				8100	
Chlorobenzene	0.05		0.05	7.5		1300	11	2.7	53	620	8900	5100	11
Chloroform	0.05		0.05	43	81	26	3	12	0.18	13000	8.9	9000	450
Chlorophenol, 2-	0.1		0.1	2		63	5.1	23				130000	
Chromium Total	5		70	390	160	28000						18000	
Chromium VI	0.2		0.66	10	910	160							
Chrysene	0.05		2.8	8.8		7.8	28	4E+11	13000		6600	9300	
Cobalt	2		21	50	180	22						30000	
Copper	5		92	180	770	600							
Cyanide (CN-)	0.05		0.051	1.1	0.11	380	23	0.03				290000	
Dibenz[a h]anthracene	0.1		0.1			0.078	31	2.7E+13	170000		430	9200	
Dibromochloromethane	0.05		0.05			9.4	2.9	61				13000	
Dichlorobenzene, 1,2-	0.05		0.05	4.3		6300	1.7	68	52	1300	9200	4800	19
Dichlorobenzene, 1,3-	0.05		0.05	6		420	34	67				4900	
Dichlorobenzene, 1,4-	0.05		0.05	4.5		47	0.57	67	0.097	170	18	4600	2.6
Dichlorobenzidine, 3,3'-	1		1			0.52	0.22	74				5000	
Dichlorodifluoromethane	0.05		0.05	50		4200	280	25				1000	
DDD	0.05		0.05	8.5		3.3	1800	38000000				5000	
DDE	0.05		0.05	0.33		2.3	1800	350000000				5000	
DDT	0.05		1.4	1.3	0.0011	2.3	2600	810000000				5000	
Dichloroethane, 1,1-	0.05		0.05	11		840	0.6	2000	31	1100	1500	6600	41
Dichloroethane, 1,2-	0.05		0.05	60	29	8.7	0.62	220	0.013	5700	1.4	7100	110
Dichloroethylene, 1,1-	0.05		0.05	63	43	1000	1.8	15	0.038	1800	1300	5800	140
Dichloroethylene, 1,2-cis-	0.05		0.05		84	630	2.5	160	30		1300	6400	
Dichloroethylene, 1,2-trans-	0.05		0.05		84	420	2.5	280	0.75	300	700	6500	18
Dichlorophenol, 2,4-	0.1		0.1	2.1		63	0.27	52				33000	

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Dichloropropane, 1,2-	0.05		0.05	31		22	0.74	91	0.085	38	27	2300	0.81
Dichloropropene,1,3-	0.05		0.05	31		8.7	0.081	4.5	0.083	140	9	6600	2.8
Dieldrin	0.05		0.05	0.055	0.00096	0.94	4.3	0.12				11000	
Diethyl Phthalate	0.5		0.5	13	85	94000	3100	0.081				9100	
Dimethylphthalate	0.5		0.5	21		94000	1800	0.029				2000	
Dimethylphenol, 2,4-	0.2		0.2			420	53	440				57000	
Dinitrophenol, 2,4-	2		2			38	2.9	66				14000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			0.92	0.021	17				5400	
Dioxane, 1,4	0.2		0.2		1.8	72	7.7	1500	1400		57000	130000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000013	0.000048	0.0026	870	0.017		0.11	8200	
Endosulfan	0.04		0.04	0.19	0.023	38	150	0.51				11000	
Endrin	0.04		0.04	0.024	0.0011	4.7	25	0.079				5000	
Ethylbenzene	0.05		0.05	120	90	2100	1.6	19	16	800	7600	3800	15
Ethylene dibromide	0.05		0.05			0.22	0.0062	110	0.00054	11000	0.099	2200	150
Fluoranthene	0.05		0.56	63	0.69	7.8	34	45000	1700		2500	9200	
Fluorene	0.05		0.12			720	1600	69				4200	
Heptachlor	0.05		0.05	0.25	3.9	0.15	92	2		110000		10000	1300
Heptachlor Epoxide	0.05		0.05			0.11	9.3	0.0039		52000		5000	620
Hexachlorobenzene	0.01		0.01	130		0.52	4	15				12000	
Hexachlorobutadiene	0.01		0.01			7.1	0.73	1.8	0.014	1600	2.8	10000	26
Hexachlorocyclohexane Gamma-	0.01		0.01	7.4		0.25	16	0.063				5000	
Hexachloroethane	0.01		0.01			21	0.69	25	0.071	160	54	12000	1.5
Hexane (n)	0.05		0.05					88	34		130000	2400	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.48		0.78	310	9.5E+13	300000		4000	9200	
Lead	10		120	310	32	200						38000	
Mercury	0.1		0.27	15	20	9.8	770	1.3E+14	1.8		36	50000	
Methoxychlor	0.05		0.05		0.13	0.38	45000	4.3				9700	
Methyl Ethyl Ketone	0.5		0.5	44	9900	13000	310	380	180	8700	44000	38000	60
Methyl Isobutyl Ketone	0.5		0.5			21000	380	210	66	400	23000	7100	4.3
Methyl Mercury **				1	0.034	2	1.4	0.0094				1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	31		440	2.3	350	1.4		170	12000	
Methylene Chloride	0.05		0.05	0.98	350	110	5.7	9.8	0.96	6300	2200	8400	230
Methlynaphthalene, 2-(1-) ***	0.05		0.59			72	42	85		260		5200	3.4
Molybdenum	2		2	40	6.9	110						34000	
Naphthalene	0.05		0.09	0.75	380	360	130	220	4.6	1200	270	4000	15
Nickel	5		82	130	5000	330							
Pentachlorophenol	0.1		0.1	21	0.013	3.6	120	3.3				12000	
Petroleum Hydrocarbons F1****	10		25	210		6900	5800	65	240		26000	2600	
Petroleum Hydrocarbons F2	10		10	150		3100	6000	250	150		25000	3900	
Petroleum Hydrocarbons F3	50		240	1300		5800	28000					7200	
Petroleum Hydrocarbons F4	50		120	5600		6100	2300000					8000	
Phenanthrene	0.05		0.69	7.8	2700		24	300				3500	
Phenol	0.5		0.5	22	9.4	5400	330	53	7500	280000	16000	240000	3400
Polychlorinated Biphenyls	0.3		0.3	41	1.1	0.35	1100	1.1E+12	19		120	5000	
Pyrene	0.05		1		4700	78	330	2900	13000		23000	9300	
Selenium	1		1.5	13	2.4	110							
Silver	0.5		0.5	25		77						35000	
Styrene	0.05		0.05	22		2500	66	75	19	140	3400	4700	2.2
Tetrachloroethane, 1,1,1,2-	0.05		0.05			30	0.2	43	0.046		5.1	6400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05			4	0.19	56	0.0096	20000	1.6	8800	270
Tetrachloroethylene	0.05		0.05	4.8	4.5	290	2.5	21	2.3	2700	2300	5700	100
Thallium	1		1	1.8	3.9	0.29						34000	
Toluene	0.2		0.2	220	140	1700	9	78	50	290	34000	4400	6

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Trichlorobenzene, 1,2,4-	0.05		0.05	16		210	63	48	1.4	8200	290	5300	110
Trichloroethane, 1,1,1-	0.05		0.05	22	820	42000	27	12	3.4	9000	12000	5500	640
Trichloroethane, 1,1,2-	0.05		0.05	100		14	0.73	150	0.018		2.9	5700	
Trichloroethylene	0.05		0.05	130	8.1	31	0.76	360	0.52	4100	24	6000	160
Trichlorofluoromethane	0.05		0.25	20		6300	33	5.8				6600	
Trichlorophenol, 2,4,5-	0.1		0.1	5.5		56	13	30				14000	
Trichlorophenol, 2,4,6-	0.1		0.1	5.5		56	2.9	4.2				15000	
Uranium	1		2.5	500	33	23						64000	
Vanadium	10		86	250	18	39						11000	
Vinyl Chloride	0.02		0.02	4.3	12	0.57	0.25	380	0.022	10000	14	8400	670
Xylene Mixture	0.05		0.05	55	96	4200	170	30	25	4600	4900	3400	93
Zinc	30		290	500	340	5600						24000	
Electrical Conductivity (mS/cm)			0.57	0.7									
Chloride	5		210				35000	430				5100	
Sodium Adsorption Ratio			2.4	5									
Sodium	50		1300										

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Acenaphthene	0.05		0.072		46000	96	3600	29	620	680	100000	1300	4300
Acenaphthylene	0.05		0.093			9.6	360	3.2	0.17	39		96	4000
Acetone	0.5		0.5		56	200000	660000	440	28	12000	200000	120000	140000
Aldrin	0.05		0.05	0.11	1200	4.7	6.3	43	170000		5600000		5000
Anthracene	0.05		0.16	40	470000	42000	420000	21000	0.74				4300
Antimony	1		1.3	50	1500	63	63						13000
Arsenic	1		18	50	330	1.3	47						19000
Barium	5		220	2000	670	32000	8600						12000
Benzene	0.02		0.02	310	6800	13	480	1.3	16	0.4	24000	17	6200
Benz[a]anthracene	0.05		0.36	1.3		0.96	36	270	5.6E+11	5700		330	9200
Benzo[a]pyrene	0.05		0.3	90	46000	0.096	3.6	9.2	4.2E+13	72000		170	9200
Benzo[b]fluoranthene	0.05		0.47			0.96	36	94	8.6E+13	430000		2000	9200
Benzo[ghi]perylene	0.1		0.68	17		9.6	360	3100	1.4E+13				9200
Benzo[k]fluoranthene	0.05		0.48	19		0.96	36	92	2.8E+13	530000		2100	9200
Beryllium	2		2.5	10	780	320	60						6200
Biphenyl 1,1'-	0.05		0.05			6000	6000	830	210		300		3900
Bis(2-chloroethyl)ether	0.5		0.5			0.44	16	0.0014	130		2400		8800
Bis(2-chloroisopropyl)ether	0.5		0.5			8800	8800	13	160		550		14
Bis(2-ethylhexyl)phthalate	5		5	35	140000	9500	16000	1200	2.8E+09				8300
Boron (Hot Water Soluble)*	0.5		0.5	2									7900
Boron (total)	5		36		120	24000	24000						7900
Bromodichloromethane	0.05		0.05			18	660	1.9	63				8100
Bromoform	0.05		0.05			140	5200	2.9	27	1.7	5500	91	15000
Bromomethane	0.05		0.05			66	660	0.1	2	0.012	990	68	10000
Cadmium	1		1.2	30	1.9	7.9	7.9						29000
Carbon Tetrachloride	0.05		0.05	15	880	150	1500	0.71	3	1.5	16000	30	6000
Chlordane	0.05		0.05	2.7	0.0085	0.8	30	710	200	510	120000	210	10000
Chloroaniline p-	0.5		0.5	50		320	320	0.89	0.53				8100
Chlorobenzene	0.05		0.05	15		13000	42000	11	2.7	340	2300	8900	5100
Chloroform	0.05		0.05	85	830	35	1300	3	12	0.18	48000	8.9	9000
Chlorophenol, 2-	0.1		0.1	3.9		660	660	5.1	23				130000
Chromium Total	5		70	630	160	240000	240000						18000
Chromium VI	0.2		0.66	10	8500	1300	40						
Chrysene	0.05		2.8	18		9.6	360	28	4E+11	150000		6600	9300
Cobalt	2		21	100	180	250	2500						30000
Copper	5		92	300	3100	5600	5600						
Cyanide (CN-)	0.05		0.051	10	0.11	3200	7900	23	0.03				290000
Dibenz[a h]anthracene	0.1		0.1			0.096	3.6	31	2.7E+13	2300000		430	9200
Dibromochloromethane	0.05		0.05			13	490	2.9	61				13000
Dichlorobenzene, 1,2-	0.05		0.05	8.5		66000	130000	1.7	68	520	4700	9200	4800
Dichlorobenzene, 1,3-	0.05		0.05	12		4400	4400	34	67				4900
Dichlorobenzene, 1,4-	0.05		0.05	9		65	2400	0.57	67	0.84	630	18	4600
Dichlorobenzidine, 3,3'-	1		1			0.66	25	0.22	74				5000
Dichlorodifluoromethane	0.05		0.05	100		44000	44000	280	25				1000
DDD	0.05		0.05	17		4.6	110	1800	38000000				5000
DDE	0.05		0.05	0.65		3.2	110	1800	350000000				5000
DDT	0.05		1.4	7.8	0.0012	3.2	110	2600	810000000				5000
Dichloroethane, 1,1-	0.05		0.05	21		8800	88000	0.6	2000	39	4100	1500	6600
Dichloroethane, 1,2-	0.05		0.05	120	29	12	450	0.62	220	0.04	21000	1.4	7100
Dichloroethylene, 1,1-	0.05		0.05	130	760	11000	11000	1.8	15	0.48	6400	1300	5800
Dichloroethylene, 1,2-cis-	0.05		0.05		940	6600	66000	2.5	160	37		1300	6400
Dichloroethylene, 1,2-trans-	0.05		0.05		940	4400	44000	2.5	280	9.3	1100	700	6500
Dichlorophenol, 2,4-	0.1		0.1	4.2		660	660	0.27	52				33000

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Dichloropropane, 1,2-	0.05		0.05	63		31	1100	0.74	91	0.68	140	27	2300
Dichloropropene,1,3-	0.05		0.05	63		12	450	0.081	4.5	0.21	500	9	6600
Dieldrin	0.05		0.05	0.11	240	7.9	16	4.3	0.12				11000
Diethyl Phthalate	0.5		0.5	27	1000000	790000	1300000	3100	0.081				9100
Dimethylphthalate	0.5		0.5	42		790000	790000	1800	0.029				2000
Dimethylphenol, 2,4-	0.2		0.2			4400	44000	53	440				57000
Dinitrophenol, 2,4-	2		2			320	3200	2.9	66				14000
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			1.2	43	0.021	17				5400
Dioxane, 1,4	0.2		0.2		1.8	100	3700	7.7	1500	17000		57000	130000
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000099	0.00051	0.0044	0.0026	870	0.21		0.11	8200
Endosulfan	0.04		0.04	0.38	1.2	320	790	150	0.51				11000
Endrin	0.04		0.04	0.048	0.0011	39	320	25	0.079				5000
Ethylbenzene	0.05		0.05	430	38000	22000	22000	1.6	19	59	2900	7600	3800
Ethylene dibromide	0.05		0.05			0.31	11	0.0062	110	0.0019	42000	0.099	2200
Fluoranthene	0.05		0.56		120000	9.6	360	34	45000	21000		2500	9200
Fluorene	0.05		0.12			5600	56000	1600	69				4200
Heptachlor	0.05		0.05	0.5	1100	0.19	2.3	92	2		400000		10000
Heptachlor Epoxide	0.05		0.05			0.14	5.3	9.3	0.0039		190000		5000
Hexachlorobenzene	0.01		0.01	250		0.66	16	4	15				12000
Hexachlorobutadiene	0.01		0.01			14	75	0.73	1.8	0.095	5900	2.8	10000
Hexachlorocyclohexane Gamma-	0.01		0.01	15		2.5	2.5	16	0.063				5000
Hexachloroethane	0.01		0.01			79	2200	0.69	25	0.43	590	54	12000
Hexane (n)	0.05		0.05				21000000		88	420		130000	2400
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.95		0.96	36	310	9.5E+13	3500000		4000	9200
Lead	10		120	1400	32	1000	1000						38000
Mercury	0.1		0.27	63	20	67	670	770	1.3E+14	22		36	50000
Methoxychlor	0.05		0.05		4100	1.6	1.6	45000	4.3				9700
Methyl Ethyl Ketone	0.5		0.5	88	9900	64000	64000	310	380	670	32000	44000	38000
Methyl Isobutyl Ketone	0.5		0.5			110000	110000	380	210	240	1400	23000	7100
Methyl Mercury **				2	0.034	9.2	9.2	1.4	0.0094				1300000
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	63		610	23000	2.3	350	3.2		170	12000
Methylene Chloride	0.05		0.05	2	400	150	5500	5.7	9.8	12	23000	2200	8400
Methlynaphthalene, 2-(1-) ***	0.05		0.59			560	560	42	85		940		5200
Molybdenum	2		2	40	74	1200	1200						34000
Naphthalene	0.05		0.09	28	1300	2800	28000	130	220	57	4300	270	4000
Nickel	5		82	340	5400	2200	510						
Pentachlorophenol	0.1		0.1	39	2000	4.1	50	120	3.3				12000
Petroleum Hydrocarbons F1****	10		25	320		47000	100000	5800	65	800		26000	2600
Petroleum Hydrocarbons F2	10		10	260		22000	48000	6000	250	950		25000	3900
Petroleum Hydrocarbons F3	50		240	2500		40000	260000	28000					7200
Petroleum Hydrocarbons F4	50		120	6600		42000	400000	2300000					8000
Phenanthrene	0.05		0.69	16	36000			24	300				3500
Phenol	0.5		0.5	40	9.4	42000	42000	330	53	94000	1000000	16000	240000
Polychlorinated Biphenyls	0.3		0.3	41	1.1	2.7	4.1	1100	1.1E+12	230		120	5000
Pyrene	0.05		1		99000	96	3600	330	2900	160000		23000	9300
Selenium	1		1.5	13	5.5	1200	1200						
Silver	0.5		0.5	50		490	490						35000
Styrene	0.05		0.05	43		26000	26000	66	75	170	510	3400	4700
Tetrachloroethane, 1,1,1,2-	0.05		0.05			42	1600	0.2	43	0.11		5.1	6400
Tetrachloroethane, 1,1,2,2-	0.05		0.05			5.5	210	0.19	56	0.094	72000	1.6	8800
Tetrachloroethylene	0.05		0.05	43	310	3100	31000	2.5	21	29	9700	2300	5700
Thallium	1		1	4.5	47	3.3	33						34000
Toluene	0.2		0.2	660	14000	18000	180000	9	78	620	1000	34000	4400

Soil Components for Table 2 - Full Depth, Potable Water Scenario

Fine - Medium Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Trichlorobenzene, 1,2,4-	0.05		0.05	30		2200	22000	63	48	16	30000	290	5300
Trichloroethane, 1,1,1-	0.05		0.05	44	39000	440000	1500000	27	12	42	33000	12000	5500
Trichloroethane, 1,1,2-	0.05		0.05	200		19	720	0.73	150	0.11		2.9	5700
Trichloroethylene	0.05		0.05	250	390	85	160	0.76	360	0.61	15000	24	6000
Trichlorofluoromethane	0.05		0.25	40		66000	66000	33	5.8				6600
Trichlorophenol, 2,4,5-	0.1		0.1	10		470	470	13	30				14000
Trichlorophenol, 2,4,6-	0.1		0.1	10		72	470	2.9	4.2				15000
Uranium	1		2.5	2000	33	300	300						64000
Vanadium	10		86	250	18	160	160						11000
Vinyl Chloride	0.02		0.02	8.5	12	0.79	29	0.25	380	0.25	38000	14	8400
Xylene Mixture	0.05		0.05	210	47000	44000	88000	170	30	140	17000	4900	3400
Zinc	30		290	800	340	47000	47000						24000
Electrical Conductivity (mS/cm)			0.57	1.4									
Chloride	5		210					35000	430				5100
Sodium Adsorption Ratio			2.4	12									
Sodium	50		1300										

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Acenaphthene	0.05		0.072		6600	78	560	7.9	3900	1300	2800	100
Acenaphthylene	0.05		0.093			7.8	0.15	0.45		96	2900	
Acetone	0.5		0.5		56	19000	16	720	4300	120000	92000	140
Aldrin	0.05		0.05	0.044	0.0024	0.56	150000		260000		5000	5200
Anthracene	0.05		0.16	2.5	38000	5400	0.67				2700	
Antimony	1		1.3	20	25	7.5					8000	
Arsenic	1		18	20	51	0.95					12000	
Barium	5		220	750	390	3800					7700	
Benzene	0.02		0.02	25	370	9.3	14	0.21	820	17	5000	63
Benz[a]anthracene	0.05		0.36	0.5		0.78	5.1E+11	65		330	7600	
Benzo[a]pyrene	0.05		0.3	20	1600	0.078	3.8E+13	820		170	7600	
Benzo[b]fluoranthene	0.05		0.47			0.78	7.7E+13	5500		2000	7600	
Benzo[ghi]perylene	0.1		0.68	6.6		7.8	1.2E+13				7600	
Benzo[k]fluoranthene	0.05		0.48	7.6		0.78	2.5E+13	6700		2100	7600	
Beryllium	2		2.5	4	13	38					3900	
Biphenyl 1,1'-	0.05		0.05			710	190		11		2600	0.31
Bis(2-chloroethyl)ether	0.5		0.5			0.32	92		69		6400	1.9
Bis(2-chloroisopropyl)ether	0.5		0.5			840	120		18		11	0.67
Bis(2-ethylhexyl)phthalate	5		5	14	0.8	1100	2.5E+09				7100	
Boron (Hot Water Soluble)*	0.5		0.5	1.5							5000	
Boron (total)	5		36		120	4300					5000	
Bromodichloromethane	0.05		0.05			13	50				5500	
Bromoform	0.05		0.05			100	21	0.27	220	91	11000	5.4
Bromomethane	0.05		0.05			6.3	1.4	0.00034	27	68	7300	6
Cadmium	1		1.2	12	1.9	0.69					18000	
Carbon Tetrachloride	0.05		0.05	5.8	7.6	15	2.3	0.013	470	30	3900	120
Chlordane	0.05		0.05	1.1	0.0085	0.59	180	7.6	5700	210	8400	110
Chloroaniline p-	0.5		0.5	20		38	0.45				6100	
Chlorobenzene	0.05		0.05	6		1300	2.4	91	78	8900	3700	3.7
Chloroform	0.05		0.05	34	81	26	9.5	0.032	1400	8.9	6600	260
Chlorophenol, 2-	0.1		0.1	1.6		63	21				130000	
Chromium Total	5		70	310	160	28000					11000	
Chromium VI	0.2		0.66	8	910	160						
Chrysene	0.05		2.8	7		7.8	3.6E+11	1900		6600	7700	
Cobalt	2		21	40	180	22					19000	
Copper	5		92	140	770	600						
Cyanide (CN-)	0.05		0.051	0.9	0.11	380	0.022				240000	
Dibenz[a h]anthracene	0.1		0.1			0.078	2.4E+13	33000		430	7600	
Dibromochloromethane	0.05		0.05			9.4	48				10000	
Dichlorobenzene, 1,2-	0.05		0.05	3.4		6300	60	35	160	9200	3100	6.1
Dichlorobenzene, 1,3-	0.05		0.05	4.8		420	59				3300	
Dichlorobenzene, 1,4-	0.05		0.05	3.6		47	59	0.083	22	18	3000	0.85
Dichlorobenzidine, 3,3'-	1		1			0.52	66				5000	
Dichlorodifluoromethane	0.05		0.05	40		4200	16				710	
DDD	0.05		0.05	6.8		3.3	34000000				5000	
DDE	0.05		0.05	0.26		2.3	310000000				5000	
DDT	0.05		1.4	1	0.0011	2.3	730000000				5000	
Dichloroethane, 1,1-	0.05		0.05	8.4		840	1600	3.5	130	1500	4800	24
Dichloroethane, 1,2-	0.05		0.05	48	29	8.7	180	0.025	640	1.4	5300	45
Dichloroethylene, 1,1-	0.05		0.05	50	43	1000	11	0.004	180	1300	3900	44
Dichloroethylene, 1,2-cis-	0.05		0.05		84	630	130	3.4		1300	4600	
Dichloroethylene, 1,2-trans-	0.05		0.05		84	420	220	0.084	34	700	4600	8.5
Dichlorophenol, 2,4-	0.1		0.1	1.7		63	46				33000	

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Dichloropropane, 1,2-	0.05		0.05	25		22	76	0.01	4.5	27	2100	0.34
Dichloropropene,1,3-	0.05		0.05	25		8.7	3.8	0.027	17	9	5000	1.2
Dieldrin	0.05		0.05	0.044	0.00096	0.94	0.11				8700	
Diethyl Phthalate	0.5		0.5	11	85	94000	0.07				7600	
Dimethylphthalate	0.5		0.5	17		94000	0.023				1800	
Dimethylphenol, 2,4-	0.2		0.2			420	390				57000	
Dinitrophenol, 2,4-	2		2			38	59				13000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			0.92	15				3800	
Dioxane, 1,4	0.2		0.2		1.8	72	810	180		57000	82000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000013	0.000048	780	0.0028		0.11	7000	
Endosulfan	0.04		0.04	0.15	0.023	38	0.46				8700	
Endrin	0.04		0.04	0.019	0.0011	4.7	0.071				5000	
Ethylbenzene	0.05		0.05	55	90	2100	17	2	100	7600	2700	5.2
Ethylene dibromide	0.05		0.05			0.22	86	0.0014	1600	0.099	2000	51
Fluoranthene	0.05		0.56	50	0.69	7.8	40000	250		2500	7600	
Fluorene	0.05		0.12			720	62				2800	
Heptachlor	0.05		0.05	0.2	3.9	0.15	1.8		19000		8300	370
Heptachlor Epoxide	0.05		0.05			0.11	0.0035		8800		5000	180
Hexachlorobenzene	0.01		0.01	100		0.52	14				9300	
Hexachlorobutadiene	0.01		0.01			7.1	1.6	0.012	210	2.8	8300	8.6
Hexachlorocyclohexane Gamma-	0.01		0.01	5.9		0.25	0.056				5000	
Hexachloroethane	0.01		0.01			21	22	0.089	51	54	9400	0.46
Hexane (n)	0.05		0.05				54	2.8		130000	1500	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.38		0.78	8.6E+13	46000		4000	7600	
Lead	10		120	250	32	200					24000	
Mercury	0.1		0.27	10	20	9.8	1.2E+14	0.25		36	34000	
Methoxychlor	0.05		0.05		0.13	0.38	3.9				8000	
Methyl Ethyl Ketone	0.5		0.5	35	9900	13000	230	16	750	44000	26000	26
Methyl Isobutyl Ketone	0.5		0.5			21000	150	6.6	39	23000	5100	1.7
Methyl Mercury **				0.8	0.034	2	0.0084				1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	25		440	220	0.75		170	8000	
Methylene Chloride	0.05		0.05	0.78	350	110	7.4	0.1	670	2200	6400	150
Methlynaphthalene, 2-(1-) ***	0.05		0.59			72	76		34		3600	0.99
Molybdenum	2		2	40	6.9	110					22000	
Naphthalene	0.05		0.09	0.6	380	360	200	0.65	150	270	2800	4.5
Nickel	5		82	100	5000	330						
Pentachlorophenol	0.1		0.1	17	0.013	3.6	2.9				9200	
Petroleum Hydrocarbons F1****	10		25	210		6900	55	130		26000	1700	
Petroleum Hydrocarbons F2	10		10	150		3100	230	98		25000	2700	
Petroleum Hydrocarbons F3	50		240	300		5800					5800	
Petroleum Hydrocarbons F4	50		120	2800		6100					6900	
Phenanthrene	0.05		0.69	6.2	2700		270				2300	
Phenol	0.5		0.5	17	9.4	5400	46	940	34000	16000	230000	970
Polychlorinated Biphenyls	0.3		0.3	33	1.1	0.35	9.9E+11	3.1		120	5000	
Pyrene	0.05		1		4700	78	2600	1900		23000	7700	
Selenium	1		1.5	10	2.4	110						
Silver	0.5		0.5	20		77					22000	
Styrene	0.05		0.05	17		2500	66	16	18	3400	3500	0.7
Tetrachloroethane, 1,1,1,2-	0.05		0.05			30	37	0.058		5.1	4400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05			4	48	0.0045	2400	1.6	6700	86
Tetrachloroethylene	0.05		0.05	3.8	4.5	290	18	0.28	320	2300	3700	61
Thallium	1		1	1.4	3.9	0.29					22000	
Toluene	0.2		0.2	150	140	1700	68	6.2	35	34000	3300	2.3

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Trichlorobenzene, 1,2,4-	0.05		0.05	13		210	43	0.36	1100	290	3400	32
Trichloroethane, 1,1,1-	0.05		0.05	18	820	42000	9.8	0.38	1000	12000	3700	250
Trichloroethane, 1,1,2-	0.05		0.05	80		14	120	0.03		2.9	3900	
Trichloroethylene	0.05		0.05	100	8.1	31	300	0.061	480	24	4100	91
Trichlorofluoromethane	0.05		0.25	16		6300	4				4400	
Trichlorophenol, 2,4,5-	0.1		0.1	4.4		56	27				14000	
Trichlorophenol, 2,4,6-	0.1		0.1	4.4		56	3.8				13000	
Uranium	1		2.5	500	33	23					40000	
Vanadium	10		86	200	18	39					7100	
Vinyl Chloride	0.02		0.02	3.4	12	0.57	270	0.0021	1000	14	6100	230
Xylene Mixture	0.05		0.05	95	96	4200	26	3.1	580	4900	2300	35
Zinc	30		290	400	340	5600					15000	
Electrical Conductivity (mS/cm)			0.57	0.7								
Chloride	5		210				220				3000	
Sodium Adsorption Ratio			2.4	5								
Sodium	50		1300									

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Acenaphthene	0.05		0.072		46000	96	3600	560	120	18000	1300	2800
Acenaphthylene	0.05		0.093			9.6	360	0.15	6.6		96	2900
Acetone	0.5		0.5		56	200000	660000	16	1900	20000	120000	92000
Aldrin	0.05		0.05	0.088	1200	4.7	6.3	150000		1200000		5000
Anthracene	0.05		0.16	32	470000	42000	420000	0.67				2700
Antimony	1		1.3	40	1500	63	63					8000
Arsenic	1		18	40	330	1.3	47					12000
Barium	5		220	1500	670	32000	8600					7700
Benzene	0.02		0.02	180	6800	13	480	14	0.32	3800	17	5000
Benz[a]anthracene	0.05		0.36	1		0.96	36	5.1E+11	970		330	7600
Benzo[a]pyrene	0.05		0.3	72	46000	0.096	3.6	3.8E+13	12000		170	7600
Benzo[b]fluoranthene	0.05		0.47			0.96	36	7.7E+13	81000		2000	7600
Benzo[ghi]perylene	0.1		0.68	13		9.6	360	1.2E+13				7600
Benzo[k]fluoranthene	0.05		0.48	15		0.96	36	2.5E+13	99000		2100	7600
Beryllium	2		2.5	8	780	320	60					3900
Biphenyl 1,1'-	0.05		0.05			6000	6000	190		52		2600
Bis(2-chloroethyl)ether	0.5		0.5			0.44	16	92		320		6400
Bis(2-chloroisopropyl)ether	0.5		0.5			8800	8800	120		82		11
Bis(2-ethylhexyl)phthalate	5		5	28	140000	9500	16000	2.5E+09				7100
Boron (Hot Water Soluble)*	0.5		0.5	2								5000
Boron (total)	5		36		120	24000	24000					5000
Bromodichloromethane	0.05		0.05			18	660	50				5500
Bromoform	0.05		0.05			140	5200	21	0.61	980	91	11000
Bromomethane	0.05		0.05			66	660	1.4	0.0016	130	68	7300
Cadmium	1		1.2	24	1.9	7.9	7.9					18000
Carbon Tetrachloride	0.05		0.05	12	880	150	1500	2.3	0.21	2200	30	3900
Chlordane	0.05		0.05	2.2	0.0085	0.8	30	180	110	26000	210	8400
Chloroaniline p-	0.5		0.5	40		320	320	0.45				6100
Chlorobenzene	0.05		0.05	12		13000	42000	2.4	130	360	8900	3700
Chloroform	0.05		0.05	68	830	35	1300	9.5	0.47	6800	8.9	6600
Chlorophenol, 2-	0.1		0.1	3.1		660	660	21				130000
Chromium Total	5		70	500	160	240000	240000					11000
Chromium VI	0.2		0.66	8	8500	1300	40					
Chrysene	0.05		2.8	14		9.6	360	3.6E+11	28000		6600	7700
Cobalt	2		21	80	180	250	2500					19000
Copper	5		92	230	3100	5600	5600					
Cyanide (CN-)	0.05		0.051	8	0.11	3200	7900	0.022				240000
Dibenz[a h]anthracene	0.1		0.1			0.096	3.6	2.4E+13	480000		430	7600
Dibromochloromethane	0.05		0.05			13	490	48				10000
Dichlorobenzene, 1,2-	0.05		0.05	6.8		66000	130000	60	110	770	9200	3100
Dichlorobenzene, 1,3-	0.05		0.05	9.6		4400	4400	59				3300
Dichlorobenzene, 1,4-	0.05		0.05	7.2		65	2400	59	0.2	100	18	3000
Dichlorobenzidine, 3,3'-	1		1			0.66	25	66				5000
Dichlorodifluoromethane	0.05		0.05	80		44000	44000	16				710
DDD	0.05		0.05	14		4.6	110	34000000				5000
DDE	0.05		0.05	0.52		3.2	110	310000000				5000
DDT	0.05		1.4	6.3	0.0012	3.2	110	730000000				5000
Dichloroethane, 1,1-	0.05		0.05	17		8800	88000	1600	56	590	1500	4800
Dichloroethane, 1,2-	0.05		0.05	96	29	12	450	180	0.038	3000	1.4	5300
Dichloroethylene, 1,1-	0.05		0.05	100	760	11000	11000	11	0.064	860	1300	3900
Dichloroethylene, 1,2-cis-	0.05		0.05		940	6600	66000	130	55		1300	4600
Dichloroethylene, 1,2-trans-	0.05		0.05		940	4400	44000	220	1.3	160	700	4600
Dichlorophenol, 2,4-	0.1		0.1	3.4		660	660	46				33000

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Dichloropropane, 1,2-	0.05		0.05	50		31	1100	76	0.16	21	27	2100
Dichloropropene,1,3-	0.05		0.05	50		12	450	3.8	0.18	78	9	5000
Dieldrin	0.05		0.05	0.088	240	7.9	16	0.11				8700
Diethyl Phthalate	0.5		0.5	21	1000000	790000	1300000	0.07				7600
Dimethylphthalate	0.5		0.5	34		790000	790000	0.023				1800
Dimethylphenol, 2,4-	0.2		0.2			4400	44000	390				57000
Dinitrophenol, 2,4-	2		2			320	3200	59				13000
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			1.2	43	15				3800
Dioxane, 1,4	0.2		0.2		1.8	100	3700	810	1800		57000	82000
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000099	0.00051	0.0044	780	0.043		0.11	7000
Endosulfan	0.04		0.04	0.3	1.2	320	790	0.46				8700
Endrin	0.04		0.04	0.038	0.0011	39	320	0.071				5000
Ethylbenzene	0.05		0.05	300	38000	22000	22000	17	9.5	470	7600	2700
Ethylene dibromide	0.05		0.05			0.31	11	86	0.0015	7100	0.099	2000
Fluoranthene	0.05		0.56	180	120000	9.6	360	40000	3700		2500	7600
Fluorene	0.05		0.12			5600	56000	62				2800
Heptachlor	0.05		0.05	0.4	1100	0.19	2.3	1.8		87000		8300
Heptachlor Epoxide	0.05		0.05			0.14	5.3	0.0035		40000		5000
Hexachlorobenzene	0.01		0.01	200		0.66	16	14				9300
Hexachlorobutadiene	0.01		0.01			14	75	1.6	0.031	980	2.8	8300
Hexachlorocyclohexane Gamma-	0.01		0.01	12		2.5	2.5	0.056				5000
Hexachloroethane	0.01		0.01			79	2200	22	0.21	220	54	9400
Hexane (n)	0.05		0.05				21000000	54	46		130000	1500
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.76		0.96	36	8.6E+13	670000		4000	7600
Lead	10		120	1100	32	1000	1000					24000
Mercury	0.1		0.27	50	20	67	670	1.2E+14	3.9		36	34000
Methoxychlor	0.05		0.05		4100	1.6	1.6	3.9				8000
Methyl Ethyl Ketone	0.5		0.5	70	9900	64000	64000	230	74	3500	44000	26000
Methyl Isobutyl Ketone	0.5		0.5			110000	110000	150	31	180	23000	5100
Methyl Mercury **				1.6	0.034	9.2	9.2	0.0084				1300000
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	50		610	23000	220	11		170	8000
Methylene Chloride	0.05		0.05	1.6	400	150	5500	7.4	1.6	3100	2200	6400
Methlynaphthalene, 2-(1-) ***	0.05		0.59			560	560	76		160		3600
Molybdenum	2		2	40	74	1200	1200					22000
Naphthalene	0.05		0.09	22	1300	2800	28000	200	9.6	710	270	2800
Nickel	5		82	270	5400	2200	510					
Pentachlorophenol	0.1		0.1	31	2000	4.1	50	2.9				9200
Petroleum Hydrocarbons F1****	10		25	320		47000	100000	55	580		26000	1700
Petroleum Hydrocarbons F2	10		10	260		22000	48000	230	380		25000	2700
Petroleum Hydrocarbons F3	50		240	1700		40000	260000					5800
Petroleum Hydrocarbons F4	50		120	3300		42000	400000					6900
Phenanthrene	0.05		0.69	12	36000			270				2300
Phenol	0.5		0.5	40	9.4	42000	42000	46	15000	160000	16000	230000
Polychlorinated Biphenyls	0.3		0.3	33	1.1	2.7	4.1	9.9E+11	45		120	5000
Pyrene	0.05		1		99000	96	3600	2600	28000		23000	7700
Selenium	1		1.5	10	5.5	1200	1200					
Silver	0.5		0.5	40		490	490					22000
Styrene	0.05		0.05	34		26000	26000	66	42	83	3400	3500
Tetrachloroethane, 1,1,1,2-	0.05		0.05			42	1600	37	0.087		5.1	4400
Tetrachloroethane, 1,1,2,2-	0.05		0.05			5.5	210	48	0.019	11000	1.6	6700
Tetrachloroethylene	0.05		0.05	34	310	3100	31000	18	4.5	1500	2300	3700
Thallium	1		1	3.6	47	3.3	33					22000
Toluene	0.2		0.2	500	14000	18000	180000	68	99	170	34000	3300

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Coarse Textured Soil		Industrial/Commercial Land Use (ug/g)										
	MOE	Mass.	Ont. Soil	Plants &	Mammals	Soil Contact	Soil Contact	Leaching	Indoor Air	Indoor Air	Outdoor Air	Free Phase
Chemical Parameter	Soil RL	PQL	Bkgrd	Soil Org.	& Birds	S2 Risk	S3 Risk	S-GW3	S-IA	Odour		Threshold
Trichlorobenzene, 1,2,4-	0.05		0.05	30		2200	22000	43	3.2	5300	290	3400
Trichloroethane, 1,1,1-	0.05		0.05	35	39000	440000	1500000	9.8	6.1	4700	12000	3700
Trichloroethane, 1,1,2-	0.05		0.05	160		19	720	120	0.042		2.9	3900
Trichloroethylene	0.05		0.05	200	390	85	160	300	0.91	2200	24	4100
Trichlorofluoromethane	0.05		0.25	32		66000	66000	4				4400
Trichlorophenol, 2,4,5-	0.1		0.1	10		470	470	27				14000
Trichlorophenol, 2,4,6-	0.1		0.1	10		72	470	3.8				13000
Uranium	1		2.5	2000	33	300	300					40000
Vanadium	10		86	200	18	160	160					7100
Vinyl Chloride	0.02		0.02	6.8	12	0.79	29	270	0.032	4800	14	6100
Xylene Mixture	0.05		0.05	350	47000	44000	88000	26	50	2700	4900	2300
Zinc	30		290	600	340	47000	47000					15000
Electrical Conductivity (mS/cm)			0.57	1.4								
Chloride	5		210					220				3000
Sodium Adsorption Ratio			2.4	12								
Sodium	50		1300									

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Fine - Medium Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Leachig S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Acenaphthene	0.05		0.072		6600	78	620	58	29000	1300	4300	360
Acenaphthylene	0.05		0.093			7.8	0.17	3.3		96	4000	
Acetone	0.5		0.5		56	19000	28	1200	54000	120000	140000	290
Aldrin	0.05		0.05	0.055	0.0024	0.56	170000		1500000		5000	18000
Anthracene	0.05		0.16	3.1	38000	5400	0.74				4300	
Antimony	1		1.3	25	25	7.5					13000	
Arsenic	1		18	25	51	0.95					19000	
Barium	5		220	1000	390	3800					12000	
Benzene	0.02		0.02	60	370	9.3	16	0.17	6700	17	6200	150
Benz[a]anthracene	0.05		0.36	0.63		0.78	5.6E+11	490		330	9200	
Benzo[a]pyrene	0.05		0.3	25	1600	0.078	4.2E+13	6100		170	9200	
Benzo[b]fluoranthene	0.05		0.47			0.78	8.6E+13	37000		2000	9200	
Benzo[ghi]perylene	0.1		0.68	8.3		7.8	1.4E+13				9200	
Benzo[k]fluoranthene	0.05		0.48	9.5		0.78	2.8E+13	45000		2100	9200	
Beryllium	2		2.5	5	13	38					6200	
Biphenyl 1,1'-	0.05		0.05			710	210		83		3900	1.1
Bis(2-chloroethyl)ether	0.5		0.5			0.32	130		660		8800	5.6
Bis(2-chloroisopropyl)ether	0.5		0.5			840	160		150		14	1.8
Bis(2-ethylhexyl)phthalate	5		5	17	0.8	1100	2.8E+09				8300	
Boron (Hot Water Soluble)*	0.5		0.5	1.5							7900	
Boron (total)	5		36		120	4300					7900	
Bromodichloromethane	0.05		0.05			13	63				8100	
Bromoform	0.05		0.05			100	27	0.26	1500	91	15000	16
Bromomethane	0.05		0.05			6.3	2	0.0034	270	68	10000	18
Cadmium	1		1.2	12	1.9	0.69					29000	
Carbon Tetrachloride	0.05		0.05	7.3	7.6	15	3	0.12	4300	30	6000	370
Chlordane	0.05		0.05	1.4	0.0085	0.59	200	43	33000	210	10000	390
Chloroaniline p-	0.5		0.5	25		38	0.53				8100	
Chlorobenzene	0.05		0.05	7.5		1300	2.7	53	620	8900	5100	11
Chloroform	0.05		0.05	43	81	26	12	0.18	13000	8.9	9000	450
Chlorophenol, 2-	0.1		0.1	2		63	23				130000	
Chromium Total	5		70	390	160	28000					18000	
Chromium VI	0.2		0.66	10	910	160						
Chrysene	0.05		2.8	8.8		7.8	4E+11	13000		6600	9300	
Cobalt	2		21	50	180	22					30000	
Copper	5		92	180	770	600						
Cyanide (CN-)	0.05		0.051	1.1	0.11	380	0.03				290000	
Dibenz[a h]anthracene	0.1		0.1			0.078	2.7E+13	170000		430	9200	
Dibromochloromethane	0.05		0.05			9.4	61				13000	
Dichlorobenzene, 1,2-	0.05		0.05	4.3		6300	68	52	1300	9200	4800	19
Dichlorobenzene, 1,3-	0.05		0.05	6		420	67				4900	
Dichlorobenzene, 1,4-	0.05		0.05	4.5		47	67	0.097	170	18	4600	2.6
Dichlorobenzidine, 3,3'-	1		1			0.52	74				5000	
Dichlorodifluoromethane	0.05		0.05	50		4200	25				1000	
DDD	0.05		0.05	8.5		3.3	38000000				5000	
DDE	0.05		0.05	0.33		2.3	350000000				5000	
DDT	0.05		1.4	1.3	0.0011	2.3	810000000				5000	
Dichloroethane, 1,1-	0.05		0.05	11		840	2000	31	1100	1500	6600	41
Dichloroethane, 1,2-	0.05		0.05	60	29	8.7	220	0.013	5700	1.4	7100	110
Dichloroethylene, 1,1-	0.05		0.05	63	43	1000	15	0.038	1800	1300	5800	140
Dichloroethylene, 1,2-cis-	0.05		0.05		84	630	160	30		1300	6400	
Dichloroethylene, 1,2-trans-	0.05		0.05		84	420	280	0.75	300	700	6500	18
Dichlorophenol, 2,4-	0.1		0.1	2.1		63	52				33000	

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Fine - Medium Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S1 Risk	Leachig S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold	Soil Odour S-Nose
Dichloropropane, 1,2-	0.05		0.05	31		22	91	0.085	38	27	2300	0.81
Dichloropropene,1,3-	0.05		0.05	31		8.7	4.5	0.083	140	9	6600	2.8
Dieldrin	0.05		0.05	0.055	0.00096	0.94	0.12				11000	
Diethyl Phthalate	0.5		0.5	13	85	94000	0.081				9100	
Dimethylphthalate	0.5		0.5	21		94000	0.029				2000	
Dimethylphenol, 2,4-	0.2		0.2			420	440				57000	
Dinitrophenol, 2,4-	2		2			38	66				14000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			0.92	17				5400	
Dioxane, 1,4	0.2		0.2		1.8	72	1500	1400		57000	130000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000013	0.000048	870	0.017		0.11	8200	
Endosulfan	0.04		0.04	0.19	0.023	38	0.51				11000	
Endrin	0.04		0.04	0.024	0.0011	4.7	0.079				5000	
Ethylbenzene	0.05		0.05	120	90	2100	19	16	800	7600	3800	15
Ethylene dibromide	0.05		0.05			0.22	110	0.00054	11000	0.099	2200	150
Fluoranthene	0.05		0.56	63	0.69	7.8	45000	1700		2500	9200	
Fluorene	0.05		0.12			720	69				4200	
Heptachlor	0.05		0.05	0.25	3.9	0.15	2		110000		10000	1300
Heptachlor Epoxide	0.05		0.05			0.11	0.0039		52000		5000	620
Hexachlorobenzene	0.01		0.01	130		0.52	15				12000	
Hexachlorobutadiene	0.01		0.01			7.1	1.8	0.014	1600	2.8	10000	26
Hexachlorocyclohexane Gamma-	0.01		0.01	7.4		0.25	0.063				5000	
Hexachloroethane	0.01		0.01			21	25	0.071	160	54	12000	1.5
Hexane (n)	0.05		0.05				88	34		130000	2400	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.48		0.78	9.5E+13	300000		4000	9200	
Lead	10		120	310	32	200					38000	
Mercury	0.1		0.27	15	20	9.8	1.3E+14	1.8		36	50000	
Methoxychlor	0.05		0.05		0.13	0.38	4.3				9700	
Methyl Ethyl Ketone	0.5		0.5	44	9900	13000	380	180	8700	44000	38000	60
Methyl Isobutyl Ketone	0.5		0.5			21000	210	66	400	23000	7100	4.3
Methyl Mercury **				1	0.034	2	0.0094				1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	31		440	350	1.4		170	12000	
Methylene Chloride	0.05		0.05	0.98	350	110	9.8	0.96	6300	2200	8400	230
Methlynaphthalene, 2-(1-) ***	0.05		0.59			72	85		260		5200	3.4
Molybdenum	2		2	40	6.9	110					34000	
Naphthalene	0.05		0.09	0.75	380	360	220	4.6	1200	270	4000	15
Nickel	5		82	130	5000	330						
Pentachlorophenol	0.1		0.1	21	0.013	3.6	3.3				12000	
Petroleum Hydrocarbons F1****	10		25	210		6900	65	240		26000	2600	
Petroleum Hydrocarbons F2	10		10	150		3100	250	150		25000	3900	
Petroleum Hydrocarbons F3	50		240	1300		5800					7200	
Petroleum Hydrocarbons F4	50		120	5600		6100					8000	
Phenanthrene	0.05		0.69	7.8	2700		300				3500	
Phenol	0.5		0.5	22	9.4	5400	53	7500	280000	16000	240000	3400
Polychlorinated Biphenyls	0.3		0.3	41	1.1	0.35	1.1E+12	19		120	5000	
Pyrene	0.05		1		4700	78	2900	13000		23000	9300	
Selenium	1		1.5	13	2.4	110						
Silver	0.5		0.5	25		77					35000	
Styrene	0.05		0.05	22		2500	75	19	140	3400	4700	2.2
Tetrachloroethane, 1,1,1,2-	0.05		0.05			30	43	0.046		5.1	6400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05			4	56	0.0096	20000	1.6	8800	270
Tetrachloroethylene	0.05		0.05	4.8	4.5	290	21	2.3	2700	2300	5700	100
Thallium	1		1	1.8	3.9	0.29					34000	
Toluene	0.2		0.2	220	140	1700	78	50	290	34000	4400	6

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario												
Fine - Medium Textured Soil		**Residential /Parkland Land Use (ug/g)**										
	MOE	Mass.	Ont. Soil	Plants &	Mammals	Soil Contact	Leachig	Indoor Air	Indoor Air	Outdoor Air	Free Phase	Soil Odour
Chemical Parameter	Soil RL	PQL	Bkgrd	Soil Org.	& Birds	S1 Risk	S-GW3	S-IA	Odour		Threshold	S-Nose
Trichlorobenzene, 1,2,4-	0.05		0.05	16		210	48	1.4	8200	290	5300	110
Trichloroethane, 1,1,1-	0.05		0.05	22	820	42000	12	3.4	9000	12000	5500	640
Trichloroethane, 1,1,2-	0.05		0.05	100		14	150	0.018		2.9	5700	
Trichloroethylene	0.05		0.05	130	8.1	31	360	0.52	4100	24	6000	160
Trichlorofluoromethane	0.05		0.25	20		6300	5.8				6600	
Trichlorophenol, 2,4,5-	0.1		0.1	5.5		56	30				14000	
Trichlorophenol, 2,4,6-	0.1		0.1	5.5		56	4.2				15000	
Uranium	1		2.5	500	33	23					64000	
Vanadium	10		86	250	18	39					11000	
Vinyl Chloride	0.02		0.02	4.3	12	0.57	380	0.022	10000	14	8400	670
Xylene Mixture	0.05		0.05	55	96	4200	30	25	4600	4900	3400	93
Zinc	30		290	500	340	5600					24000	
Electrical Conductivity (mS/cm)			0.57	0.7								
Chloride	5		210				430				5100	
Sodium Adsorption Ratio			2.4	5								
Sodium	50		1300									

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Fine - Medium Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Acenaphthene	0.05		0.072		46000	96	3600	620	680	100000	1300	4300
Acenaphthylene	0.05		0.093			9.6	360	0.17	39		96	4000
Acetone	0.5		0.5		56	200000	660000	28	12000	200000	120000	140000
Aldrin	0.05		0.05	0.11	1200	4.7	6.3	170000		5600000		5000
Anthracene	0.05		0.16	40	470000	42000	420000	0.74				4300
Antimony	1		1.3	50	1500	63	63					13000
Arsenic	1		18	50	330	1.3	47					19000
Barium	5		220	2000	670	32000	8600					12000
Benzene	0.02		0.02	310	6800	13	480	16	0.4	24000	17	6200
Benz[a]anthracene	0.05		0.36	1.3		0.96	36	5.6E+11	5700		330	9200
Benzo[a]pyrene	0.05		0.3	90	46000	0.096	3.6	4.2E+13	72000		170	9200
Benzo[b]fluoranthene	0.05		0.47			0.96	36	8.6E+13	430000		2000	9200
Benzo[ghi]perylene	0.1		0.68	17		9.6	360	1.4E+13				9200
Benzo[k]fluoranthene	0.05		0.48	19		0.96	36	2.8E+13	530000		2100	9200
Beryllium	2		2.5	10	780	320	60					6200
Biphenyl 1,1'-	0.05		0.05			6000	6000	210		300		3900
Bis(2-chloroethyl)ether	0.5		0.5			0.44	16	130		2400		8800
Bis(2-chloroisopropyl)ether	0.5		0.5			8800	8800	160		550		14
Bis(2-ethylhexyl)phthalate	5		5	35	140000	9500	16000	2.8E+09				8300
Boron (Hot Water Soluble)*	0.5		0.5	2								7900
Boron (total)	5		36		120	24000	24000					7900
Bromodichloromethane	0.05		0.05			18	660	63				8100
Bromoform	0.05		0.05			140	5200	27	1.7	5500	91	15000
Bromomethane	0.05		0.05			66	660	2	0.012	990	68	10000
Cadmium	1		1.2	30	1.9	7.9	7.9					29000
Carbon Tetrachloride	0.05		0.05	15	880	150	1500	3	1.5	16000	30	6000
Chlordane	0.05		0.05	2.7	0.0085	0.8	30	200	510	120000	210	10000
Chloroaniline p-	0.5		0.5	50		320	320	0.53				8100
Chlorobenzene	0.05		0.05	15		13000	42000	2.7	340	2300	8900	5100
Chloroform	0.05		0.05	85	830	35	1300	12	0.18	48000	8.9	9000
Chlorophenol, 2-	0.1		0.1	3.9		660	660	23				130000
Chromium Total	5		70	630	160	240000	240000					18000
Chromium VI	0.2		0.66	10	8500	1300	40					
Chrysene	0.05		2.8	18		9.6	360	4E+11	150000		6600	9300
Cobalt	2		21	100	180	250	2500					30000
Copper	5		92	300	3100	5600	5600					
Cyanide (CN-)	0.05		0.051	10	0.11	3200	7900	0.03				290000
Dibenz[a h]anthracene	0.1		0.1			0.096	3.6	2.7E+13	2300000		430	9200
Dibromochloromethane	0.05		0.05			13	490	61				13000
Dichlorobenzene, 1,2-	0.05		0.05	8.5		66000	130000	68	520	4700	9200	4800
Dichlorobenzene, 1,3-	0.05		0.05	12		4400	4400	67				4900
Dichlorobenzene, 1,4-	0.05		0.05	9		65	2400	67	0.84	630	18	4600
Dichlorobenzidine, 3,3'-	1		1			0.66	25	74				5000
Dichlorodifluoromethane	0.05		0.05	100		44000	44000	25				1000
DDD	0.05		0.05	17		4.6	110	38000000				5000
DDE	0.05		0.05	0.65		3.2	110	350000000				5000
DDT	0.05		1.4	7.8	0.0012	3.2	110	810000000				5000
Dichloroethane, 1,1-	0.05		0.05	21		8800	88000	2000	39	4100	1500	6600
Dichloroethane, 1,2-	0.05		0.05	120	29	12	450	220	0.04	21000	1.4	7100
Dichloroethylene, 1,1-	0.05		0.05	130	760	11000	11000	15	0.48	6400	1300	5800
Dichloroethylene, 1,2-cis-	0.05		0.05		940	6600	66000	160	37		1300	6400
Dichloroethylene, 1,2-trans-	0.05		0.05		940	4400	44000	280	9.3	1100	700	6500
Dichlorophenol, 2,4-	0.1		0.1	4.2		660	660	52				33000

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Fine - Medium Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Dichloropropane, 1,2-	0.05		0.05	63		31	1100	91	0.68	140	27	2300
Dichloropropene,1,3-	0.05		0.05	63		12	450	4.5	0.21	500	9	6600
Dieldrin	0.05		0.05	0.11	240	7.9	16	0.12				11000
Diethyl Phthalate	0.5		0.5	27	1000000	790000	1300000	0.081				9100
Dimethylphthalate	0.5		0.5	42		790000	790000	0.029				2000
Dimethylphenol, 2,4-	0.2		0.2			4400	44000	440				57000
Dinitrophenol, 2,4-	2		2			320	3200	66				14000
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5			1.2	43	17				5400
Dioxane, 1,4	0.2		0.2		1.8	100	3700	1500	17000		57000	130000
Dioxin/Furan (TEQ)		5.4E-07	0.000007		0.000099	0.00051	0.0044	870	0.21		0.11	8200
Endosulfan	0.04		0.04	0.38	1.2	320	790	0.51				11000
Endrin	0.04		0.04	0.048	0.0011	39	320	0.079				5000
Ethylbenzene	0.05		0.05	430	38000	22000	22000	19	59	2900	7600	3800
Ethylene dibromide	0.05		0.05			0.31	11	110	0.0019	42000	0.099	2200
Fluoranthene	0.05		0.56	230	120000	9.6	360	45000	21000		2500	9200
Fluorene	0.05		0.12			5600	56000	69				4200
Heptachlor	0.05		0.05	0.5	1100	0.19	2.3	2		400000		10000
Heptachlor Epoxide	0.05		0.05			0.14	5.3	0.0039		190000		5000
Hexachlorobenzene	0.01		0.01	250		0.66	16	15				12000
Hexachlorobutadiene	0.01		0.01			14	75	1.8	0.095	5900	2.8	10000
Hexachlorocyclohexane Gamma-	0.01		0.01	15		2.5	2.5	0.063				5000
Hexachloroethane	0.01		0.01			79	2200	25	0.43	590	54	12000
Hexane (n)	0.05		0.05				21000000	88	420		130000	2400
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.95		0.96	36	9.5E+13	3500000		4000	9200
Lead	10		120	1400	32	1000	1000					38000
Mercury	0.1		0.27	63	20	67	670	1.3E+14	22		36	50000
Methoxychlor	0.05		0.05		4100	1.6	1.6	4.3				9700
Methyl Ethyl Ketone	0.5		0.5	88	9900	64000	64000	380	670	32000	44000	38000
Methyl Isobutyl Ketone	0.5		0.5			110000	110000	210	240	1400	23000	7100
Methyl Mercury **				2	0.034	9.2	9.2	0.0094				1300000
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	63		610	23000	350	3.2		170	12000
Methylene Chloride	0.05		0.05	2	400	150	5500	9.8	12	23000	2200	8400
Methlynaphthalene, 2-(1-) ***	0.05		0.59			560	560	85		940		5200
Molybdenum	2		2	40	74	1200	1200					34000
Naphthalene	0.05		0.09	28	1300	2800	28000	220	57	4300	270	4000
Nickel	5		82	340	5400	2200	510					
Pentachlorophenol	0.1		0.1	39	2000	4.1	50	3.3				12000
Petroleum Hydrocarbons F1****	10		25	320		47000	100000	65	800		26000	2600
Petroleum Hydrocarbons F2	10		10	260		22000	48000	250	950		25000	3900
Petroleum Hydrocarbons F3	50		240	2500		40000	260000					7200
Petroleum Hydrocarbons F4	50		120	6600		42000	400000					8000
Phenanthrene	0.05		0.69	16	36000			300				3500
Phenol	0.5		0.5	40	9.4	42000	42000	53	94000	1000000	16000	240000
Polychlorinated Biphenyls	0.3		0.3	41	1.1	2.7	4.1	1.1E+12	230		120	5000
Pyrene	0.05		1		99000	96	3600	2900	160000		23000	9300
Selenium	1		1.5	13	5.5	1200	1200					
Silver	0.5		0.5	50		490	490					35000
Styrene	0.05		0.05	43		26000	26000	75	170	510	3400	4700
Tetrachloroethane, 1,1,1,2-	0.05		0.05			42	1600	43	0.11		5.1	6400
Tetrachloroethane, 1,1,2,2-	0.05		0.05			5.5	210	56	0.094	72000	1.6	8800
Tetrachloroethylene	0.05		0.05	43	310	3100	31000	21	29	9700	2300	5700
Thallium	1		1	4.5	47	3.3	33					34000
Toluene	0.2		0.2	660	14000	18000	180000	78	620	1000	34000	4400

Soil Components for Table 3 - Full Depth, Non-potable Water Scenario

Fine - Medium Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Plants & Soil Org.	Mammals & Birds	Soil Contact S2 Risk	Soil Contact S3 Risk	Leaching S-GW3	Indoor Air S-IA	Indoor Air Odour	Outdoor Air	Free Phase Threshold
Trichlorobenzene, 1,2,4-	0.05		0.05	30		2200	22000	48	16	30000	290	5300
Trichloroethane, 1,1,1-	0.05		0.05	44	39000	440000	1500000	12	42	33000	12000	5500
Trichloroethane, 1,1,2-	0.05		0.05	200		19	720	150	0.11		2.9	5700
Trichloroethylene	0.05		0.05	250	390	85	160	360	0.61	15000	24	6000
Trichlorofluoromethane	0.05		0.25	40		66000	66000	5.8				6600
Trichlorophenol, 2,4,5-	0.1		0.1	10		470	470	30				14000
Trichlorophenol, 2,4,6-	0.1		0.1	10		72	470	4.2				15000
Uranium	1		2.5	2000	33	300	300					64000
Vanadium	10		86	250	18	160	160					11000
Vinyl Chloride	0.02		0.02	8.5	12	0.79	29	380	0.25	38000	14	8400
Xylene Mixture	0.05		0.05	210	47000	44000	88000	30	140	17000	4900	3400
Zinc	30		290	800	340	47000	47000					24000
Electrical Conductivity (mS/cm)			0.57	1.4								
Chloride	5		210					430				5100
Sodium Adsorption Ratio			2.4	12								
Sodium	50		1300									

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Acenaphthene	0.05		0.072	96	3600	21	560	7.9	2800	3900
Acenaphthylene	0.05		0.093	9.6	360	2.3	0.15	0.45	2900	
Acetone	0.5		0.5	200000	660000	320	16	720	92000	4300
Aldrin	0.05		0.05	4.7	6.3	31	150000		5000	260000
Anthracene	0.05		0.16	42000	420000	15000	0.67		2700	
Antimony	1		1.3	63	63				8000	
Arsenic	1		18	1.3	47				12000	
Barium	5		220	32000	8600				7700	
Benzene	0.02		0.02	13	480	0.92	14	0.21	5000	820
Benz[a]anthracene	0.05		0.36	0.96	36	190	5.1E+11	65	7600	
Benzo[a]pyrene	0.05		0.3	0.096	3.6	6.6	3.8E+13	820	7600	
Benzo[b]fluoranthene	0.05		0.47	0.96	36	67	7.7E+13	5500	7600	
Benzo[ghi]perylene	0.1		0.68	9.6	360	2200	1.2E+13		7600	
Benzo[k]fluoranthene	0.05		0.48	0.96	36	66	2.5E+13	6700	7600	
Beryllium	2		2.5	320	60				3900	
Biphenyl 1,1'-	0.05		0.05	6000	6000	590	190		2600	11
Bis(2-chloroethyl)ether	0.5		0.5	0.44	16	0.0014	92		6400	69
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	8800	12	120		11	18
Bis(2-ethylhexyl)phthalate	5		5	9500	16000	830	2.5E+09		7100	
Boron (Hot Water Soluble)*	0.5		0.5						5000	
Boron (total)	5		36	24000	24000				5000	
Bromodichloromethane	0.05		0.05	18	660	1.5	50		5500	
Bromoform	0.05		0.05	140	5200	2.3	21	0.27	11000	220
Bromomethane	0.05		0.05	66	660	0.097	1.4	0.00034	7300	27
Cadmium	1		1.2	7.9	7.9				18000	
Carbon Tetrachloride	0.05		0.05	150	1500	0.51	2.3	0.013	3900	470
Chlordane	0.05		0.05	0.8	30	510	180	7.6	8400	5700
Chloroaniline p-	0.5		0.5	320	320	0.66	0.45		6100	
Chlorobenzene	0.05		0.05	13000	42000	8	2.4	91	3700	78
Chloroform	0.05		0.05	35	1300	2.3	9.5	0.032	6600	1400
Chlorophenol, 2-	0.1		0.1	660	660	3.7	21		130000	
Chromium Total	5		70	240000	240000				11000	
Chromium VI	0.2		0.66	1300	40					
Chrysene	0.05		2.8	9.6	360	20	3.6E+11	1900	7700	
Cobalt	2		21	250	2500				19000	
Copper	5		92	5600	5600					
Cyanide (CN-)	0.05		0.051	3200	7900	22	0.022		240000	
Dibenz[a h]anthracene	0.1		0.1	0.096	3.6	22	2.4E+13	33000	7600	
Dibromochloromethane	0.05		0.05	13	490	2.3	48		10000	
Dichlorobenzene, 1,2-	0.05		0.05	66000	130000	1.2	60	35	3100	160
Dichlorobenzene, 1,3-	0.05		0.05	4400	4400	24	59		3300	
Dichlorobenzene, 1,4-	0.05		0.05	65	2400	0.4	59	0.083	3000	22
Dichlorobenzidine, 3,3'-	1		1	0.66	25	0.16	66		5000	
Dichlorodifluoromethane	0.05		0.05	44000	44000	150	16		710	
DDD	0.05		0.05	4.6	110	1300	34000000		5000	
DDE	0.05		0.05	3.2	110	1300	310000000		5000	
DDT	0.05		1.4	3.2	110	1800	730000000		5000	
Dichloroethane, 1,1-	0.05		0.05	8800	88000	0.47	1600	3.5	4800	130
Dichloroethane, 1,2-	0.05		0.05	12	450	0.48	180	0.025	5300	640
Dichloroethylene, 1,1-	0.05		0.05	11000	11000	1.3	11	0.004	3900	180
Dichloroethylene, 1,2-cis-	0.05		0.05	6600	66000	1.9	130	3.4	4600	
Dichloroethylene, 1,2-trans-	0.05		0.05	4400	44000	1.9	220	0.084	4600	34
Dichlorophenol, 2,4-	0.1		0.1	660	660	0.19	46		33000	

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Coarse Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Dichloropropane, 1,2-	0.05		0.05	31	1100	0.54	76	0.01	2100	4.5
Dichloropropene,1,3-	0.05		0.05	12	450	0.059	3.8	0.027	5000	17
Dieldrin	0.05		0.05	7.9	16	3.1	0.11		8700	
Diethyl Phthalate	0.5		0.5	790000	1300000	2200	0.07		7600	
Dimethylphthalate	0.5		0.5	790000	790000	1400	0.023		1800	
Dimethylphenol, 2,4-	0.2		0.2	4400	44000	38	390		57000	
Dinitrophenol, 2,4-	2		2	320	3200	2	59		13000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	1.2	43	0.015	15		3800	
Dioxane, 1,4	0.2		0.2	100	3700	7.5	810	180	82000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.00051	0.0044	0.0018	780	0.0028	7000	
Endosulfan	0.04		0.04	320	790	110	0.46		8700	
Endrin	0.04		0.04	39	320	18	0.071		5000	
Ethylbenzene	0.05		0.05	22000	22000	1.1	17	2	2700	100
Ethylene dibromide	0.05		0.05	0.31	11	0.0048	86	0.0014	2000	1600
Fluoranthene	0.05		0.56	9.6	360	24	40000	250	7600	
Fluorene	0.05		0.12	5600	56000	1100	62		2800	
Heptachlor	0.05		0.05	0.19	2.3	66	1.8		8300	19000
Heptachlor Epoxide	0.05		0.05	0.14	5.3	6.6	0.0035		5000	8800
Hexachlorobenzene	0.01		0.01	0.66	16	2.9	14		9300	
Hexachlorobutadiene	0.01		0.01	14	75	0.52	1.6	0.012	8300	210
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	2.5	11	0.056		5000	
Hexachloroethane	0.01		0.01	79	2200	0.49	22	0.089	9400	51
Hexane (n)	0.05		0.05		21000000		54	2.8	1500	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.96	36	220	8.6E+13	46000	7600	
Lead	10		120	1000	1000				24000	
Mercury	0.1		0.27	67	670	550	1.2E+14	0.25	34000	
Methoxychlor	0.05		0.05	1.6	1.6	32000	3.9		8000	
Methyl Ethyl Ketone	0.5		0.5	64000	64000	160	230	16	26000	750
Methyl Isobutyl Ketone	0.5		0.5	110000	110000	440	150	6.6	5100	39
Methyl Mercury **				9.2	9.2	1	0.0084		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	610	23000	1.6	220	0.75	8000	
Methylene Chloride	0.05		0.05	150	5500	4.8	7.4	0.1	6400	670
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	560	30	76		3600	34
Molybdenum	2		2	1200	1200				22000	
Naphthalene	0.05		0.09	2800	28000	93	200	0.65	2800	150
Nickel	5		82	2200	510					
Pentachlorophenol	0.1		0.1	4.1	50	86	2.9		9200	
Petroleum Hydrocarbons F1****	10		25	47000	100000	4100	55	130	1700	
Petroleum Hydrocarbons F2	10		10	22000	48000	4300	230	98	2700	
Petroleum Hydrocarbons F3	50		240	40000	260000	20000			5800	
Petroleum Hydrocarbons F4	50		120	42000	400000	1600000			6900	
Phenanthrene	0.05		0.69			17	270		2300	
Phenol	0.5		0.5	42000	42000	240	46	940	230000	34000
Polychlorinated Biphenyls	0.3		0.3	2.7	4.1	770	9.9E+11	3.1	5000	
Pyrene	0.05		1	96	3600	240	2600	1900	7700	
Selenium	1		1.5	1200	1200					
Silver	0.5		0.5	490	490				22000	
Styrene	0.05		0.05	26000	26000	47	66	16	3500	18
Tetrachloroethane, 1,1,1,2-	0.05		0.05	42	1600	0.15	37	0.058	4400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	5.5	210	0.14	48	0.0045	6700	2400
Tetrachloroethylene	0.05		0.05	3100	31000	1.9	18	0.28	3700	320
Thallium	1		1	3.3	33				22000	
Toluene	0.2		0.2	18000	180000	6.4	68	6.2	3300	35

Soil Components for Table 4 - Sub-surface, Potable Water Scenario										
Coarse Textured Soil		**Residential /Parkland Land Use (ug/g)**								
	MOE	Mass.	Ont. Soil	Soil Contact	Soil Contact	Soil Leaching		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S2 Risk	S3 Risk	S-GW1	S-GW3	S-IA	Threshold	Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	2200	22000	45	43	0.36	3400	1100
Trichloroethane, 1,1,1-	0.05		0.05	440000	1500000	20	9.8	0.38	3700	1000
Trichloroethane, 1,1,2-	0.05		0.05	19	720	0.54	120	0.03	3900	
Trichloroethylene	0.05		0.05	85	160	0.55	300	0.061	4100	480
Trichlorofluoromethane	0.05		0.25	66000	66000	20	4		4400	
Trichlorophenol, 2,4,5-	0.1		0.1	470	470	9.1	27		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	72	470	2.1	3.8		13000	
Uranium	1		2.5	300	300				40000	
Vanadium	10		86	160	160				7100	
Vinyl Chloride	0.02		0.02	0.79	29	0.19	270	0.0021	6100	1000
Xylene Mixture	0.05		0.05	44000	88000	120	26	3.1	2300	580
Zinc	30		290	47000	47000				15000	
Electrical Conductivity (mS/cm)			0.57							
Chloride	5		210			52000	220		3000	
Sodium Adsorption Ratio			2.4							
Sodium	50		1300							

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Acenaphthene	0.05		0.072	3600	21	560	330	2800	18000
Acenaphthylene	0.05		0.093	360	2.3	0.15	18	2900	
Acetone	0.5		0.5	660000	320	16	3000	92000	20000
Aldrin	0.05		0.05	6.3	31	150000		5000	1200000
Anthracene	0.05		0.16	420000	15000	0.67		2700	
Antimony	1		1.3	63				8000	
Arsenic	1		18	47				12000	
Barium	5		220	8600				7700	
Benzene	0.02		0.02	480	0.92	14	6.1	5000	3800
Benz[a]anthracene	0.05		0.36	36	190	5.1E+11	2300	7600	
Benzo[a]pyrene	0.05		0.3	3.6	6.6	3.8E+13	16000	7600	
Benzo[b]fluoranthene	0.05		0.47	36	67	7.7E+13	130000	7600	
Benzo[ghi]perylene	0.1		0.68	360	2200	1.2E+13		7600	
Benzo[k]fluoranthene	0.05		0.48	36	66	2.5E+13	150000	7600	
Beryllium	2		2.5	60				3900	
Biphenyl 1,1'-	0.05		0.05	6000	590	190		2600	52
Bis(2-chloroethyl)ether	0.5		0.5	16	0.0014	92		6400	320
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	12	120		11	82
Bis(2-ethylhexyl)phthalate	5		5	16000	830	2.5E+09		7100	
Boron (Hot Water Soluble)*	0.5		0.5					5000	
Boron (total)	5		36	24000				5000	
Bromodichloromethane	0.05		0.05	660	1.5	50		5500	
Bromoform	0.05		0.05	5200	2.3	21	2	11000	980
Bromomethane	0.05		0.05	660	0.097	1.4	0.0033	7300	130
Cadmium	1		1.2	7.9				18000	
Carbon Tetrachloride	0.05		0.05	1500	0.51	2.3	0.43	3900	2200
Chlordane	0.05		0.05	30	510	180	620	8400	26000
Chloroaniline p-	0.5		0.5	320	0.66	0.45		6100	
Chlorobenzene	0.05		0.05	42000	8	2.4	220	3700	360
Chloroform	0.05		0.05	1300	2.3	9.5	0.85	6600	6800
Chlorophenol, 2-	0.1		0.1	660	3.7	21		130000	
Chromium Total	5		70	240000				11000	
Chromium VI	0.2		0.66	40					
Chrysene	0.05		2.8	360	20	3.6E+11	81000	7700	
Cobalt	2		21	2500				19000	
Copper	5		92	5600					
Cyanide (CN-)	0.05		0.051	7900	22	0.022		240000	
Dibenz[a h]anthracene	0.1		0.1	3.6	22	2.4E+13	500000	7600	
Dibromochloromethane	0.05		0.05	490	2.3	48		10000	
Dichlorobenzene, 1,2-	0.05		0.05	130000	1.2	60	230	3100	770
Dichlorobenzene, 1,3-	0.05		0.05	4400	24	59		3300	
Dichlorobenzene, 1,4-	0.05		0.05	2400	0.4	59	0.39	3000	100
Dichlorobenzidine, 3,3'-	1		1	25	0.16	66		5000	
Dichlorodifluoromethane	0.05		0.05	44000	150	16		710	
DDD	0.05		0.05	110	1300	34000000		5000	
DDE	0.05		0.05	110	1300	310000000		5000	
DDT	0.05		1.4	110	1800	730000000		5000	
Dichloroethane, 1,1-	0.05		0.05	88000	0.47	1600	120	4800	590
Dichloroethane, 1,2-	0.05		0.05	450	0.48	180	0.055	5300	3000
Dichloroethylene, 1,1-	0.05		0.05	11000	1.3	11	0.12	3900	860
Dichloroethylene, 1,2-cis-	0.05		0.05	66000	1.9	130	110	4600	
Dichloroethylene, 1,2-trans-	0.05		0.05	44000	1.9	220	2.9	4600	160
Dichlorophenol, 2,4-	0.1		0.1	660	0.19	46		33000	

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Dichloropropane, 1,2-	0.05		0.05	1100	0.54	76	0.33	2100	21
Dichloropropene,1,3-	0.05		0.05	450	0.059	3.8	0.34	5000	78
Dieldrin	0.05		0.05	16	3.1	0.11		8700	
Diethyl Phthalate	0.5		0.5	1300000	2200	0.07		7600	
Dimethylphthalate	0.5		0.5	790000	1400	0.023		1800	
Dimethylphenol, 2,4-	0.2		0.2	44000	38	390		57000	
Dinitrophenol, 2,4-	2		2	3200	2	59		13000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	43	0.015	15		3800	
Dioxane, 1,4	0.2		0.2	3700	7.5	810	2400	82000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.0044	0.0018	780	0.23	7000	
Endosulfan	0.04		0.04	790	110	0.46		8700	
Endrin	0.04		0.04	320	18	0.071		5000	
Ethylbenzene	0.05		0.05	22000	1.1	17	200	2700	470
Ethylene dibromide	0.05		0.05	11	0.0048	86	0.0026	2000	7100
Fluoranthene	0.05		0.56	360	24	40000	11000	7600	
Fluorene	0.05		0.12	56000	1100	62		2800	
Heptachlor	0.05		0.05	2.3	66	1.8		8300	87000
Heptachlor Epoxide	0.05		0.05	5.3	6.6	0.0035		5000	40000
Hexachlorobenzene	0.01		0.01	16	2.9	14		9300	
Hexachlorobutadiene	0.01		0.01	75	0.52	1.6	0.06	8300	980
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	11	0.056		5000	
Hexachloroethane	0.01		0.01	2200	0.49	22	1.7	9400	220
Hexane (n)	0.05		0.05	21000000		54	650	1500	
Indeno[1 2 3-cd]pyrene	0.1		0.23	36	220	8.6E+13	870000	7600	
Lead	10		120	1000				24000	
Mercury	0.1		0.27	670	550	1.2E+14	13	34000	
Methoxychlor	0.05		0.05	1.6	32000	3.9		8000	
Methyl Ethyl Ketone	0.5		0.5	64000	160	230	150	26000	3500
Methyl Isobutyl Ketone	0.5		0.5	110000	440	150	64	5100	180
Methyl Mercury **				9.2	1	0.0084		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	23000	1.6	220	14	8000	
Methylene Chloride	0.05		0.05	5500	4.8	7.4	3	6400	3100
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	30	76		3600	160
Molybdenum	2		2	1200				22000	
Naphthalene	0.05		0.09	28000	93	200	220	2800	710
Nickel	5		82	510					
Pentachlorophenol	0.1		0.1	50	86	2.9		9200	
Petroleum Hydrocarbons F1****	10		25	100000	4100	55	11000	1700	
Petroleum Hydrocarbons F2	10		10	48000	4300	230	7500	2700	
Petroleum Hydrocarbons F3	50		240	260000	20000			5800	
Petroleum Hydrocarbons F4	50		120	400000	1600000			6900	
Phenanthrene	0.05		0.69		17	270		2300	
Phenol	0.5		0.5	42000	240	46	21000	230000	160000
Polychlorinated Biphenyls	0.3		0.3	4.1	770	9.9E+11	210	5000	
Pyrene	0.05		1	3600	240	2600	91000	7700	
Selenium	1		1.5	1200					
Silver	0.5		0.5	490				22000	
Styrene	0.05		0.05	26000	47	66	81	3500	83
Tetrachloroethane, 1,1,1,2-	0.05		0.05	1600	0.15	37	0.24	4400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	210	0.14	48	0.038	6700	11000
Tetrachloroethylene	0.05		0.05	31000	1.9	18	9.5	3700	1500
Thallium	1		1	33				22000	
Toluene	0.2		0.2	180000	6.4	68	1900	3300	170

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Coarse Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	22000	45	43	10	3400	5300
Trichloroethane, 1,1,1-	0.05		0.05	1500000	20	9.8	12	3700	4700
Trichloroethane, 1,1,2-	0.05		0.05	720	0.54	120	0.068	3900	
Trichloroethylene	0.05		0.05	160	0.55	300	1.8	4100	2200
Trichlorofluoromethane	0.05		0.25	66000	20	4		4400	
Trichlorophenol, 2,4,5-	0.1		0.1	470	9.1	27		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	470	2.1	3.8		13000	
Uranium	1		2.5	300				40000	
Vanadium	10		86	160				7100	
Vinyl Chloride	0.02		0.02	29	0.19	270	0.057	6100	4800
Xylene Mixture	0.05		0.05	88000	120	26	1100	2300	2700
Zinc	30		290	47000				15000	
Electrical Conductivity (mS/cm)			0.57						
Chloride	5		210		52000	220		3000	
Sodium Adsorption Ratio			2.4						
Sodium	50		1300						

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Medium - Fine Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Acenaphthene	0.05		0.072	96	3600	29	620	58	4300	29000
Acenaphthylene	0.05		0.093	9.6	360	3.2	0.17	3.3	4000	
Acetone	0.5		0.5	200000	660000	440	28	1200	140000	54000
Aldrin	0.05		0.05	4.7	6.3	43	170000		5000	1500000
Anthracene	0.05		0.16	42000	420000	21000	0.74		4300	
Antimony	1		1.3	63	63				13000	
Arsenic	1		18	1.3	47				19000	
Barium	5		220	32000	8600				12000	
Benzene	0.02		0.02	13	480	1.3	16	0.17	6200	6700
Benz[a]anthracene	0.05		0.36	0.96	36	270	5.6E+11	490	9200	
Benzo[a]pyrene	0.05		0.3	0.096	3.6	9.2	4.2E+13	6100	9200	
Benzo[b]fluoranthene	0.05		0.47	0.96	36	94	8.6E+13	37000	9200	
Benzo[ghi]perylene	0.1		0.68	9.6	360	3100	1.4E+13		9200	
Benzo[k]fluoranthene	0.05		0.48	0.96	36	92	2.8E+13	45000	9200	
Beryllium	2		2.5	320	60				6200	
Biphenyl 1,1'-	0.05		0.05	6000	6000	830	210		3900	83
Bis(2-chloroethyl)ether	0.5		0.5	0.44	16	0.0014	130		8800	660
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	8800	13	160		14	150
Bis(2-ethylhexyl)phthalate	5		5	9500	16000	1200	2.8E+09		8300	
Boron (Hot Water Soluble)*	0.5		0.5						7900	
Boron (total)	5		36	24000	24000				7900	
Bromodichloromethane	0.05		0.05	18	660	1.9	63		8100	
Bromoform	0.05		0.05	140	5200	2.9	27	0.26	15000	1500
Bromomethane	0.05		0.05	66	660	0.1	2	0.0034	10000	270
Cadmium	1		1.2	7.9	7.9				29000	
Carbon Tetrachloride	0.05		0.05	150	1500	0.71	3	0.12	6000	4300
Chlordane	0.05		0.05	0.8	30	710	200	43	10000	33000
Chloroaniline p-	0.5		0.5	320	320	0.89	0.53		8100	
Chlorobenzene	0.05		0.05	13000	42000	11	2.7	53	5100	620
Chloroform	0.05		0.05	35	1300	3	12	0.18	9000	13000
Chlorophenol, 2-	0.1		0.1	660	660	5.1	23		130000	
Chromium Total	5		70	240000	240000				18000	
Chromium VI	0.2		0.66	1300	40					
Chrysene	0.05		2.8	9.6	360	28	4E+11	13000	9300	
Cobalt	2		21	250	2500				30000	
Copper	5		92	5600	5600					
Cyanide (CN-)	0.05		0.051	3200	7900	23	0.03		290000	
Dibenz[a h]anthracene	0.1		0.1	0.096	3.6	31	2.7E+13	170000	9200	
Dibromochloromethane	0.05		0.05	13	490	2.9	61		13000	
Dichlorobenzene, 1,2-	0.05		0.05	66000	130000	1.7	68	52	4800	1300
Dichlorobenzene, 1,3-	0.05		0.05	4400	4400	34	67		4900	
Dichlorobenzene, 1,4-	0.05		0.05	65	2400	0.57	67	0.097	4600	170
Dichlorobenzidine, 3,3'-	1		1	0.66	25	0.22	74		5000	
Dichlorodifluoromethane	0.05		0.05	44000	44000	280	25		1000	
DDD	0.05		0.05	4.6	110	1800	38000000		5000	
DDE	0.05		0.05	3.2	110	1800	350000000		5000	
DDT	0.05		1.4	3.2	110	2600	810000000		5000	
Dichloroethane, 1,1-	0.05		0.05	8800	88000	0.6	2000	31	6600	1100
Dichloroethane, 1,2-	0.05		0.05	12	450	0.62	220	0.013	7100	5700
Dichloroethylene, 1,1-	0.05		0.05	11000	11000	1.8	15	0.038	5800	1800
Dichloroethylene, 1,2-cis-	0.05		0.05	6600	66000	2.5	160	30	6400	
Dichloroethylene, 1,2-trans-	0.05		0.05	4400	44000	2.5	280	0.75	6500	300
Dichlorophenol, 2,4-	0.1		0.1	660	660	0.27	52		33000	

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Medium - Fine Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Dichloropropane, 1,2-	0.05		0.05	31	1100	0.74	91	0.085	2300	38
Dichloropropene,1,3-	0.05		0.05	12	450	0.081	4.5	0.083	6600	140
Dieldrin	0.05		0.05	7.9	16	4.3	0.12		11000	
Diethyl Phthalate	0.5		0.5	790000	1300000	3100	0.081		9100	
Dimethylphthalate	0.5		0.5	790000	790000	1800	0.029		2000	
Dimethylphenol, 2,4-	0.2		0.2	4400	44000	53	440		57000	
Dinitrophenol, 2,4-	2		2	320	3200	2.9	66		14000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	1.2	43	0.021	17		5400	
Dioxane, 1,4	0.2		0.2	100	3700	7.7	1500	1400	130000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.00051	0.0044	0.0026	870	0.017	8200	
Endosulfan	0.04		0.04	320	790	150	0.51		11000	
Endrin	0.04		0.04	39	320	25	0.079		5000	
Ethylbenzene	0.05		0.05	22000	22000	1.6	19	16	3800	800
Ethylene dibromide	0.05		0.05	0.31	11	0.0062	110	0.00054	2200	11000
Fluoranthene	0.05		0.56	9.6	360	34	45000	1700	9200	
Fluorene	0.05		0.12	5600	56000	1600	69		4200	
Heptachlor	0.05		0.05	0.19	2.3	92	2		10000	110000
Heptachlor Epoxide	0.05		0.05	0.14	5.3	9.3	0.0039		5000	52000
Hexachlorobenzene	0.01		0.01	0.66	16	4	15		12000	
Hexachlorobutadiene	0.01		0.01	14	75	0.73	1.8	0.014	10000	1600
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	2.5	16	0.063		5000	
Hexachloroethane	0.01		0.01	79	2200	0.69	25	0.071	12000	160
Hexane (n)	0.05		0.05		21000000		88	34	2400	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.96	36	310	9.5E+13	300000	9200	
Lead	10		120	1000	1000				38000	
Mercury	0.1		0.27	67	670	770	1.3E+14	1.8	50000	
Methoxychlor	0.05		0.05	1.6	1.6	45000	4.3		9700	
Methyl Ethyl Ketone	0.5		0.5	64000	64000	310	380	180	38000	8700
Methyl Isobutyl Ketone	0.5		0.5	110000	110000	380	210	66	7100	400
Methyl Mercury **				9.2	9.2	1.4	0.0094		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	610	23000	2.3	350	1.4	12000	
Methylene Chloride	0.05		0.05	150	5500	5.7	9.8	0.96	8400	6300
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	560	42	85		5200	260
Molybdenum	2		2	1200	1200				34000	
Naphthalene	0.05		0.09	2800	28000	130	220	4.6	4000	1200
Nickel	5		82	2200	510					
Pentachlorophenol	0.1		0.1	4.1	50	120	3.3		12000	
Petroleum Hydrocarbons F1****	10		25	47000	100000	5800	65	240	2600	
Petroleum Hydrocarbons F2	10		10	22000	48000	6000	250	150	3900	
Petroleum Hydrocarbons F3	50		240	40000	260000	28000			7200	
Petroleum Hydrocarbons F4	50		120	42000	400000	2300000			8000	
Phenanthrene	0.05		0.69			24	300		3500	
Phenol	0.5		0.5	42000	42000	330	53	7500	240000	280000
Polychlorinated Biphenyls	0.3		0.3	2.7	4.1	1100	1.1E+12	19	5000	
Pyrene	0.05		1	96	3600	330	2900	13000	9300	
Selenium	1		1.5	1200	1200					
Silver	0.5		0.5	490	490				35000	
Styrene	0.05		0.05	26000	26000	66	75	19	4700	140
Tetrachloroethane, 1,1,1,2-	0.05		0.05	42	1600	0.2	43	0.046	6400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	5.5	210	0.19	56	0.0096	8800	20000
Tetrachloroethylene	0.05		0.05	3100	31000	2.5	21	2.3	5700	2700
Thallium	1		1	3.3	33				34000	
Toluene	0.2		0.2	18000	180000	9	78	50	4400	290

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Medium - Fine Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S2 Risk	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	2200	22000	63	48	1.4	5300	8200
Trichloroethane, 1,1,1-	0.05		0.05	440000	1500000	27	12	3.4	5500	9000
Trichloroethane, 1,1,2-	0.05		0.05	19	720	0.73	150	0.018	5700	
Trichloroethylene	0.05		0.05	85	160	0.76	360	0.52	6000	4100
Trichlorofluoromethane	0.05		0.25	66000	66000	33	5.8		6600	
Trichlorophenol, 2,4,5-	0.1		0.1	470	470	13	30		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	72	470	2.9	4.2		15000	
Uranium	1		2.5	300	300				64000	
Vanadium	10		86	160	160				11000	
Vinyl Chloride	0.02		0.02	0.79	29	0.25	380	0.022	8400	10000
Xylene Mixture	0.05		0.05	44000	88000	170	30	25	3400	4600
Zinc	30		290	47000	47000				24000	
Electrical Conductivity (mS/cm)			0.57							
Chloride	5		210			35000	430		5100	
Sodium Adsorption Ratio			2.4							
Sodium	50		1300							

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Medium - Fine Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Acenaphthene	0.05		0.072	3600	29	620	850	4300	100000
Acenaphthylene	0.05		0.093	360	3.2	0.17	48	4000	
Acetone	0.5		0.5	660000	440	28	13000	140000	200000
Aldrin	0.05		0.05	6.3	43	170000		5000	5600000
Anthracene	0.05		0.16	420000	21000	0.74		4300	
Antimony	1		1.3	63				13000	
Arsenic	1		18	47				19000	
Barium	5		220	8600				12000	
Benzene	0.02		0.02	480	1.3	16	4.4	6200	24000
Benz[a]anthracene	0.05		0.36	36	270	5.6E+11	6800	9200	
Benzo[a]pyrene	0.05		0.3	3.6	9.2	4.2E+13	74000	9200	
Benzo[b]fluoranthene	0.05		0.47	36	94	8.6E+13	460000	9200	
Benzo[ghi]perylene	0.1		0.68	360	3100	1.4E+13		9200	
Benzo[k]fluoranthene	0.05		0.48	36	92	2.8E+13	560000	9200	
Beryllium	2		2.5	60				6200	
Biphenyl 1,1'-	0.05		0.05	6000	830	210		3900	300
Bis(2-chloroethyl)ether	0.5		0.5	16	0.0014	130		8800	2400
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	13	160		14	550
Bis(2-ethylhexyl)phthalate	5		5	16000	1200	2.8E+09		8300	
Boron (Hot Water Soluble)*	0.5		0.5					7900	
Boron (total)	5		36	24000				7900	
Bromodichloromethane	0.05		0.05	660	1.9	63		8100	
Bromoform	0.05		0.05	5200	2.9	27	2.7	15000	5500
Bromomethane	0.05		0.05	660	0.1	2	0.014	10000	990
Cadmium	1		1.2	7.9				29000	
Carbon Tetrachloride	0.05		0.05	1500	0.71	3	1.7	6000	16000
Chlordane	0.05		0.05	30	710	200	920	10000	120000
Chloroaniline p-	0.5		0.5	320	0.89	0.53		8100	
Chlorobenzene	0.05		0.05	42000	11	2.7	390	5100	2300
Chloroform	0.05		0.05	1300	3	12	0.19	9000	48000
Chlorophenol, 2-	0.1		0.1	660	5.1	23		130000	
Chromium Total	5		70	240000				18000	
Chromium VI	0.2		0.66	40					
Chrysene	0.05		2.8	360	28	4E+11	190000	9300	
Cobalt	2		21	2500				30000	
Copper	5		92	5600					
Cyanide (CN-)	0.05		0.051	7900	23	0.03		290000	
Dibenz[a h]anthracene	0.1		0.1	3.6	31	2.7E+13	2300000	9200	
Dibromochloromethane	0.05		0.05	490	2.9	61		13000	
Dichlorobenzene, 1,2-	0.05		0.05	130000	1.7	68	600	4800	4700
Dichlorobenzene, 1,3-	0.05		0.05	4400	34	67		4900	
Dichlorobenzene, 1,4-	0.05		0.05	2400	0.57	67	0.97	4600	630
Dichlorobenzidine, 3,3'-	1		1	25	0.22	74		5000	
Dichlorodifluoromethane	0.05		0.05	44000	280	25		1000	
DDD	0.05		0.05	110	1800	38000000		5000	
DDE	0.05		0.05	110	1800	350000000		5000	
DDT	0.05		1.4	110	2600	810000000		5000	
Dichloroethane, 1,1-	0.05		0.05	88000	0.6	2000	45	6600	4100
Dichloroethane, 1,2-	0.05		0.05	450	0.62	220	0.044	7100	21000
Dichloroethylene, 1,1-	0.05		0.05	11000	1.8	15	0.53	5800	6400
Dichloroethylene, 1,2-cis-	0.05		0.05	66000	2.5	160	43	6400	
Dichloroethylene, 1,2-trans-	0.05		0.05	44000	2.5	280	11	6500	1100
Dichlorophenol, 2,4-	0.1		0.1	660	0.27	52		33000	

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Medium - Fine Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Dichloropropane, 1,2-	0.05		0.05	1100	0.74	91	0.75	2300	140
Dichloropropene,1,3-	0.05		0.05	450	0.081	4.5	0.24	6600	500
Dieldrin	0.05		0.05	16	4.3	0.12		11000	
Diethyl Phthalate	0.5		0.5	1300000	3100	0.081		9100	
Dimethylphthalate	0.5		0.5	790000	1800	0.029		2000	
Dimethylphenol, 2,4-	0.2		0.2	44000	53	440		57000	
Dinitrophenol, 2,4-	2		2	3200	2.9	66		14000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	43	0.021	17		5400	
Dioxane, 1,4	0.2		0.2	3700	7.7	1500	18000	130000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.0044	0.0026	870	0.36	8200	
Endosulfan	0.04		0.04	790	150	0.51		11000	
Endrin	0.04		0.04	320	25	0.079		5000	
Ethylbenzene	0.05		0.05	22000	1.6	19	670	3800	2900
Ethylene dibromide	0.05		0.05	11	0.0062	110	0.0026	2200	42000
Fluoranthene	0.05		0.56	360	34	45000	26000	9200	
Fluorene	0.05		0.12	56000	1600	69		4200	
Heptachlor	0.05		0.05	2.3	92	2		10000	400000
Heptachlor Epoxide	0.05		0.05	5.3	9.3	0.0039		5000	190000
Hexachlorobenzene	0.01		0.01	16	4	15		12000	
Hexachlorobutadiene	0.01		0.01	75	0.73	1.8	0.11	10000	5900
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	16	0.063		5000	
Hexachloroethane	0.01		0.01	2200	0.69	25	1.7	12000	590
Hexane (n)	0.05		0.05	21000000		88	4500	2400	
Indeno[1 2 3-cd]pyrene	0.1		0.23	36	310	9.5E+13	3600000	9200	
Lead	10		120	1000				38000	
Mercury	0.1		0.27	670	770	1.3E+14	30	50000	
Methoxychlor	0.05		0.05	1.6	45000	4.3		9700	
Methyl Ethyl Ketone	0.5		0.5	64000	310	380	760	38000	32000
Methyl Isobutyl Ketone	0.5		0.5	110000	380	210	280	7100	1400
Methyl Mercury **				9.2	1.4	0.0094		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	23000	2.3	350	3.4	12000	
Methylene Chloride	0.05		0.05	5500	5.7	9.8	13	8400	23000
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	42	85		5200	940
Molybdenum	2		2	1200				34000	
Naphthalene	0.05		0.09	28000	130	220	670	4000	4300
Nickel	5		82	510					
Pentachlorophenol	0.1		0.1	50	120	3.3		12000	
Petroleum Hydrocarbons F1****	10		25	100000	5800	65	9200	2600	
Petroleum Hydrocarbons F2	10		10	48000	6000	250	11000	3900	
Petroleum Hydrocarbons F3	50		240	260000	28000			7200	
Petroleum Hydrocarbons F4	50		120	400000	2300000			8000	
Phenanthrene	0.05		0.69		24	300		3500	
Phenol	0.5		0.5	42000	330	53	97000	240000	1000000
Polychlorinated Biphenyls	0.3		0.3	4.1	1100	1.1E+12	360	5000	
Pyrene	0.05		1	3600	330	2900	200000	9300	
Selenium	1		1.5	1200					
Silver	0.5		0.5	490				35000	
Styrene	0.05		0.05	26000	66	75	200	4700	510
Tetrachloroethane, 1,1,1,2-	0.05		0.05	1600	0.2	43	0.14	6400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	210	0.19	56	0.11	8800	72000
Tetrachloroethylene	0.05		0.05	31000	2.5	21	34	5700	9700
Thallium	1		1	33				34000	
Toluene	0.2		0.2	180000	9	78	7000	4400	1000

Soil Components for Table 4 - Sub-surface, Potable Water Scenario

Medium - Fine Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	Soil Leaching S-GW1	Soil Leaching S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	22000	63	48	22	5300	30000
Trichloroethane, 1,1,1-	0.05		0.05	1500000	27	12	48	5500	33000
Trichloroethane, 1,1,2-	0.05		0.05	720	0.73	150	0.13	5700	
Trichloroethylene	0.05		0.05	160	0.76	360	0.69	6000	15000
Trichlorofluoromethane	0.05		0.25	66000	33	5.8		6600	
Trichlorophenol, 2,4,5-	0.1		0.1	470	13	30		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	470	2.9	4.2		15000	
Uranium	1		2.5	300				64000	
Vanadium	10		86	160				11000	
Vinyl Chloride	0.02		0.02	29	0.25	380	0.28	8400	38000
Xylene Mixture	0.05		0.05	88000	170	30	1600	3400	17000
Zinc	30		290	47000				24000	
Electrical Conductivity (mS/cm)			0.57						
Chloride	5		210		35000	430		5100	
Sodium Adsorption Ratio			2.4						
Sodium	50		1300						

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario									
Coarse Textured Soil		**Residential /Parkland Land Use (ug/g)**							
	MOE	Mass.	Ont. Soil	Soil Contact	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S2 Risk	S3 Risk	S-GW3	S-IA	Threshold	Odour
Acenaphthene	0.05		0.072	96	3600	560	7.9	2800	3900
Acenaphthylene	0.05		0.093	9.6	360	0.15	0.45	2900	
Acetone	0.5		0.5	200000	660000	16	720	92000	4300
Aldrin	0.05		0.05	4.7	6.3	150000		5000	260000
Anthracene	0.05		0.16	42000	420000	0.67		2700	
Antimony	1		1.3	63	63			8000	
Arsenic	1		18	1.3	47			12000	
Barium	5		220	32000	8600			7700	
Benzene	0.02		0.02	13	480	14	0.21	5000	820
Benz[a]anthracene	0.05		0.36	0.96	36	5.1E+11	65	7600	
Benzo[a]pyrene	0.05		0.3	0.096	3.6	3.8E+13	820	7600	
Benzo[b]fluoranthene	0.05		0.47	0.96	36	7.7E+13	5500	7600	
Benzo[ghi]perylene	0.1		0.68	9.6	360	1.2E+13		7600	
Benzo[k]fluoranthene	0.05		0.48	0.96	36	2.5E+13	6700	7600	
Beryllium	2		2.5	320	60			3900	
Biphenyl 1,1'-	0.05		0.05	6000	6000	190		2600	11
Bis(2-chloroethyl)ether	0.5		0.5	0.44	16	92		6400	69
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	8800	120		11	18
Bis(2-ethylhexyl)phthalate	5		5	9500	16000	2.5E+09		7100	
Boron (Hot Water Soluble)*	0.5		0.5					5000	
Boron (total)	5		36	24000	24000			5000	
Bromodichloromethane	0.05		0.05	18	660	50		5500	
Bromoform	0.05		0.05	140	5200	21	0.27	11000	220
Bromomethane	0.05		0.05	66	660	1.4	0.00034	7300	27
Cadmium	1		1.2	7.9	7.9			18000	
Carbon Tetrachloride	0.05		0.05	150	1500	2.3	0.013	3900	470
Chlordane	0.05		0.05	0.8	30	180	7.6	8400	5700
Chloroaniline p-	0.5		0.5	320	320	0.45		6100	
Chlorobenzene	0.05		0.05	13000	42000	2.4	91	3700	78
Chloroform	0.05		0.05	35	1300	9.5	0.032	6600	1400
Chlorophenol, 2-	0.1		0.1	660	660	21		130000	
Chromium Total	5		70	240000	240000			11000	
Chromium VI	0.2		0.66	1300	40				
Chrysene	0.05		2.8	9.6	360	3.6E+11	1900	7700	
Cobalt	2		21	250	2500			19000	
Copper	5		92	5600	5600				
Cyanide (CN-)	0.05		0.051	3200	7900	0.022		240000	
Dibenz[a h]anthracene	0.1		0.1	0.096	3.6	2.4E+13	33000	7600	
Dibromochloromethane	0.05		0.05	13	490	48		10000	
Dichlorobenzene, 1,2-	0.05		0.05	66000	130000	60	35	3100	160
Dichlorobenzene, 1,3-	0.05		0.05	4400	4400	59		3300	
Dichlorobenzene, 1,4-	0.05		0.05	65	2400	59	0.083	3000	22
Dichlorobenzidine, 3,3'-	1		1	0.66	25	66		5000	
Dichlorodifluoromethane	0.05		0.05	44000	44000	16		710	
DDD	0.05		0.05	4.6	110	34000000		5000	
DDE	0.05		0.05	3.2	110	310000000		5000	
DDT	0.05		1.4	3.2	110	730000000		5000	
Dichloroethane, 1,1-	0.05		0.05	8800	88000	1600	3.5	4800	130
Dichloroethane, 1,2-	0.05		0.05	12	450	180	0.025	5300	640
Dichloroethylene, 1,1-	0.05		0.05	11000	11000	11	0.004	3900	180
Dichloroethylene, 1,2-cis-	0.05		0.05	6600	66000	130	3.4	4600	
Dichloroethylene, 1,2-trans-	0.05		0.05	4400	44000	220	0.084	4600	34
Dichlorophenol, 2,4-	0.1		0.1	660	660	46		33000	

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario									
Coarse Textured Soil		**Residential /Parkland Land Use (ug/g)**							
	MOE	Mass.	Ont. Soil	Soil Contact	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S2 Risk	S3 Risk	S-GW3	S-IA	Threshold	Odour
Dichloropropane, 1,2-	0.05		0.05	31	1100	76	0.01	2100	4.5
Dichloropropene,1,3-	0.05		0.05	12	450	3.8	0.027	5000	17
Dieldrin	0.05		0.05	7.9	16	0.11		8700	
Diethyl Phthalate	0.5		0.5	790000	1300000	0.07		7600	
Dimethylphthalate	0.5		0.5	790000	790000	0.023		1800	
Dimethylphenol, 2,4-	0.2		0.2	4400	44000	390		57000	
Dinitrophenol, 2,4-	2		2	320	3200	59		13000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	1.2	43	15		3800	
Dioxane, 1,4	0.2		0.2	100	3700	810	180	82000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.00051	0.0044	780	0.0028	7000	
Endosulfan	0.04		0.04	320	790	0.46		8700	
Endrin	0.04		0.04	39	320	0.071		5000	
Ethylbenzene	0.05		0.05	22000	22000	17	2	2700	100
Ethylene dibromide	0.05		0.05	0.31	11	86	0.0014	2000	1600
Fluoranthene	0.05		0.56	9.6	360	40000	250	7600	
Fluorene	0.05		0.12	5600	56000	62		2800	
Heptachlor	0.05		0.05	0.19	2.3	1.8		8300	19000
Heptachlor Epoxide	0.05		0.05	0.14	5.3	0.0035		5000	8800
Hexachlorobenzene	0.01		0.01	0.66	16	14		9300	
Hexachlorobutadiene	0.01		0.01	14	75	1.6	0.012	8300	210
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	2.5	0.056		5000	
Hexachloroethane	0.01		0.01	79	2200	22	0.089	9400	51
Hexane (n)	0.05		0.05		21000000	54	2.8	1500	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.96	36	8.6E+13	46000	7600	
Lead	10		120	1000	1000			24000	
Mercury	0.1		0.27	67	670	1.2E+14	0.25	34000	
Methoxychlor	0.05		0.05	1.6	1.6	3.9		8000	
Methyl Ethyl Ketone	0.5		0.5	64000	64000	230	16	26000	750
Methyl Isobutyl Ketone	0.5		0.5	110000	110000	150	6.6	5100	39
Methyl Mercury **				9.2	9.2	0.0084		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	610	23000	220	0.75	8000	
Methylene Chloride	0.05		0.05	150	5500	7.4	0.1	6400	670
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	560	76		3600	34
Molybdenum	2		2	1200	1200			22000	
Naphthalene	0.05		0.09	2800	28000	200	0.65	2800	150
Nickel	5		82	2200	510				
Pentachlorophenol	0.1		0.1	4.1	50	2.9		9200	
Petroleum Hydrocarbons F1****	10		25	47000	100000	55	130	1700	
Petroleum Hydrocarbons F2	10		10	22000	48000	230	98	2700	
Petroleum Hydrocarbons F3	50		240	40000	260000			5800	
Petroleum Hydrocarbons F4	50		120	42000	400000			6900	
Phenanthrene	0.05		0.69			270		2300	
Phenol	0.5		0.5	42000	42000	46	940	230000	34000
Polychlorinated Biphenyls	0.3		0.3	2.7	4.1	9.9E+11	3.1	5000	
Pyrene	0.05		1	96	3600	2600	1900	7700	
Selenium	1		1.5	1200	1200				
Silver	0.5		0.5	490	490			22000	
Styrene	0.05		0.05	26000	26000	66	16	3500	18
Tetrachloroethane, 1,1,1,2-	0.05		0.05	42	1600	37	0.058	4400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	5.5	210	48	0.0045	6700	2400
Tetrachloroethylene	0.05		0.05	3100	31000	18	0.28	3700	320
Thallium	1		1	3.3	33			22000	
Toluene	0.2		0.2	18000	180000	68	6.2	3300	35

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario									
Coarse Textured Soil		**Residential /Parkland Land Use (ug/g)**							
	MOE	Mass.	Ont. Soil	Soil Contact	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S2 Risk	S3 Risk	S-GW3	S-IA	Threshold	Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	2200	22000	43	0.36	3400	1100
Trichloroethane, 1,1,1-	0.05		0.05	440000	1500000	9.8	0.38	3700	1000
Trichloroethane, 1,1,2-	0.05		0.05	19	720	120	0.03	3900	
Trichloroethylene	0.05		0.05	85	160	300	0.061	4100	480
Trichlorofluoromethane	0.05		0.25	66000	66000	4		4400	
Trichlorophenol, 2,4,5-	0.1		0.1	470	470	27		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	72	470	3.8		13000	
Uranium	1		2.5	300	300			40000	
Vanadium	10		86	160	160			7100	
Vinyl Chloride	0.02		0.02	0.79	29	270	0.0021	6100	1000
Xylene Mixture	0.05		0.05	44000	88000	26	3.1	2300	580
Zinc	30		290	47000	47000			15000	
Electrical Conductivity (mS/cm)			0.57						
Chloride	5		210			220		3000	
Sodium Adsorption Ratio			2.4						
Sodium	50		1300						

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario								
Coarse Textured Soil		**Industrial/Commercial Land Use (ug/g)**						
	MOE	Mass.	Ont. Soil	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S3 Risk	S-GW3	S-IA	Threshold	Odour
Acenaphthene	0.05		0.072	3600	560	330	2800	18000
Acenaphthylene	0.05		0.093	360	0.15	18	2900	
Acetone	0.5		0.5	660000	16	3000	92000	20000
Aldrin	0.05		0.05	6.3	150000		5000	1200000
Anthracene	0.05		0.16	420000	0.67		2700	
Antimony	1		1.3	63			8000	
Arsenic	1		18	47			12000	
Barium	5		220	8600			7700	
Benzene	0.02		0.02	480	14	6.1	5000	3800
Benz[a]anthracene	0.05		0.36	36	5.1E+11	2300	7600	
Benzo[a]pyrene	0.05		0.3	3.6	3.8E+13	16000	7600	
Benzo[b]fluoranthene	0.05		0.47	36	7.7E+13	130000	7600	
Benzo[ghi]perylene	0.1		0.68	360	1.2E+13		7600	
Benzo[k]fluoranthene	0.05		0.48	36	2.5E+13	150000	7600	
Beryllium	2		2.5	60			3900	
Biphenyl 1,1'-	0.05		0.05	6000	190		2600	52
Bis(2-chloroethyl)ether	0.5		0.5	16	92		6400	320
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	120		11	82
Bis(2-ethylhexyl)phthalate	5		5	16000	2.5E+09		7100	
Boron (Hot Water Soluble)*	0.5		0.5				5000	
Boron (total)	5		36	24000			5000	
Bromodichloromethane	0.05		0.05	660	50		5500	
Bromoform	0.05		0.05	5200	21	2	11000	980
Bromomethane	0.05		0.05	660	1.4	0.0033	7300	130
Cadmium	1		1.2	7.9			18000	
Carbon Tetrachloride	0.05		0.05	1500	2.3	0.43	3900	2200
Chlordane	0.05		0.05	30	180	620	8400	26000
Chloroaniline p-	0.5		0.5	320	0.45		6100	
Chlorobenzene	0.05		0.05	42000	2.4	220	3700	360
Chloroform	0.05		0.05	1300	9.5	0.85	6600	6800
Chlorophenol, 2-	0.1		0.1	660	21		130000	
Chromium Total	5		70	240000			11000	
Chromium VI	0.2		0.66	40				
Chrysene	0.05		2.8	360	3.6E+11	81000	7700	
Cobalt	2		21	2500			19000	
Copper	5		92	5600				
Cyanide (CN-)	0.05		0.051	7900	0.022		240000	
Dibenz[a h]anthracene	0.1		0.1	3.6	2.4E+13	500000	7600	
Dibromochloromethane	0.05		0.05	490	48		10000	
Dichlorobenzene, 1,2-	0.05		0.05	130000	60	230	3100	770
Dichlorobenzene, 1,3-	0.05		0.05	4400	59		3300	
Dichlorobenzene, 1,4-	0.05		0.05	2400	59	0.39	3000	100
Dichlorobenzidine, 3,3'-	1		1	25	66		5000	
Dichlorodifluoromethane	0.05		0.05	44000	16		710	
DDD	0.05		0.05	110	34000000		5000	
DDE	0.05		0.05	110	310000000		5000	
DDT	0.05		1.4	110	730000000		5000	
Dichloroethane, 1,1-	0.05		0.05	88000	1600	120	4800	590
Dichloroethane, 1,2-	0.05		0.05	450	180	0.055	5300	3000
Dichloroethylene, 1,1-	0.05		0.05	11000	11	0.12	3900	860
Dichloroethylene, 1,2-cis-	0.05		0.05	66000	130	110	4600	
Dichloroethylene, 1,2-trans-	0.05		0.05	44000	220	2.9	4600	160
Dichlorophenol, 2,4-	0.1		0.1	660	46		33000	

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario								
Coarse Textured Soil		**Industrial/Commercial Land Use (ug/g)**						
	MOE	Mass.	Ont. Soil	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S3 Risk	S-GW3	S-IA	Threshold	Odour
Dichloropropane, 1,2-	0.05		0.05	1100	76	0.33	2100	21
Dichloropropene,1,3-	0.05		0.05	450	3.8	0.34	5000	78
Dieldrin	0.05		0.05	16	0.11		8700	
Diethyl Phthalate	0.5		0.5	1300000	0.07		7600	
Dimethylphthalate	0.5		0.5	790000	0.023		1800	
Dimethylphenol, 2,4-	0.2		0.2	44000	390		57000	
Dinitrophenol, 2,4-	2		2	3200	59		13000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	43	15		3800	
Dioxane, 1,4	0.2		0.2	3700	810	2400	82000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.0044	780	0.23	7000	
Endosulfan	0.04		0.04	790	0.46		8700	
Endrin	0.04		0.04	320	0.071		5000	
Ethylbenzene	0.05		0.05	22000	17	200	2700	470
Ethylene dibromide	0.05		0.05	11	86	0.0026	2000	7100
Fluoranthene	0.05		0.56	360	40000	11000	7600	
Fluorene	0.05		0.12	56000	62		2800	
Heptachlor	0.05		0.05	2.3	1.8		8300	87000
Heptachlor Epoxide	0.05		0.05	5.3	0.0035		5000	40000
Hexachlorobenzene	0.01		0.01	16	14		9300	
Hexachlorobutadiene	0.01		0.01	75	1.6	0.06	8300	980
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	0.056		5000	
Hexachloroethane	0.01		0.01	2200	22	1.7	9400	220
Hexane (n)	0.05		0.05	21000000	54	650	1500	
Indeno[1 2 3-cd]pyrene	0.1		0.23	36	8.6E+13	870000	7600	
Lead	10		120	1000			24000	
Mercury	0.1		0.27	670	1.2E+14	13	34000	
Methoxychlor	0.05		0.05	1.6	3.9		8000	
Methyl Ethyl Ketone	0.5		0.5	64000	230	150	26000	3500
Methyl Isobutyl Ketone	0.5		0.5	110000	150	64	5100	180
Methyl Mercury **				9.2	0.0084		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	23000	220	14	8000	
Methylene Chloride	0.05		0.05	5500	7.4	3	6400	3100
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	76		3600	160
Molybdenum	2		2	1200			22000	
Naphthalene	0.05		0.09	28000	200	220	2800	710
Nickel	5		82	510				
Pentachlorophenol	0.1		0.1	50	2.9		9200	
Petroleum Hydrocarbons F1****	10		25	100000	55	11000	1700	
Petroleum Hydrocarbons F2	10		10	48000	230	7500	2700	
Petroleum Hydrocarbons F3	50		240	260000			5800	
Petroleum Hydrocarbons F4	50		120	400000			6900	
Phenanthrene	0.05		0.69		270		2300	
Phenol	0.5		0.5	42000	46	21000	230000	160000
Polychlorinated Biphenyls	0.3		0.3	4.1	9.9E+11	210	5000	
Pyrene	0.05		1	3600	2600	91000	7700	
Selenium	1		1.5	1200				
Silver	0.5		0.5	490			22000	
Styrene	0.05		0.05	26000	66	81	3500	83
Tetrachloroethane, 1,1,1,2-	0.05		0.05	1600	37	0.24	4400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	210	48	0.038	6700	11000
Tetrachloroethylene	0.05		0.05	31000	18	9.5	3700	1500
Thallium	1		1	33			22000	
Toluene	0.2		0.2	180000	68	1900	3300	170

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario								
Coarse Textured Soil		**Industrial/Commercial Land Use (ug/g)**						
	MOE	Mass.	Ont. Soil	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S3 Risk	S-GW3	S-IA	Threshold	Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	22000	43	10	3400	5300
Trichloroethane, 1,1,1-	0.05		0.05	1500000	9.8	12	3700	4700
Trichloroethane, 1,1,2-	0.05		0.05	720	120	0.068	3900	
Trichloroethylene	0.05		0.05	160	300	1.8	4100	2200
Trichlorofluoromethane	0.05		0.25	66000	4		4400	
Trichlorophenol, 2,4,5-	0.1		0.1	470	27		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	470	3.8		13000	
Uranium	1		2.5	300			40000	
Vanadium	10		86	160			7100	
Vinyl Chloride	0.02		0.02	29	270	0.057	6100	4800
Xylene Mixture	0.05		0.05	88000	26	1100	2300	2700
Zinc	30		290	47000			15000	
Electrical Conductivity (mS/cm)			0.57					
Chloride	5		210		220		3000	
Sodium Adsorption Ratio			2.4					
Sodium	50		1300					

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario

Medium - Fine Textured Soil | **Residential /Parkland Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S2 Risk	Soil Contact S3 Risk	S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Acenaphthene	0.05		0.072	96	3600	620	58	4300	29000
Acenaphthylene	0.05		0.093	9.6	360	0.17	3.3	4000	
Acetone	0.5		0.5	200000	660000	28	1200	140000	54000
Aldrin	0.05		0.05	4.7	6.3	170000		5000	1500000
Anthracene	0.05		0.16	42000	420000	0.74		4300	
Antimony	1		1.3	63	63			13000	
Arsenic	1		18	1.3	47			19000	
Barium	5		220	32000	8600			12000	
Benzene	0.02		0.02	13	480	16	0.17	6200	6700
Benz[a]anthracene	0.05		0.36	0.96	36	5.6E+11	490	9200	
Benzo[a]pyrene	0.05		0.3	0.096	3.6	4.2E+13	6100	9200	
Benzo[b]fluoranthene	0.05		0.47	0.96	36	8.6E+13	37000	9200	
Benzo[ghi]perylene	0.1		0.68	9.6	360	1.4E+13		9200	
Benzo[k]fluoranthene	0.05		0.48	0.96	36	2.8E+13	45000	9200	
Beryllium	2		2.5	320	60			6200	
Biphenyl 1,1'-	0.05		0.05	6000	6000	210		3900	83
Bis(2-chloroethyl)ether	0.5		0.5	0.44	16	130		8800	660
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	8800	160		14	150
Bis(2-ethylhexyl)phthalate	5		5	9500	16000	2.8E+09		8300	
Boron (Hot Water Soluble)*	0.5		0.5					7900	
Boron (total)	5		36	24000	24000			7900	
Bromodichloromethane	0.05		0.05	18	660	63		8100	
Bromoform	0.05		0.05	140	5200	27	0.26	15000	1500
Bromomethane	0.05		0.05	66	660	2	0.0034	10000	270
Cadmium	1		1.2	7.9	7.9			29000	
Carbon Tetrachloride	0.05		0.05	150	1500	3	0.12	6000	4300
Chlordane	0.05		0.05	0.8	30	200	43	10000	33000
Chloroaniline p-	0.5		0.5	320	320	0.53		8100	
Chlorobenzene	0.05		0.05	13000	42000	2.7	53	5100	620
Chloroform	0.05		0.05	35	1300	12	0.18	9000	13000
Chlorophenol, 2-	0.1		0.1	660	660	23		130000	
Chromium Total	5		70	240000	240000			18000	
Chromium VI	0.2		0.66	1300	40				
Chrysene	0.05		2.8	9.6	360	4E+11	13000	9300	
Cobalt	2		21	250	2500			30000	
Copper	5		92	5600	5600				
Cyanide (CN-)	0.05		0.051	3200	7900	0.03		290000	
Dibenz[a h]anthracene	0.1		0.1	0.096	3.6	2.7E+13	170000	9200	
Dibromochloromethane	0.05		0.05	13	490	61		13000	
Dichlorobenzene, 1,2-	0.05		0.05	66000	130000	68	52	4800	1300
Dichlorobenzene, 1,3-	0.05		0.05	4400	4400	67		4900	
Dichlorobenzene, 1,4-	0.05		0.05	65	2400	67	0.097	4600	170
Dichlorobenzidine, 3,3'-	1		1	0.66	25	74		5000	
Dichlorodifluoromethane	0.05		0.05	44000	44000	25		1000	
DDD	0.05		0.05	4.6	110	38000000		5000	
DDE	0.05		0.05	3.2	110	350000000		5000	
DDT	0.05		1.4	3.2	110	810000000		5000	
Dichloroethane, 1,1-	0.05		0.05	8800	88000	2000	31	6600	1100
Dichloroethane, 1,2-	0.05		0.05	12	450	220	0.013	7100	5700
Dichloroethylene, 1,1-	0.05		0.05	11000	11000	15	0.038	5800	1800
Dichloroethylene, 1,2-cis-	0.05		0.05	6600	66000	160	30	6400	
Dichloroethylene, 1,2-trans-	0.05		0.05	4400	44000	280	0.75	6500	300
Dichlorophenol, 2,4-	0.1		0.1	660	660	52		33000	

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario									
Medium - Fine Textured Soil		**Residential /Parkland Land Use (ug/g)**							
	MOE	Mass.	Ont. Soil	Soil Contact	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S2 Risk	S3 Risk	S-GW3	S-IA	Threshold	Odour
Dichloropropane, 1,2-	0.05		0.05	31	1100	91	0.085	2300	38
Dichloropropene,1,3-	0.05		0.05	12	450	4.5	0.083	6600	140
Dieldrin	0.05		0.05	7.9	16	0.12		11000	
Diethyl Phthalate	0.5		0.5	790000	1300000	0.081		9100	
Dimethylphthalate	0.5		0.5	790000	790000	0.029		2000	
Dimethylphenol, 2,4-	0.2		0.2	4400	44000	440		57000	
Dinitrophenol, 2,4-	2		2	320	3200	66		14000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	1.2	43	17		5400	
Dioxane, 1,4	0.2		0.2	100	3700	1500	1400	130000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.00051	0.0044	870	0.017	8200	
Endosulfan	0.04		0.04	320	790	0.51		11000	
Endrin	0.04		0.04	39	320	0.079		5000	
Ethylbenzene	0.05		0.05	22000	22000	19	16	3800	800
Ethylene dibromide	0.05		0.05	0.31	11	110	0.00054	2200	11000
Fluoranthene	0.05		0.56	9.6	360	45000	1700	9200	
Fluorene	0.05		0.12	5600	56000	69		4200	
Heptachlor	0.05		0.05	0.19	2.3	2		10000	110000
Heptachlor Epoxide	0.05		0.05	0.14	5.3	0.0039		5000	52000
Hexachlorobenzene	0.01		0.01	0.66	16	15		12000	
Hexachlorobutadiene	0.01		0.01	14	75	1.8	0.014	10000	1600
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	2.5	0.063		5000	
Hexachloroethane	0.01		0.01	79	2200	25	0.071	12000	160
Hexane (n)	0.05		0.05		21000000	88	34	2400	
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.96	36	9.5E+13	300000	9200	
Lead	10		120	1000	1000			38000	
Mercury	0.1		0.27	67	670	1.3E+14	1.8	50000	
Methoxychlor	0.05		0.05	1.6	1.6	4.3		9700	
Methyl Ethyl Ketone	0.5		0.5	64000	64000	380	180	38000	8700
Methyl Isobutyl Ketone	0.5		0.5	110000	110000	210	66	7100	400
Methyl Mercury **				9.2	9.2	0.0094		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	610	23000	350	1.4	12000	
Methylene Chloride	0.05		0.05	150	5500	9.8	0.96	8400	6300
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	560	85		5200	260
Molybdenum	2		2	1200	1200			34000	
Naphthalene	0.05		0.09	2800	28000	220	4.6	4000	1200
Nickel	5		82	2200	510				
Pentachlorophenol	0.1		0.1	4.1	50	3.3		12000	
Petroleum Hydrocarbons F1****	10		25	47000	100000	65	240	2600	
Petroleum Hydrocarbons F2	10		10	22000	48000	250	150	3900	
Petroleum Hydrocarbons F3	50		240	40000	260000			7200	
Petroleum Hydrocarbons F4	50		120	42000	400000			8000	
Phenanthrene	0.05		0.69			300		3500	
Phenol	0.5		0.5	42000	42000	53	7500	240000	280000
Polychlorinated Biphenyls	0.3		0.3	2.7	4.1	1.1E+12	19	5000	
Pyrene	0.05		1	96	3600	2900	13000	9300	
Selenium	1		1.5	1200	1200				
Silver	0.5		0.5	490	490			35000	
Styrene	0.05		0.05	26000	26000	75	19	4700	140
Tetrachloroethane, 1,1,1,2-	0.05		0.05	42	1600	43	0.046	6400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	5.5	210	56	0.0096	8800	20000
Tetrachloroethylene	0.05		0.05	3100	31000	21	2.3	5700	2700
Thallium	1		1	3.3	33			34000	
Toluene	0.2		0.2	18000	180000	78	50	4400	290

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario									
Medium - Fine Textured Soil		**Residential /Parkland Land Use (ug/g)**							
	MOE	Mass.	Ont. Soil	Soil Contact	Soil Contact		Indoor Air	Free Phase	Indoor Air
Chemical Parameter	Soil RL	PQL	Bkgrd	S2 Risk	S3 Risk	S-GW3	S-IA	Threshold	Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	2200	22000	48	1.4	5300	8200
Trichloroethane, 1,1,1-	0.05		0.05	440000	1500000	12	3.4	5500	9000
Trichloroethane, 1,1,2-	0.05		0.05	19	720	150	0.018	5700	
Trichloroethylene	0.05		0.05	85	160	360	0.52	6000	4100
Trichlorofluoromethane	0.05		0.25	66000	66000	5.8		6600	
Trichlorophenol, 2,4,5-	0.1		0.1	470	470	30		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	72	470	4.2		15000	
Uranium	1		2.5	300	300			64000	
Vanadium	10		86	160	160			11000	
Vinyl Chloride	0.02		0.02	0.79	29	380	0.022	8400	10000
Xylene Mixture	0.05		0.05	44000	88000	30	25	3400	4600
Zinc	30		290	47000	47000			24000	
Electrical Conductivity (mS/cm)			0.57						
Chloride	5		210			430		5100	
Sodium Adsorption Ratio			2.4						
Sodium	50		1300						

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario

Medium - Fine Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Acenaphthene	0.05		0.072	3600	620	850	4300	100000
Acenaphthylene	0.05		0.093	360	0.17	48	4000	
Acetone	0.5		0.5	660000	28	13000	140000	200000
Aldrin	0.05		0.05	6.3	170000		5000	5600000
Anthracene	0.05		0.16	420000	0.74		4300	
Antimony	1		1.3	63			13000	
Arsenic	1		18	47			19000	
Barium	5		220	8600			12000	
Benzene	0.02		0.02	480	16	4.4	6200	24000
Benz[a]anthracene	0.05		0.36	36	5.6E+11	6800	9200	
Benzo[a]pyrene	0.05		0.3	3.6	4.2E+13	74000	9200	
Benzo[b]fluoranthene	0.05		0.47	36	8.6E+13	460000	9200	
Benzo[ghi]perylene	0.1		0.68	360	1.4E+13		9200	
Benzo[k]fluoranthene	0.05		0.48	36	2.8E+13	560000	9200	
Beryllium	2		2.5	60			6200	
Biphenyl 1,1'-	0.05		0.05	6000	210		3900	300
Bis(2-chloroethyl)ether	0.5		0.5	16	130		8800	2400
Bis(2-chloroisopropyl)ether	0.5		0.5	8800	160		14	550
Bis(2-ethylhexyl)phthalate	5		5	16000	2.8E+09		8300	
Boron (Hot Water Soluble)*	0.5		0.5				7900	
Boron (total)	5		36	24000			7900	
Bromodichloromethane	0.05		0.05	660	63		8100	
Bromoform	0.05		0.05	5200	27	2.7	15000	5500
Bromomethane	0.05		0.05	660	2	0.014	10000	990
Cadmium	1		1.2	7.9			29000	
Carbon Tetrachloride	0.05		0.05	1500	3	1.7	6000	16000
Chlordane	0.05		0.05	30	200	920	10000	120000
Chloroaniline p-	0.5		0.5	320	0.53		8100	
Chlorobenzene	0.05		0.05	42000	2.7	390	5100	2300
Chloroform	0.05		0.05	1300	12	0.19	9000	48000
Chlorophenol, 2-	0.1		0.1	660	23		130000	
Chromium Total	5		70	240000			18000	
Chromium VI	0.2		0.66	40				
Chrysene	0.05		2.8	360	4E+11	190000	9300	
Cobalt	2		21	2500			30000	
Copper	5		92	5600				
Cyanide (CN-)	0.05		0.051	7900	0.03		290000	
Dibenz[a h]anthracene	0.1		0.1	3.6	2.7E+13	2300000	9200	
Dibromochloromethane	0.05		0.05	490	61		13000	
Dichlorobenzene, 1,2-	0.05		0.05	130000	68	600	4800	4700
Dichlorobenzene, 1,3-	0.05		0.05	4400	67		4900	
Dichlorobenzene, 1,4-	0.05		0.05	2400	67	0.97	4600	630
Dichlorobenzidine, 3,3'-	1		1	25	74		5000	
Dichlorodifluoromethane	0.05		0.05	44000	25		1000	
DDD	0.05		0.05	110	38000000		5000	
DDE	0.05		0.05	110	350000000		5000	
DDT	0.05		1.4	110	810000000		5000	
Dichloroethane, 1,1-	0.05		0.05	88000	2000	45	6600	4100
Dichloroethane, 1,2-	0.05		0.05	450	220	0.044	7100	21000
Dichloroethylene, 1,1-	0.05		0.05	11000	15	0.53	5800	6400
Dichloroethylene, 1,2-cis-	0.05		0.05	66000	160	43	6400	
Dichloroethylene, 1,2-trans-	0.05		0.05	44000	280	11	6500	1100
Dichlorophenol, 2,4-	0.1		0.1	660	52		33000	

Soil Components for Table 6 are the same as soil components for Table 2

Soil Components for Table 7 are the same as soil components for Table 3

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario

Medium - Fine Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Dichloropropane, 1,2-	0.05		0.05	1100	91	0.75	2300	140
Dichloropropene,1,3-	0.05		0.05	450	4.5	0.24	6600	500
Dieldrin	0.05		0.05	16	0.12		11000	
Diethyl Phthalate	0.5		0.5	1300000	0.081		9100	
Dimethylphthalate	0.5		0.5	790000	0.029		2000	
Dimethylphenol, 2,4-	0.2		0.2	44000	440		57000	
Dinitrophenol, 2,4-	2		2	3200	66		14000	
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	43	17		5400	
Dioxane, 1,4	0.2		0.2	3700	1500	18000	130000	
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.0044	870	0.36	8200	
Endosulfan	0.04		0.04	790	0.51		11000	
Endrin	0.04		0.04	320	0.079		5000	
Ethylbenzene	0.05		0.05	22000	19	670	3800	2900
Ethylene dibromide	0.05		0.05	11	110	0.0026	2200	42000
Fluoranthene	0.05		0.56	360	45000	26000	9200	
Fluorene	0.05		0.12	56000	69		4200	
Heptachlor	0.05		0.05	2.3	2		10000	400000
Heptachlor Epoxide	0.05		0.05	5.3	0.0039		5000	190000
Hexachlorobenzene	0.01		0.01	16	15		12000	
Hexachlorobutadiene	0.01		0.01	75	1.8	0.11	10000	5900
Hexachlorocyclohexane Gamma-	0.01		0.01	2.5	0.063		5000	
Hexachloroethane	0.01		0.01	2200	25	1.7	12000	590
Hexane (n)	0.05		0.05	21000000	88	4500	2400	
Indeno[1 2 3-cd]pyrene	0.1		0.23	36	9.5E+13	3600000	9200	
Lead	10		120	1000			38000	
Mercury	0.1		0.27	670	1.3E+14	30	50000	
Methoxychlor	0.05		0.05	1.6	4.3		9700	
Methyl Ethyl Ketone	0.5		0.5	64000	380	760	38000	32000
Methyl Isobutyl Ketone	0.5		0.5	110000	210	280	7100	1400
Methyl Mercury **				9.2	0.0094		1300000	
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	23000	350	3.4	12000	
Methylene Chloride	0.05		0.05	5500	9.8	13	8400	23000
Methlynaphthalene, 2-(1-) ***	0.05		0.59	560	85		5200	940
Molybdenum	2		2	1200			34000	
Naphthalene	0.05		0.09	28000	220	670	4000	4300
Nickel	5		82	510				
Pentachlorophenol	0.1		0.1	50	3.3		12000	
Petroleum Hydrocarbons F1****	10		25	100000	65	9200	2600	
Petroleum Hydrocarbons F2	10		10	48000	250	11000	3900	
Petroleum Hydrocarbons F3	50		240	260000			7200	
Petroleum Hydrocarbons F4	50		120	400000			8000	
Phenanthrene	0.05		0.69		300		3500	
Phenol	0.5		0.5	42000	53	97000	240000	1000000
Polychlorinated Biphenyls	0.3		0.3	4.1	1.1E+12	360	5000	
Pyrene	0.05		1	3600	2900	200000	9300	
Selenium	1		1.5	1200				
Silver	0.5		0.5	490			35000	
Styrene	0.05		0.05	26000	75	200	4700	510
Tetrachloroethane, 1,1,1,2-	0.05		0.05	1600	43	0.14	6400	
Tetrachloroethane, 1,1,2,2-	0.05		0.05	210	56	0.11	8800	72000
Tetrachloroethylene	0.05		0.05	31000	21	34	5700	9700
Thallium	1		1	33			34000	
Toluene	0.2		0.2	180000	78	7000	4400	1000

Soil Components for Table 6 are the

Soil Components for Table 5 - Sub-surface, Non-potable Water Scenario

Medium - Fine Textured Soil | **Industrial/Commercial Land Use (ug/g)**

Chemical Parameter	MOE Soil RL	Mass. PQL	Ont. Soil Bkgrd	Soil Contact S3 Risk	S-GW3	Indoor Air S-IA	Free Phase Threshold	Indoor Air Odour
Trichlorobenzene, 1,2,4-	0.05		0.05	22000	48	22	5300	30000
Trichloroethane, 1,1,1-	0.05		0.05	1500000	12	48	5500	33000
Trichloroethane, 1,1,2-	0.05		0.05	720	150	0.13	5700	
Trichloroethylene	0.05		0.05	160	360	0.69	6000	15000
Trichlorofluoromethane	0.05		0.25	66000	5.8		6600	
Trichlorophenol, 2,4,5-	0.1		0.1	470	30		14000	
Trichlorophenol, 2,4,6-	0.1		0.1	470	4.2		15000	
Uranium	1		2.5	300			64000	
Vanadium	10		86	160			11000	
Vinyl Chloride	0.02		0.02	29	380	0.28	8400	38000
Xylene Mixture	0.05		0.05	88000	30	1600	3400	17000
Zinc	30		290	47000			24000	
Electrical Conductivity (mS/cm)			0.57					
Chloride	5		210		430		5100	
Sodium Adsorption Ratio			2.4					
Sodium	50		1300					

Soil Components for Table 6 are the

Soil Components for Within 30 M of a Water Body (Table 8)					
Potable Water Scenario		**Agricultural and Other Land Use (ug/g)**			
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Agricultural	Quality
Acenaphthene	0.05		0.05	7.9	NV
Acenaphthylene	0.05		0.093	0.15	NV
Acetone	0.5		0.5	16	NV
Aldrin	0.05		0.05	0.05	0.002
Anthracene	0.05		0.05	0.67	0.22
Antimony	1		1	7.5	NV
Arsenic	1		11	11	6
Barium	5		210	390	NV
Benzene	0.02		0.02	0.21	NV
Benz[a]anthracene	0.05		0.095	0.5	0.32
Benzo[a]pyrene	0.05		0.05	0.078	0.37
Benzo[b]fluoranthene	0.05		0.3	0.78	NV
Benzo[ghi]perylene	0.1		0.2	6.6	0.17
Benzo[k]fluoranthene	0.05		0.05	0.78	0.24
Beryllium	2		2.5	4	NV
Biphenyl 1,1'-	0.05		0.05	0.31	NV
Bis(2-chloroethyl)ether	0.5		0.5	0.5	NV
Bis(2-chloroisopropyl)ether	0.5		0.5	0.67	NV
Bis(2-ethylhexyl)phthalate	5		5	5	NV
Boron (Hot Water Soluble)*	0.5		0.5	1.5	NA
Boron (total)	5		36	120	NV
Bromodichloromethane	0.05		0.05	1.5	NV
Bromoform	0.05		0.05	0.27	NV
Bromomethane	0.05		0.05	0.05	NV
Cadmium	1		1	1	0.6
Carbon Tetrachloride	0.05		0.05	0.05	NV
Chlordane	0.05		0.05	0.05	0.007
Chloroaniline p-	0.5		0.5	0.5	NV
Chlorobenzene	0.05		0.05	2.4	NV
Chloroform	0.05		0.05	0.05	NV
Chlorophenol, 2-	0.1		0.1	1.6	NV
Chromium Total	5		67	160	26
Chromium VI	0.2		0.66	8	NV
Chrysene	0.05		0.18	7	0.34
Cobalt	2		19	22	50
Copper	5		62	140	16
Cyanide (CN-)	0.05		0.051	0.051	0.1
Dibenz[a h]anthracene	0.1		0.1	0.1	0.06
Dibromochloromethane	0.05		0.05	2.3	NV
Dichlorobenzene, 1,2-	0.05		0.05	1.2	NV
Dichlorobenzene, 1,3-	0.05		0.05	4.8	NV
Dichlorobenzene, 1,4-	0.05		0.05	0.083	NV
Dichlorobenzidine, 3,3'-	1		1	1	NV
Dichlorodifluoromethane	0.05		0.05	16	NV
DDD	0.05		0.05	3.3	0.008
DDE	0.05		0.05	0.26	0.005
DDT	0.05		0.078	0.078	0.007
Dichloroethane, 1,1-	0.05		0.05	0.47	NV
Dichloroethane, 1,2-	0.05		0.05	0.05	NV
Dichloroethylene, 1,1-	0.05		0.05	0.05	NV
Dichloroethylene, 1,2-cis-	0.05		0.05	1.9	NV
Dichloroethylene, 1,2-trans-	0.05		0.05	0.084	NV
Dichlorophenol, 2,4-	0.1		0.1	0.19	NV

Soil Components for Within 30 M of a Water Body (Table 8)					
Potable Water Scenario		**Agricultural and Other Land Use (ug/g)**			
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Agricultural	Quality
Dichloropropane, 1,2-	0.05		0.05	0.05	NV
Dichloropropene,1,3-	0.05		0.05	0.05	NV
Dieldrin	0.05		0.05	0.05	0.002
Diethyl Phthalate	0.5		0.5	0.5	NV
Dimethylphthalate	0.5		0.5	0.5	NV
Dimethylphenol, 2,4-	0.2		0.2	38	NV
Dinitrophenol, 2,4-	2		2	2	NV
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	0.5	NV
Dioxane, 1,4	0.2		0.2	0.2	NV
Dioxin/Furan (TEQ)		5.4E-07	7E-06	0.000013	NV
Endosulfan	0.04		0.04	0.04	NV
Endrin	0.04		0.04	0.04	0.003
Ethylbenzene	0.05		0.05	1.1	NV
Ethylene dibromide	0.05		0.05	0.05	NV
Fluoranthene	0.05		0.24	0.69	0.75
Fluorene	0.05		0.05	62	0.19
Heptachlor	0.05		0.05	0.15	NV
Heptachlor Epoxide	0.05		0.05	0.05	0.005
Hexachlorobenzene	0.01		0.01	0.52	0.02
Hexachlorobutadiene	0.01		0.01	0.012	NV
Hexachlorocyclohexane Gamma-	0.01		0.01	0.056	NV
Hexachloroethane	0.01		0.01	0.089	NV
Hexane (n)	0.05		0.05	2.8	NV
Indeno[1 2 3-cd]pyrene	0.1		0.11	0.38	0.2
Lead	10		45	45	31
Mercury	0.1		0.16	0.25	0.2
Methoxychlor	0.05		0.05	0.13	NV
Methyl Ethyl Ketone	0.5		0.5	16	NV
Methyl Isobutyl Ketone	0.5		0.5	1.7	NV
Methyl Mercury **				0.0084	NV
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	0.75	NV
Methylene Chloride	0.05		0.05	0.1	NV
Methlynaphthalene, 2-(1-) ***	0.05		0.05	0.99	NV
Molybdenum	2		2	6.9	NV
Naphthalene	0.05		0.05	0.6	NV
Nickel	5		37	100	16
Pentachlorophenol	0.1		0.1	0.1	NV
Petroleum Hydrocarbons F1****	10		17	55	NV
Petroleum Hydrocarbons F2	10		10	98	NV
Petroleum Hydrocarbons F3	50		240	300	NV
Petroleum Hydrocarbons F4	50		120	2800	NV
Phenanthrene	0.05		0.19	6.2	0.56
Phenol	0.5		0.5	9.4	NV
Polychlorinated Biphenyls	0.3		0.3	0.35	0.07
Pyrene	0.05		0.19	78	0.49
Selenium	1		1.2	2.4	NV
Silver	0.5		0.5	20	0.5
Styrene	0.05		0.05	0.7	NV
Tetrachloroethane, 1,1,1,2-	0.05		0.05	0.058	NV
Tetrachloroethane, 1,1,2,2-	0.05		0.05	0.05	NV
Tetrachloroethylene	0.05		0.05	0.28	NV
Thallium	1		1	1	NV
Toluene	0.2		0.2	2.3	NV

Soil Components for Within 30 M of a Water Body (Table 8)					
Potable Water Scenario		**Agricultural and Other Land Use (ug/g)**			
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Agricultural	Quality
Trichlorobenzene, 1,2,4-	0.05		0.05	0.36	NV
Trichloroethane, 1,1,1-	0.05		0.05	0.38	NV
Trichloroethane, 1,1,2-	0.05		0.05	0.05	NV
Trichloroethylene	0.05		0.05	0.061	NV
Trichlorofluoromethane	0.05		0.05	4	NV
Trichlorophenol, 2,4,5-	0.1		0.1	4.4	NV
Trichlorophenol, 2,4,6-	0.1		0.1	2.1	NV
Uranium	1		1.9	23	NV
Vanadium	10		86	86	NV
Vinyl Chloride	0.02		0.02	0.02	NV
Xylene Mixture	0.05		0.05	3.1	NV
Zinc	30		290	340	120
Electrical Conductivity (mS/cm)			0.47	0.7	NA
Chloride	5		52	NA	NV
Sodium Adsorption Ratio			1	5	NA
Sodium	50		430	NA	NV

Soil Components for Within 30 M of a Water Body (Table 8)					
Potable Water Scenario	**Res/Park/Inst/Com/Ind/Comm Land Uses (ug/g)**				
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Res/Park	Quality
Acenaphthene	0.05		0.072	7.9	NV
Acenaphthylene	0.05		0.093	0.15	NV
Acetone	0.5		0.5	16	NV
Aldrin	0.05		0.05	0.05	0.002
Anthracene	0.05		0.16	0.67	0.22
Antimony	1		1.3	7.5	NV
Arsenic	1		18	18	6
Barium	5		220	390	NV
Benzene	0.02		0.02	0.21	NV
Benz[a]anthracene	0.05		0.36	0.5	0.32
Benzo[a]pyrene	0.05		0.3	0.3	0.37
Benzo[b]fluoranthene	0.05		0.47	0.78	NV
Benzo[ghi]perylene	0.1		0.68	6.6	0.17
Benzo[k]fluoranthene	0.05		0.48	0.78	0.24
Beryllium	2		2.5	4	NV
Biphenyl 1,1'-	0.05		0.05	0.31	NV
Bis(2-chloroethyl)ether	0.5		0.5	0.5	NV
Bis(2-chloroisopropyl)ether	0.5		0.5	0.67	NV
Bis(2-ethylhexyl)phthalate	5		5	5	NV
Boron (Hot Water Soluble)*	0.5		0.5	1.5	NA
Boron (total)	5		36	120	NV
Bromodichloromethane	0.05		0.05	1.5	NV
Bromoform	0.05		0.05	0.27	NV
Bromomethane	0.05		0.05	0.05	NV
Cadmium	1		1.2	1.2	0.6
Carbon Tetrachloride	0.05		0.05	0.05	NV
Chlordane	0.05		0.05	0.05	0.007
Chloroaniline p-	0.5		0.5	0.5	NV
Chlorobenzene	0.05		0.05	2.4	NV
Chloroform	0.05		0.05	0.05	NV
Chlorophenol, 2-	0.1		0.1	1.6	NV
Chromium Total	5		70	160	26
Chromium VI	0.2		0.66	8	NV
Chrysene	0.05		2.8	7	0.34
Cobalt	2		21	22	50
Copper	5		92	140	16
Cyanide (CN-)	0.05		0.051	0.051	0.1
Dibenz[a h]anthracene	0.1		0.1	0.1	0.06
Dibromochloromethane	0.05		0.05	2.3	NV
Dichlorobenzene, 1,2-	0.05		0.05	1.2	NV
Dichlorobenzene, 1,3-	0.05		0.05	4.8	NV
Dichlorobenzene, 1,4-	0.05		0.05	0.083	NV
Dichlorobenzidine, 3,3'-	1		1	1	NV
Dichlorodifluoromethane	0.05		0.05	16	NV
DDD	0.05		0.05	3.3	0.008
DDE	0.05		0.05	0.26	0.005
DDT	0.05		1.4	1.4	0.007
Dichloroethane, 1,1-	0.05		0.05	0.47	NV
Dichloroethane, 1,2-	0.05		0.05	0.05	NV
Dichloroethylene, 1,1-	0.05		0.05	0.05	NV
Dichloroethylene, 1,2-cis-	0.05		0.05	1.9	NV
Dichloroethylene, 1,2-trans-	0.05		0.05	0.084	NV
Dichlorophenol, 2,4-	0.1		0.1	0.19	NV

Soil Components for Within 30 M of a Water Body (Table 8)					
Potable Water Scenario	**Res/Park/Inst/Com/Ind/Comm Land Uses (ug/g)**				
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Res/Park	Quality
Dichloropropane, 1,2-	0.05		0.05	0.05	NV
Dichloropropene,1,3-	0.05		0.05	0.05	NV
Dieldrin	0.05		0.05	0.05	0.002
Diethyl Phthalate	0.5		0.5	0.5	NV
Dimethylphthalate	0.5		0.5	0.5	NV
Dimethylphenol, 2,4-	0.2		0.2	38	NV
Dinitrophenol, 2,4-	2		2	2	NV
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	0.5	NV
Dioxane, 1,4	0.2		0.2	1.8	NV
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.000013	NV
Endosulfan	0.04		0.04	0.04	NV
Endrin	0.04		0.04	0.04	0.003
Ethylbenzene	0.05		0.05	1.1	NV
Ethylene dibromide	0.05		0.05	0.05	NV
Fluoranthene	0.05		0.56	0.69	0.75
Fluorene	0.05		0.12	62	0.19
Heptachlor	0.05		0.05	0.15	NV
Heptachlor Epoxide	0.05		0.05	0.05	0.005
Hexachlorobenzene	0.01		0.01	0.52	0.02
Hexachlorobutadiene	0.01		0.01	0.012	NV
Hexachlorocyclohexane Gamma-	0.01		0.01	0.056	NV
Hexachloroethane	0.01		0.01	0.089	NV
Hexane (n)	0.05		0.05	2.8	NV
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.38	0.2
Lead	10		120	120	31
Mercury	0.1		0.27	0.27	0.2
Methoxychlor	0.05		0.05	0.13	NV
Methyl Ethyl Ketone	0.5		0.5	16	NV
Methyl Isobutyl Ketone	0.5		0.5	1.7	NV
Methyl Mercury **				0.0084	NV
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	0.75	NV
Methylene Chloride	0.05		0.05	0.1	NV
Methlynaphthalene, 2-(1-) ***	0.05		0.59	0.99	NV
Molybdenum	2		2	6.9	NV
Naphthalene	0.05		0.09	0.6	NV
Nickel	5		82	100	16
Pentachlorophenol	0.1		0.1	0.1	NV
Petroleum Hydrocarbons F1****	10		25	55	NV
Petroleum Hydrocarbons F2	10		10	98	NV
Petroleum Hydrocarbons F3	50		240	300	NV
Petroleum Hydrocarbons F4	50		120	2800	NV
Phenanthrene	0.05		0.69	6.2	0.56
Phenol	0.5		0.5	9.4	NV
Polychlorinated Biphenyls	0.3		0.3	0.35	0.07
Pyrene	0.05		1	78	0.49
Selenium	1		1.5	2.4	NV
Silver	0.5		0.5	20	0.5
Styrene	0.05		0.05	0.7	NV
Tetrachloroethane, 1,1,1,2-	0.05		0.05	0.058	NV
Tetrachloroethane, 1,1,2,2-	0.05		0.05	0.05	NV
Tetrachloroethylene	0.05		0.05	0.28	NV
Thallium	1		1	1	NV
Toluene	0.2		0.2	2.3	NV

Soil Components for Within 30 M of a Water Body (Table 8)					
Potable Water Scenario	**Res/Park/Inst/Com/Ind/Comm Land Uses (ug/g)**				
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Res/Park	Quality
Trichlorobenzene, 1,2,4-	0.05		0.05	0.36	NV
Trichloroethane, 1,1,1-	0.05		0.05	0.38	NV
Trichloroethane, 1,1,2-	0.05		0.05	0.05	NV
Trichloroethylene	0.05		0.05	0.061	NV
Trichlorofluoromethane	0.05		0.25	4	NV
Trichlorophenol, 2,4,5-	0.1		0.1	4.4	NV
Trichlorophenol, 2,4,6-	0.1		0.1	2.1	NV
Uranium	1		2.5	23	NV
Vanadium	10		86	86	NV
Vinyl Chloride	0.02		0.02	0.02	NV
Xylene Mixture	0.05		0.05	3.1	NV
Zinc	30		290	340	120
Electrical Conductivity (mS/cm)			0.57	0.7	NA
Chloride	5		210	NA	NV
Sodium Adsorption Ratio			2.4	5	NA
Sodium	50		1300	NA	NV

Soil Components for Within 30 M of a Water Body (Table 9)					
Non-Potable Water Scenario	**Res/Park/Inst/Com/Ind/Comm Land Uses (ug/g)**				
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Res/Park	Quality
Acenaphthene	0.05		0.072	7.9	NV
Acenaphthylene	0.05		0.093	0.15	NV
Acetone	0.5		0.5	16	NV
Aldrin	0.05		0.05	0.05	0.002
Anthracene	0.05		0.16	0.67	0.22
Antimony	1		1.3	7.5	NV
Arsenic	1		18	18	6
Barium	5		220	390	NV
Benzene	0.02		0.02	0.21	NV
Benz[a]anthracene	0.05		0.36	0.5	0.32
Benzo[a]pyrene	0.05		0.3	0.3	0.37
Benzo[b]fluoranthene	0.05		0.47	0.78	NV
Benzo[ghi]perylene	0.1		0.68	6.6	0.17
Benzo[k]fluoranthene	0.05		0.48	0.78	0.24
Beryllium	2		2.5	4	NV
Biphenyl 1,1'-	0.05		0.05	0.31	NV
Bis(2-chloroethyl)ether	0.5		0.5	0.5	NV
Bis(2-chloroisopropyl)ether	0.5		0.5	0.67	NV
Bis(2-ethylhexyl)phthalate	5		5	5	NV
Boron (Hot Water Soluble)*	0.5		0.5	1.5	NA
Boron (total)	5		36	120	NV
Bromodichloromethane	0.05		0.05	13	NV
Bromoform	0.05		0.05	0.27	NV
Bromomethane	0.05		0.05	0.05	NV
Cadmium	1		1.2	1.2	0.6
Carbon Tetrachloride	0.05		0.05	0.05	NV
Chlordane	0.05		0.05	0.05	0.007
Chloroaniline p-	0.5		0.5	0.5	NV
Chlorobenzene	0.05		0.05	2.4	NV
Chloroform	0.05		0.05	0.05	NV
Chlorophenol, 2-	0.1		0.1	1.6	NV
Chromium Total	5		70	160	26
Chromium VI	0.2		0.66	8	NV
Chrysene	0.05		2.8	7	0.34
Cobalt	2		21	22	50
Copper	5		92	140	16
Cyanide (CN-)	0.05		0.051	0.051	0.1
Dibenz[a h]anthracene	0.1		0.1	0.1	0.06
Dibromochloromethane	0.05		0.05	9.4	NV
Dichlorobenzene, 1,2-	0.05		0.05	3.4	NV
Dichlorobenzene, 1,3-	0.05		0.05	4.8	NV
Dichlorobenzene, 1,4-	0.05		0.05	0.083	NV
Dichlorobenzidine, 3,3'-	1		1	1	NV
Dichlorodifluoromethane	0.05		0.05	16	NV
DDD	0.05		0.05	3.3	0.008
DDE	0.05		0.05	0.26	0.005
DDT	0.05		1.4	1.4	0.007
Dichloroethane, 1,1-	0.05		0.05	3.5	NV
Dichloroethane, 1,2-	0.05		0.05	0.05	NV
Dichloroethylene, 1,1-	0.05		0.05	0.05	NV
Dichloroethylene, 1,2-cis-	0.05		0.05	3.4	NV
Dichloroethylene, 1,2-trans-	0.05		0.05	0.084	NV
Dichlorophenol, 2,4-	0.1		0.1	1.7	NV

Soil Components for Within 30 M of a Water Body (Table 9)					
Non-Potable Water Scenario	**Res/Park/Inst/Com/Ind/Comm Land Uses (ug/g)**				
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Res/Park	Quality
Dichloropropane, 1,2-	0.05		0.05	0.05	NV
Dichloropropene,1,3-	0.05		0.05	0.05	NV
Dieldrin	0.05		0.05	0.05	0.002
Diethyl Phthalate	0.5		0.5	0.5	NV
Dimethylphthalate	0.5		0.5	0.5	NV
Dimethylphenol, 2,4-	0.2		0.2	390	NV
Dinitrophenol, 2,4-	2		2	38	NV
Dinitrotoluene, 2,4 & 2,6-	0.5		0.5	0.92	NV
Dioxane, 1,4	0.2		0.2	1.8	NV
Dioxin/Furan (TEQ)		5.4E-07	0.000007	0.000013	NV
Endosulfan	0.04		0.04	0.04	NV
Endrin	0.04		0.04	0.04	0.003
Ethylbenzene	0.05		0.05	2	NV
Ethylene dibromide	0.05		0.05	0.05	NV
Fluoranthene	0.05		0.56	0.69	0.75
Fluorene	0.05		0.12	62	0.19
Heptachlor	0.05		0.05	0.15	NV
Heptachlor Epoxide	0.05		0.05	0.05	0.005
Hexachlorobenzene	0.01		0.01	0.52	0.02
Hexachlorobutadiene	0.01		0.01	0.012	NV
Hexachlorocyclohexane Gamma-	0.01		0.01	0.056	NV
Hexachloroethane	0.01		0.01	0.089	NV
Hexane (n)	0.05		0.05	2.8	NV
Indeno[1 2 3-cd]pyrene	0.1		0.23	0.38	0.2
Lead	10		120	120	31
Mercury	0.1		0.27	0.27	0.2
Methoxychlor	0.05		0.05	0.13	NV
Methyl Ethyl Ketone	0.5		0.5	16	NV
Methyl Isobutyl Ketone	0.5		0.5	1.7	NV
Methyl Mercury **				0.0084	NV
Methyl tert-Butyl Ether (MTBE)	0.05		0.05	0.75	NV
Methylene Chloride	0.05		0.05	0.1	NV
Methlynaphthalene, 2-(1-) ***	0.05		0.59	0.99	NV
Molybdenum	2		2	6.9	NV
Naphthalene	0.05		0.09	0.6	NV
Nickel	5		82	100	16
Pentachlorophenol	0.1		0.1	0.1	NV
Petroleum Hydrocarbons F1****	10		25	55	NV
Petroleum Hydrocarbons F2	10		10	98	NV
Petroleum Hydrocarbons F3	50		240	300	NV
Petroleum Hydrocarbons F4	50		120	2800	NV
Phenanthrene	0.05		0.69	6.2	0.56
Phenol	0.5		0.5	9.4	NV
Polychlorinated Biphenyls	0.3		0.3	0.35	0.07
Pyrene	0.05		1	78	0.49
Selenium	1		1.5	2.4	NV
Silver	0.5		0.5	20	0.5
Styrene	0.05		0.05	0.7	NV
Tetrachloroethane, 1,1,1,2-	0.05		0.05	0.058	NV
Tetrachloroethane, 1,1,2,2-	0.05		0.05	0.05	NV
Tetrachloroethylene	0.05		0.05	0.28	NV
Thallium	1		1	1	NV
Toluene	0.2		0.2	2.3	NV

Soil Components for Within 30 M of a Water Body (Table 9)					
Non-Potable Water Scenario	**Res/Park/Inst/Com/Ind/Comm Land Uses (ug/g)**				
	MOE	Mass.	Ont. Soil	Table 2	Sediment
Chemical Parameter	Soil RL	PQL	Bkgrd	Res/Park	Quality
Trichlorobenzene, 1,2,4-	0.05		0.05	0.36	NV
Trichloroethane, 1,1,1-	0.05		0.05	0.38	NV
Trichloroethane, 1,1,2-	0.05		0.05	0.05	NV
Trichloroethylene	0.05		0.05	0.061	NV
Trichlorofluoromethane	0.05		0.25	4	NV
Trichlorophenol, 2,4,5-	0.1		0.1	4.4	NV
Trichlorophenol, 2,4,6-	0.1		0.1	3.8	NV
Uranium	1		2.5	23	NV
Vanadium	10		86	86	NV
Vinyl Chloride	0.02		0.02	0.02	NV
Xylene Mixture	0.05		0.05	3.1	NV
Zinc	30		290	340	120
Electrical Conductivity (mS/cm)			0.57	0.7	NA
Chloride	5		210	NA	NV
Sodium Adsorption Ratio			2.4	5	NA
Sodium	50		1300	NA	NV

Groundwater Components for Potable Water Scenario (µg/L)										
Coarse Textured Soil										
	MOE	Ont. GW		GW1	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW1	Odour	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Acenaphthene	1	4.1	4.1	67	600	13000	300000	2000000	6600	2000
Acenaphthylene	1	1	0.45		36	750			1.8	8100
Acetone	30	2700	2700	93000	1800000	39000000	110000000	680000000	130000	500000000
Aldrin	0.01	0.01	0.35	150			1500000	12000000	100000	8.5
Anthracene	0.1	0.1	890						2.4	22
Antimony	0.5	1.5	6						20000	12000000
Arsenic	1	13	25						1900	17000000
Barium	2	610	1000						29000	27000000
Benzene	0.5	0.5	5	860	44	830	1700000	10000000	5800	900000
Benz[a]anthracene	0.2	0.2	1		70	1800			1.6E+11	4.7
Benzo[a]pyrene	0.01	0.01	0.01		130	2500			3.4E+12	0.81
Benzo[b]fluoranthene	0.1	0.1	0.1		1100	25000			6.9E+12	0.75
Benzo[ghi]perylene	0.2	0.2	1						3.3E+11	0.13
Benzo[k]fluoranthene	0.1	0.1	0.1		1300	28000			2.3E+12	0.4
Beryllium	0.5	0.5	4						67	75000000
Biphenyl 1,1'-	0.5	0.5	110	0.49			1000	6600	2200	3500
Bis(2-chloroethyl)ether	5	5	0.012	410			810000	5700000	300000	8600000
Bis(2-chloroisopropyl)ether	4	120	120	160			400000	2500000	300000	20000
Bis(2-ethylhexyl)phthalate	10	10	6						1.1E+09	140
Boron (Hot Water Soluble)*										
Boron (total)	10	1700	5000						45000	22000000
Bromodichloromethane	2	2	16						85000	1500000
Bromoform	5	5	25	590	380	8400	4900000	34000000	37000	1600000
Bromomethane	0.5	0.89	0.89	310	5.6	33	450000	2700000	4000	7600000
Cadmium	0.5	0.5	5						2.7	62000000
Carbon Tetrachloride	0.2	0.2	5	1300	0.79	16	2800000	17000000	2500	400000
Chlordane	0.06	0.06	7	4.2	58	1600	44000	370000	150	28
Chloroaniline p-	10	10	5.9						400	2000000
Chlorobenzene	0.5	0.5	30	46	4100	84000	120000	690000	630	250000
Chloroform	1	2	25	6400	2.4	44	11000000	63000000	16000	4000000
Chlorophenol, 2-	2	8.9	8.9						3300	14000000
Chromium Total	10	11	50						810	6000000
Chromium VI	10	25	25						140	6000000
Chrysene	0.1	0.1	0.1		2400	63000			1.1E+11	1
Cobalt	1	3.8	3						66	44000000
Copper	5	5	1000						87	210000000
Cyanide (CN-)	5	5	200						66	500000000
Dibenz[a h]anthracene	0.2	0.2	0.01		1300	20000			6.6E+11	0.52
Dibromochloromethane	2	2	25						82000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	3	54	4600	95000	160000	930000	9600	40000
Dichlorobenzene, 1,3-	0.5	0.5	59						9600	63000
Dichlorobenzene, 1,4-	0.5	0.5	1	7.4	8	150	21000	130000	9600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5	0.025						640	1600
Dichlorodifluoromethane	2	590	590						4400	140000
DDD	0.05	1.8	10						16000000	45
DDE	0.01	10	10						150000000	20
DDT	0.05	0.05	10						240000000	2.8
Dichloroethane, 1,1-	0.5	0.5	5	540	320	6600	1200000	7000000	2600000	2500000
Dichloroethane, 1,2-	0.5	0.5	5	2300	1.6	30	4000000	24000000	250000	2600000
Dichloroethylene, 1,1-	0.5	0.5	14	710	1.6	30	1300000	7400000	15000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	20		1.6	30			180000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	20	170	1.6	30	260000	1500000	280000	1800000
Dichlorophenol, 2,4-	20	20	0.3						4600	2300000
Dichloropropane, 1,2-	0.5	0.5	5	10	16	330	23000	140000	72000	1400000
Dichloropropene,1,3-	0.5	0.5	0.5	32	5.2	100	86000	520000	3100	1400000
Dieldrin	0.05	0.05	0.35						0.75	130
Diethyl Phthalate	2	30	15000						38	540000
Dimethylphthalate	2	30	15000						38	2000000
Dimethylphenol, 2,4-	10	10	59						39000	3900000
Dinitrophenol, 2,4-	10	10	5.9						11000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5	0.044						2900	140000
Dioxane, 1,4	2	50	50		1900000	40000000			7300000	500000000
Dioxin/Furan (TEQ)		0.000015	0.000015		0.014	0.37			390	0.1
Endosulfan	0.05	0.05	5.9						1.5	230
Endrin	0.05	0.05	2						0.48	130
Ethylbenzene	0.5	0.5	2.4	31	16000	93000	78000	460000	2300	85000
Ethylene dibromide	0.2	0.2	0.05	7300	0.25	5.1	27000000	170000000	120000	2000000

Groundwater Components for Potable Water Scenario (µg/L)										
Coarse Textured Soil										
	MOE	Ont. GW		GW1	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW1	Odour	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Fluoranthene	0.4	0.4	0.41		1100	30000			41000	130
Fluorene	0.5	120	120						400	950
Heptachlor	0.01	0.01	1.5	25			360000	2600000	2.5	90
Heptachlor Epoxide	0.01	0.01	1.5	350			1100000	9200000	0.048	100
Hexachlorobenzene	0.01	0.01	1						290	3.1
Hexachlorobutadiene	0.01	0.01	0.6	29	0.44	8.6	110000	630000	120	1600
Hexachlorocyclohexane Gamma-	0.01	0.01	4						1.2	4000
Hexachloroethane	0.01	0.01	2.1	9.4	94	2000	510000	3400000	6800	25000
Hexane (n)	5	5			51	980			3200	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	0.1		2200	42000			2.3E+12	0.095
Lead	1	1.9	10						25	4800000
Mercury	0.1	0.1	1		0.29	6.1			1.3E+13	30
Methoxychlor	0.05	0.05	900						6.5	50
Methyl Ethyl Ketone	20	400	1800	20000	470000	2900000	22000000	140000000	1500000	110000000
Methyl Isobutyl Ketone	20	640	3000	640	140000	830000	820000	5000000	580000	9500000
Methyl Mercury **		0.12	0.3						0.15	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	15		190	3700			1300000	26000000
Methylene Chloride	5	5	50	4100	610	11000	6900000	41000000	17000	6500000
Methlynaphthalene, 2-(1-) ***	2	2	12	3.2			6200	38000	1800	12000
Molybdenum	0.5	23	70						9200	38000000
Naphthalene	2	7	59	11	1400	30000	37000	230000	7800	16000
Nickel	1	14	100						490	210000000
Pentachlorophenol	0.5	0.5	30						62	7000
Petroleum Hydrocarbons F1****	25	420	820		1400	28000			750	1900
Petroleum Hydrocarbons F2	100	150	300		2300	47000			970	150
Petroleum Hydrocarbons F3	500	500	1000							4.9E-08
Petroleum Hydrocarbons F4	500	500	1100							3.9E-12
Phenanthrene	0.1	0.1	1						920	580
Phenol	1	5	890	17000	470000	10000000	17000000	110000000	12000	41000000
Polychlorinated Biphenyls	0.2	0.2	3		7.8	180			2.3E+11	140
Pyrene	0.2	0.2	4.1		9300	250000			2700	68
Selenium	5	5	10						63	41000000
Silver	0.3	0.3	100						1.5	35000000
Styrene	0.5	0.5	100	5.4	1300	26000	14000	85000	9100	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	1.1		3.3	66			25000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	1	3300	3.2	63	8400000	51000000	30000	1400000
Tetrachloroethylene	0.5	0.5	20	440	1.6	30	1100000	6600000	11000	100000
Thallium	0.5	0.5	2						510	13000000
Toluene	0.5	0.8	24	22	82000	1700000	47000	280000	18000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	70	190	180	3800	1200000	7300000	4300	25000
Trichloroethane, 1,1,1-	0.5	0.5	200	3000	640	13000	6400000	38000000	11000	650000
Trichloroethane, 1,1,2-	0.5	0.5	5		4.7	91			120000	550000
Trichloroethylene	0.5	0.5	5	1100	1.6	30	2400000	14000000	280000	640000
Trichlorofluoromethane	5	150	150						2500	550000
Trichlorophenol, 2,4,5-	0.2	0.2	8.9						1600	600000
Trichlorophenol, 2,4,6-	0.2	0.2	2						230	400000
Uranium	2	8.9	20						420	
Vanadium	0.5	3.9	6.2						250	43000000
Vinyl Chloride	0.5	0.5	2	5300	0.16	3	7600000	44000000	450000	4400000
Xylene Mixture	0.5	72	300	370	7800	160000	530000	3200000	4200	53000
Zinc	5	160	5000						1100	170000000
Electrical Conductivity (mS/cm)	0.005	0.005								
Chloride	1000	790000	250000						2300000	21000000
Sodium Adsorption Ratio										
Sodium	5000	490000	200000						2300000	220000000

Groundwater Components for Potable Water Scenario (µg/L)

Medium - Fine Textured Soil

Chemical Parameter	MOE Water RL	Ont. GW Bkgrd	GW1	GW1 Odour	Residential GW2	Industrial GW2	Residential GW2 Odour	Industrial GW2 Odour	GW3	1/2 Solubility
Acenaphthene	1	4.1	4.1	67	1700	24000	820000	3800000	6600	2000
Acenaphthylene	1	1	0.45		120	1700			1.8	8100
Acetone	30	2700	2700	93000	7700000	110000000	460000000	1900000000	130000	500000000
Aldrin	0.01	0.01	0.35	150			2300000	14000000	100000	8.5
Anthracene	0.1	0.1	890						2.4	22
Antimony	0.5	1.5	6						20000	12000000
Arsenic	1	13	25						1900	17000000
Barium	2	610	1000						29000	27000000
Benzene	0.5	0.5	5	860	430	5700	17000000	69000000	5800	900000
Benz[a]anthracene	0.2	0.2	1		240	3500			1.6E+11	4.7
Benzo[a]pyrene	0.01	0.01	0.01		790	9600			3.4E+12	0.81
Benzo[b]fluoranthene	0.1	0.1	0.1		4800	62000			6.9E+12	0.75
Benzo[ghi]perylene	0.2	0.2	1						3.3E+11	0.13
Benzo[k]fluoranthene	0.1	0.1	0.1		5900	75000			2.3E+12	0.4
Beryllium	0.5	0.5	4						67	75000000
Biphenyl 1,1'-	0.5	0.5	110	0.49			4300	19000	2200	3500
Bis(2-chloroethyl)ether	5	5	0.012	410			2800000	12000000	300000	8600000
Bis(2-chloroisopropyl)ether	4	120	120	160			1600000	7100000	300000	20000
Bis(2-ethylhexyl)phthalate	10	10	6						1.1E+09	140
Boron (Hot Water Soluble)*										
Boron (total)	10	1700	5000						45000	22000000
Bromodichloromethane	2	2	16						85000	1500000
Bromoform	5	5	25	590	770	13000	10000000	50000000	37000	1600000
Bromomethane	0.5	0.89	0.89	310	56	230	4500000	19000000	4000	7600000
Cadmium	0.5	0.5	5						2.7	62000000
Carbon Tetrachloride	0.2	0.2	5	1300	8.4	120	30000000	130000000	2500	400000
Chlordane	0.06	0.06	7	4.2	86	1700	65000	400000	150	28
Chloroaniline p-	10	10	5.9						400	2000000
Chlorobenzene	0.5	0.5	30	46	36000	520000	1000000	4300000	630	250000
Chloroform	1	2	25	6400	22	300	100000000	420000000	16000	4000000
Chlorophenol, 2-	2	8.9	8.9						3300	14000000
Chromium Total	10	11	50						810	6000000
Chromium VI	10	25	25						140	6000000
Chrysene	0.1	0.1	0.1		6300	97000			1.1E+11	1
Cobalt	1	3.8	3						66	44000000
Copper	5	5	1000						87	210000000
Cyanide (CN-)	5	5	200						66	500000000
Dibenz[a h]anthracene	0.2	0.2	0.01		6400	87000			6.6E+11	0.52
Dibromochloromethane	2	2	25						82000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	3	54	36000	520000	1200000	5100000	9600	40000
Dichlorobenzene, 1,3-	0.5	0.5	59						9600	63000
Dichlorobenzene, 1,4-	0.5	0.5	1	7.4	67	900	180000	740000	9600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5	0.025						640	1600
Dichlorodifluoromethane	2	590	590						4400	140000
DDD	0.05	1.8	10						16000000	45
DDE	0.01	10	10						150000000	20
DDT	0.05	0.05	10						240000000	2.8
Dichloroethane, 1,1-	0.5	0.5	5	540	3100	44000	11000000	47000000	2600000	2500000
Dichloroethane, 1,2-	0.5	0.5	5	2300	12	160	31000000	130000000	250000	2600000
Dichloroethylene, 1,1-	0.5	0.5	14	710	17	230	13000000	55000000	15000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	20		17	230			180000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	20	170	17	230	2600000	11000000	280000	1800000
Dichlorophenol, 2,4-	20	20	0.3						4600	2300000
Dichloropropane, 1,2-	0.5	0.5	5	10	140	2000	210000	860000	72000	1400000
Dichloropropene,1,3-	0.5	0.5	0.5	32	45	610	740000	3100000	3100	1400000
Dieldrin	0.05	0.05	0.35						0.75	130
Diethyl Phthalate	2	30	15000						38	540000
Dimethylphthalate	2	30	15000						38	2000000
Dimethylphenol, 2,4-	10	10	59						39000	3900000
Dinitrophenol, 2,4-	10	10	5.9						11000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5	0.044						2900	140000
Dioxane, 1,4	2	50	50		11000000	140000000			7300000	500000000
Dioxin/Furan (TEQ)		0.000015	0.000015		0.023	0.45			390	0.1
Endosulfan	0.05	0.05	5.9						1.5	230
Endrin	0.05	0.05	2						0.48	130
Ethylbenzene	0.5	0.5	2.4	31	160000	660000	780000	3300000	2300	85000
Ethylene dibromide	0.2	0.2	0.05	7300	0.83	12	90000000	410000000	120000	2000000

Groundwater Components for Potable Water Scenario (µg/L)

Medium - Fine Textured Soil

Chemical Parameter	MOE Water RL	Ont. GW Bkgrd	GW1	GW1 Odour	Residential GW2	Industrial GW2	Residential GW2 Odour	Industrial GW2 Odour	GW3	1/2 Solubility
Fluoranthene	0.4	0.4	0.41		3000	46000			41000	130
Fluorene	0.5	120	120						400	950
Heptachlor	0.01	0.01	1.5	25			560000	3100000	2.5	90
Heptachlor Epoxide	0.01	0.01	1.5	350			1800000	10000000	0.048	100
Hexachlorobenzene	0.01	0.01	1						290	3.1
Hexachlorobutadiene	0.01	0.01	0.6	29	4.5	61	1100000	4500000	120	1600
Hexachlorocyclohexane Gamma-	0.01	0.01	4						1.2	4000
Hexachloroethane	0.01	0.01	2.1	9.4	200	3300	1100000	5600000	6800	25000
Hexane (n)	5	5			520	7300			3200	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	0.1		11000	140000			2.3E+12	0.095
Lead	1	1.9	10						25	4800000
Mercury	0.1	0.1	1		2.8	40			1.3E+13	30
Methoxychlor	0.05	0.05	900						6.5	50
Methyl Ethyl Ketone	20	400	1800	20000	1700000	7200000	79000000	340000000	1500000	110000000
Methyl Isobutyl Ketone	20	640	3000	640	600000	2500000	3600000	15000000	580000	9500000
Methyl Mercury **		0.12	0.3						0.15	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	15		1400	18000			1300000	26000000
Methylene Chloride	5	5	50	4100	5500	74000	63000000	260000000	17000	6500000
Methlynaphthalene, 2-(1-) ***	2	2	12	3.2			35000	150000	1800	12000
Molybdenum	0.5	23	70						9200	38000000
Naphthalene	2	7	59	11	6400	94000	160000	710000	7800	16000
Nickel	1	14	100						490	210000000
Pentachlorophenol	0.5	0.5	30						62	7000
Petroleum Hydrocarbons F1****	25	420	820		15000	220000			750	1900
Petroleum Hydrocarbons F2	100	150	300		25000	360000			970	150
Petroleum Hydrocarbons F3	500	500	1000							4.9E-08
Petroleum Hydrocarbons F4	500	500	1100							3.9E-12
Phenanthrene	0.1	0.1	1						920	580
Phenol	1	5	890	17000	2700000	36000000	100000000	390000000	12000	41000000
Polychlorinated Biphenyls	0.2	0.2	3		15	250			2.3E+11	140
Pyrene	0.2	0.2	4.1		23000	370000			2700	68
Selenium	5	5	10						63	41000000
Silver	0.3	0.3	100						1.5	35000000
Styrene	0.5	0.5	100	5.4	11000	160000	120000	520000	9100	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	1.1		28	380			25000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	1	3300	15	210	40000000	170000000	30000	1400000
Tetrachloroethylene	0.5	0.5	20	440	17	230	12000000	49000000	11000	100000
Thallium	0.5	0.5	2						510	13000000
Toluene	0.5	0.8	24	22	810000	12000000	470000	1900000	18000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	70	190	850	13000	5600000	25000000	4300	25000
Trichloroethane, 1,1,1-	0.5	0.5	200	3000	6700	95000	67000000	280000000	11000	650000
Trichloroethane, 1,1,2-	0.5	0.5	5		30	410			120000	550000
Trichloroethylene	0.5	0.5	5	1100	17	230	24000000	100000000	280000	640000
Trichlorofluoromethane	5	150	150						2500	550000
Trichlorophenol, 2,4,5-	0.2	0.2	8.9						1600	600000
Trichlorophenol, 2,4,6-	0.2	0.2	2						230	400000
Uranium	2	8.9	20						420	
Vanadium	0.5	3.9	6.2						250	43000000
Vinyl Chloride	0.5	0.5	2	5300	1.7	23	81000000	340000000	450000	4400000
Xylene Mixture	0.5	72	300	370	80000	1100000	5400000	23000000	4200	53000
Zinc	5	160	5000						1100	170000000
Electrical Conductivity (mS/cm)	0.005	0.005								
Chloride	1000	790000	250000						2300000	21000000
Sodium Adsorption Ratio										
Sodium	5000	490000	200000						2300000	220000000

Groundwater Components for Non-potable Water Scenario (µg/L)								
Coarse Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Acenaphthene	1	4.1	600	13000	300000	2000000	6600	2000
Acenaphthylene	1	1	36	750			1.8	8100
Acetone	30	2700	1800000	39000000	110000000	680000000	130000	500000000
Aldrin	0.01	0.01			1500000	12000000	100000	8.5
Anthracene	0.1	0.1					2.4	22
Antimony	0.5	1.5					20000	12000000
Arsenic	1	13					1900	17000000
Barium	2	610					29000	27000000
Benzene	0.5	0.5	44	830	1700000	10000000	5800	900000
Benz[a]anthracene	0.2	0.2	70	1800			1.6E+11	4.7
Benzo[a]pyrene	0.01	0.01	130	2500			3.4E+12	0.81
Benzo[b]fluoranthene	0.1	0.1	1100	25000			6.9E+12	0.75
Benzo[ghi]perylene	0.2	0.2					3.3E+11	0.13
Benzo[k]fluoranthene	0.1	0.1	1300	28000			2.3E+12	0.4
Beryllium	0.5	0.5					67	75000000
Biphenyl 1,1'-	0.5	0.5			1000	6600	2200	3500
Bis(2-chloroethyl)ether	5	5			810000	5700000	300000	8600000
Bis(2-chloroisopropyl)ether	4	120			400000	2500000	300000	20000
Bis(2-ethylhexyl)phthalate	10	10					1.1E+09	140
Boron (Hot Water Soluble)*								
Boron (total)	10	1700					45000	22000000
Bromodichloromethane	2	2					85000	1500000
Bromoform	5	5	380	8400	4900000	34000000	37000	1600000
Bromomethane	0.5	0.89	5.6	33	450000	2700000	4000	7600000
Cadmium	0.5	0.5					2.7	62000000
Carbon Tetrachloride	0.2	0.2	0.79	16	2800000	17000000	2500	400000
Chlordane	0.06	0.06	58	1600	44000	370000	150	28
Chloroaniline p-	10	10					400	2000000
Chlorobenzene	0.5	0.5	4100	84000	120000	690000	630	250000
Chloroform	1	2	2.4	44	11000000	63000000	16000	4000000
Chlorophenol, 2-	2	8.9					3300	14000000
Chromium Total	10	11					810	6000000
Chromium VI	10	25					140	6000000
Chrysene	0.1	0.1	2400	63000			1.1E+11	1
Cobalt	1	3.8					66	44000000
Copper	5	5					87	210000000
Cyanide (CN-)	5	5					66	500000000
Dibenz[a h]anthracene	0.2	0.2	1300	20000			6.6E+11	0.52
Dibromochloromethane	2	2					82000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	4600	95000	160000	930000	9600	40000
Dichlorobenzene, 1,3-	0.5	0.5					9600	63000
Dichlorobenzene, 1,4-	0.5	0.5	8	150	21000	130000	9600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5					640	1600
Dichlorodifluoromethane	2	590					4400	140000
DDD	0.05	1.8					16000000	45
DDE	0.01	10					150000000	20
DDT	0.05	0.05					240000000	2.8
Dichloroethane, 1,1-	0.5	0.5	320	6600	1200000	7000000	2600000	2500000
Dichloroethane, 1,2-	0.5	0.5	1.6	30	4000000	24000000	250000	2600000
Dichloroethylene, 1,1-	0.5	0.5	1.6	30	1300000	7400000	15000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	1.6	30			180000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	1.6	30	260000	1500000	280000	1800000
Dichlorophenol, 2,4-	20	20					4600	2300000
Dichloropropane, 1,2-	0.5	0.5	16	330	23000	140000	72000	1400000
Dichloropropene,1,3-	0.5	0.5	5.2	100	86000	520000	3100	1400000
Dieldrin	0.05	0.05					0.75	130
Diethyl Phthalate	2	30					38	540000
Dimethylphthalate	2	30					38	2000000
Dimethylphenol, 2,4-	10	10					39000	3900000
Dinitrophenol, 2,4-	10	10					11000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5					2900	140000
Dioxane, 1,4	2	50	1900000	40000000			7300000	500000000
Dioxin/Furan (TEQ)		0.000015	0.014	0.37			390	0.1
Endosulfan	0.05	0.05					1.5	230
Endrin	0.05	0.05					0.48	130
Ethylbenzene	0.5	0.5	16000	93000	78000	460000	2300	85000
Ethylene dibromide	0.2	0.2	0.25	5.1	27000000	170000000	120000	2000000

Groundwater Components for Non-potable Water Scenario (µg/L)								
Coarse Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Fluoranthene	0.4	0.4	1100	30000			41000	130
Fluorene	0.5	120					400	950
Heptachlor	0.01	0.01			360000	2600000	2.5	90
Heptachlor Epoxide	0.01	0.01			1100000	9200000	0.048	100
Hexachlorobenzene	0.01	0.01					290	3.1
Hexachlorobutadiene	0.01	0.01	0.44	8.6	110000	630000	120	1600
Hexachlorocyclohexane Gamma-	0.01	0.01					1.2	4000
Hexachloroethane	0.01	0.01	94	2000	510000	3400000	6800	25000
Hexane (n)	5	5	51	980			3200	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	2200	42000			2.3E+12	0.095
Lead	1	1.9					25	4800000
Mercury	0.1	0.1	0.29	6.1			1.3E+13	30
Methoxychlor	0.05	0.05					6.5	50
Methyl Ethyl Ketone	20	400	470000	2900000	22000000	140000000	1500000	110000000
Methyl Isobutyl Ketone	20	640	140000	830000	820000	5000000	580000	9500000
Methyl Mercury **		0.12					0.15	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	190	3700			1300000	26000000
Methylene Chloride	5	5	610	11000	6900000	41000000	17000	6500000
Methlynaphthalene, 2-(1-) ***	2	2			6200	38000	1800	12000
Molybdenum	0.5	23					9200	38000000
Naphthalene	2	7	1400	30000	37000	230000	7800	16000
Nickel	1	14					490	210000000
Pentachlorophenol	0.5	0.5					62	7000
Petroleum Hydrocarbons F1****	25	420	1400	28000			750	1900
Petroleum Hydrocarbons F2	100	150	2300	47000			970	150
Petroleum Hydrocarbons F3	500	500						4.9E-08
Petroleum Hydrocarbons F4	500	500						3.9E-12
Phenanthrene	0.1	0.1					920	580
Phenol	1	5	470000	10000000	17000000	110000000	12000	41000000
Polychlorinated Biphenyls	0.2	0.2	7.8	180			2.3E+11	140
Pyrene	0.2	0.2	9300	250000			2700	68
Selenium	5	5					63	41000000
Silver	0.3	0.3					1.5	35000000
Styrene	0.5	0.5	1300	26000	14000	85000	9100	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	3.3	66			25000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	3.2	63	8400000	51000000	30000	1400000
Tetrachloroethylene	0.5	0.5	1.6	30	1100000	6600000	11000	100000
Thallium	0.5	0.5					510	13000000
Toluene	0.5	0.8	82000	1700000	47000	280000	18000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	180	3800	1200000	7300000	4300	25000
Trichloroethane, 1,1,1-	0.5	0.5	640	13000	6400000	38000000	11000	650000
Trichloroethane, 1,1,2-	0.5	0.5	4.7	91			120000	550000
Trichloroethylene	0.5	0.5	1.6	30	2400000	14000000	280000	640000
Trichlorofluoromethane	5	150					2500	550000
Trichlorophenol, 2,4,5-	0.2	0.2					1600	600000
Trichlorophenol, 2,4,6-	0.2	0.2					230	400000
Uranium	2	8.9					420	
Vanadium	0.5	3.9					250	43000000
Vinyl Chloride	0.5	0.5	0.16	3	7600000	44000000	450000	4400000
Xylene Mixture	0.5	72	7800	160000	530000	3200000	4200	53000
Zinc	5	160					1100	170000000
Electrical Conductivity (mS/cm)	0.005	0.005						
Chloride	1000	790000					2300000	21000000
Sodium Adsorption Ratio								
Sodium	5000	490000					2300000	220000000

Groundwater Components for Non-potable Water Scenario (µg/L)								
Medium - Fine Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Acenaphthene	1	4.1	1700	24000	820000	3800000	6600	2000
Acenaphthylene	1	1	120	1700			1.8	8100
Acetone	30	2700	7700000	110000000	460000000	1900000000	130000	500000000
Aldrin	0.01	0.01			2300000	14000000	100000	8.5
Anthracene	0.1	0.1					2.4	22
Antimony	0.5	1.5					20000	12000000
Arsenic	1	13					1900	17000000
Barium	2	610					29000	27000000
Benzene	0.5	0.5	430	5700	17000000	69000000	5800	900000
Benz[a]anthracene	0.2	0.2	240	3500			1.6E+11	4.7
Benzo[a]pyrene	0.01	0.01	790	9600			3.4E+12	0.81
Benzo[b]fluoranthene	0.1	0.1	4800	62000			6.9E+12	0.75
Benzo[ghi]perylene	0.2	0.2					3.3E+11	0.13
Benzo[k]fluoranthene	0.1	0.1	5900	75000			2.3E+12	0.4
Beryllium	0.5	0.5					67	75000000
Biphenyl 1,1'-	0.5	0.5			4300	19000	2200	3500
Bis(2-chloroethyl)ether	5	5			2800000	12000000	300000	8600000
Bis(2-chloroisopropyl)ether	4	120			1600000	7100000	300000	20000
Bis(2-ethylhexyl)phthalate	10	10					1.1E+09	140
Boron (Hot Water Soluble)*								
Boron (total)	10	1700					45000	22000000
Bromodichloromethane	2	2					85000	1500000
Bromoform	5	5	770	13000	10000000	50000000	37000	1600000
Bromomethane	0.5	0.89	56	230	4500000	19000000	4000	7600000
Cadmium	0.5	0.5					2.7	62000000
Carbon Tetrachloride	0.2	0.2	8.4	120	30000000	130000000	2500	400000
Chlordane	0.06	0.06	86	1700	65000	400000	150	28
Chloroaniline p-	10	10					400	2000000
Chlorobenzene	0.5	0.5	36000	520000	1000000	4300000	630	250000
Chloroform	1	2	22	300	100000000	420000000	16000	4000000
Chlorophenol, 2-	2	8.9					3300	14000000
Chromium Total	10	11					810	6000000
Chromium VI	10	25					140	6000000
Chrysene	0.1	0.1	6300	97000			1.1E+11	1
Cobalt	1	3.8					66	44000000
Copper	5	5					87	210000000
Cyanide (CN-)	5	5					66	500000000
Dibenz[a h]anthracene	0.2	0.2	6400	87000			6.6E+11	0.52
Dibromochloromethane	2	2					82000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	36000	520000	1200000	5100000	9600	40000
Dichlorobenzene, 1,3-	0.5	0.5					9600	63000
Dichlorobenzene, 1,4-	0.5	0.5	67	900	180000	740000	9600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5					640	1600
Dichlorodifluoromethane	2	590					4400	140000
DDD	0.05	1.8					16000000	45
DDE	0.01	10					150000000	20
DDT	0.05	0.05					240000000	2.8
Dichloroethane, 1,1-	0.5	0.5	3100	44000	11000000	47000000	2600000	2500000
Dichloroethane, 1,2-	0.5	0.5	12	160	31000000	130000000	250000	2600000
Dichloroethylene, 1,1-	0.5	0.5	17	230	13000000	55000000	15000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	17	230			180000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	17	230	2600000	11000000	280000	1800000
Dichlorophenol, 2,4-	20	20					4600	2300000
Dichloropropane, 1,2-	0.5	0.5	140	2000	210000	860000	72000	1400000
Dichloropropene,1,3-	0.5	0.5	45	610	740000	3100000	3100	1400000
Dieldrin	0.05	0.05					0.75	130
Diethyl Phthalate	2	30					38	540000
Dimethylphthalate	2	30					38	2000000
Dimethylphenol, 2,4-	10	10					39000	3900000
Dinitrophenol, 2,4-	10	10					11000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5					2900	140000
Dioxane, 1,4	2	50	11000000	140000000			7300000	500000000
Dioxin/Furan (TEQ)		0.000015	0.023	0.45			390	0.1
Endosulfan	0.05	0.05					1.5	230
Endrin	0.05	0.05					0.48	130
Ethylbenzene	0.5	0.5	160000	660000	780000	3300000	2300	85000
Ethylene dibromide	0.2	0.2	0.83	12	90000000	410000000	120000	2000000

Groundwater Components for Non-potable Water Scenario (µg/L)								
Medium - Fine Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Fluoranthene	0.4	0.4	3000	46000			41000	130
Fluorene	0.5	120					400	950
Heptachlor	0.01	0.01			560000	3100000	2.5	90
Heptachlor Epoxide	0.01	0.01			1800000	10000000	0.048	100
Hexachlorobenzene	0.01	0.01					290	3.1
Hexachlorobutadiene	0.01	0.01	4.5	61	1100000	4500000	120	1600
Hexachlorocyclohexane Gamma-	0.01	0.01					1.2	4000
Hexachloroethane	0.01	0.01	200	3300	1100000	5600000	6800	25000
Hexane (n)	5	5	520	7300			3200	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	11000	140000			2.3E+12	0.095
Lead	1	1.9					25	4800000
Mercury	0.1	0.1	2.8	40			1.3E+13	30
Methoxychlor	0.05	0.05					6.5	50
Methyl Ethyl Ketone	20	400	1700000	7200000	79000000	340000000	1500000	110000000
Methyl Isobutyl Ketone	20	640	600000	2500000	3600000	15000000	580000	9500000
Methyl Mercury **		0.12					0.15	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	1400	18000			1300000	26000000
Methylene Chloride	5	5	5500	74000	63000000	260000000	17000	6500000
Methlynaphthalene, 2-(1-) ***	2	2			35000	150000	1800	12000
Molybdenum	0.5	23					9200	38000000
Naphthalene	2	7	6400	94000	160000	710000	7800	16000
Nickel	1	14					490	210000000
Pentachlorophenol	0.5	0.5					62	7000
Petroleum Hydrocarbons F1****	25	420	15000	220000			750	1900
Petroleum Hydrocarbons F2	100	150	25000	360000			970	150
Petroleum Hydrocarbons F3	500	500						4.9E-08
Petroleum Hydrocarbons F4	500	500						3.9E-12
Phenanthrene	0.1	0.1					920	580
Phenol	1	5	2700000	36000000	100000000	390000000	12000	41000000
Polychlorinated Biphenyls	0.2	0.2	15	250			2.3E+11	140
Pyrene	0.2	0.2	23000	370000			2700	68
Selenium	5	5					63	41000000
Silver	0.3	0.3					1.5	35000000
Styrene	0.5	0.5	11000	160000	120000	520000	9100	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	28	380			25000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	15	210	40000000	170000000	30000	1400000
Tetrachloroethylene	0.5	0.5	17	230	12000000	49000000	11000	100000
Thallium	0.5	0.5					510	13000000
Toluene	0.5	0.8	810000	12000000	470000	1900000	18000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	850	13000	5600000	25000000	4300	25000
Trichloroethane, 1,1,1-	0.5	0.5	6700	95000	67000000	280000000	11000	650000
Trichloroethane, 1,1,2-	0.5	0.5	30	410			120000	550000
Trichloroethylene	0.5	0.5	17	230	24000000	100000000	280000	640000
Trichlorofluoromethane	5	150					2500	550000
Trichlorophenol, 2,4,5-	0.2	0.2					1600	600000
Trichlorophenol, 2,4,6-	0.2	0.2					230	400000
Uranium	2	8.9					420	
Vanadium	0.5	3.9					250	43000000
Vinyl Chloride	0.5	0.5	1.7	23	81000000	340000000	450000	4400000
Xylene Mixture	0.5	72	80000	1100000	5400000	23000000	4200	53000
Zinc	5	160					1100	170000000
Electrical Conductivity (mS/cm)	0.005	0.005						
Chloride	1000	790000					2300000	21000000
Sodium Adsorption Ratio								
Sodium	5000	490000					2300000	220000000

Groundwater Components for Potable Water, Shallow Soil Scenario (Table 6) (µg/L)

Coarse Textured Soil

Chemical Parameter	MOE Water RL	Ont. GW Bkgrd	GW1	GW1 Odour	Residential GW2	Industrial GW2	Residential GW2 Odour	Industrial GW2 Odour	GW3	1/2 Solubility
Acenaphthene	1	4.1	4.1	67	17	270	300000	2000000	5200	2000
Acenaphthylene	1	1	0.45		0.96	15			1.4	8100
Acetone	30	2700	2700	93000	120000	2000000	110000000	680000000	100000	500000000
Aldrin	0.01	0.01	0.35	150			1500000	12000000	3	8.5
Anthracene	0.1	0.1	890						1	22
Antimony	0.5	1.5	6						16000	12000000
Arsenic	1	13	25						1500	17000000
Barium	2	610	1000						23000	27000000
Benzene	0.5	0.5	5	860	0.17	2.8	1700000	10000000	4600	900000
Benz[a]anthracene	0.2	0.2	1		3.8	61			1.8	4.7
Benzo[a]pyrene	0.01	0.01	0.01		14	220			2.1	0.81
Benzo[b]fluoranthene	0.1	0.1	0.1		81	1300			4.2	0.75
Benzo[ghi]perylene	0.2	0.2	1						0.2	0.13
Benzo[k]fluoranthene	0.1	0.1	0.1		100	1600			1.4	0.4
Beryllium	0.5	0.5	4						53	75000000
Biphenyl 1,1'-	0.5	0.5	110	0.49			1000	6600	1700	3500
Bis(2-chloroethyl)ether	5	5	0.012	410			810000	5700000	240000	8600000
Bis(2-chloroisopropyl)ether	4	120	120	160			400000	2500000	240000	20000
Bis(2-ethylhexyl)phthalate	10	10	6						30	140
Boron (Hot Water Soluble)*										
Boron (total)	10	1700	5000						36000	22000000
Bromodichloromethane	2	2	16						67000	1500000
Bromoform	5	5	25	590	4.2	68	4900000	34000000	29000	1600000
Bromomethane	0.5	0.89	0.89	310	0.19	0.95	450000	2700000	3200	7600000
Cadmium	0.5	0.5	5						2.1	62000000
Carbon Tetrachloride	0.2	0.2	5	1300	0.028	0.48	2800000	17000000	2000	400000
Chlordane	0.06	0.06	7	4.2	0.85	14	44000	370000	0.043	28
Chloroaniline p-	10	10	5.9						320	2000000
Chlorobenzene	0.5	0.5	30	46	140	2400	120000	690000	500	250000
Chloroform	1	2	25	6400	0.1	1.7	11000000	63000000	12000	4000000
Chlorophenol, 2-	2	8.9	8.9						2600	14000000
Chromium Total	10	11	50						640	6000000
Chromium VI	10	25	25						110	6000000
Chrysene	0.1	0.1	0.1		95	1500			0.7	1
Cobalt	1	3.8	3						52	44000000
Copper	5	5	1000						69	210000000
Cyanide (CN-)	5	5	200						52	500000000
Dibenz[a h]anthracene	0.2	0.2	0.01		140	2300			0.4	0.52
Dibromochloromethane	2	2	25						65000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	3	54	150	2600	160000	930000	7600	40000
Dichlorobenzene, 1,3-	0.5	0.5	59						7600	63000
Dichlorobenzene, 1,4-	0.5	0.5	1	7.4	0.26	4.2	21000	130000	7600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5	0.025						500	1600
Dichlorodifluoromethane	2	590	590						3500	140000
DDD	0.05	1.8	10						1.8	45
DDE	0.01	10	10						17	20
DDT	0.05	0.05	10						0.01	2.8
Dichloroethane, 1,1-	0.5	0.5	5	540	11	190	1200000	7000000	2000000	2500000
Dichloroethane, 1,2-	0.5	0.5	5	2300	0.07	1.1	4000000	24000000	200000	2600000
Dichloroethylene, 1,1-	0.5	0.5	14	710	0.072	1.2	1300000	7400000	12000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	20		0.072	1.2			140000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	20	170	0.072	1.2	260000	1500000	220000	1800000
Dichlorophenol, 2,4-	20	20	0.3						3700	2300000
Dichloropropane, 1,2-	0.5	0.5	5	10	0.58	9.9	23000	140000	57000	1400000
Dichloropropene,1,3-	0.5	0.5	0.5	32	0.16	2.5	86000	520000	2400	1400000
Dieldrin	0.05	0.05	0.35						0.56	130
Diethyl Phthalate	2	30	15000						30	540000
Dimethylphthalate	2	30	15000						30	2000000
Dimethylphenol, 2,4-	10	10	59						31000	3900000
Dinitrophenol, 2,4-	10	10	5.9						9000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5	0.044						2300	140000
Dioxane, 1,4	2	50	50		190000	3200000			5800000	500000000
Dioxin/Furan (TEQ)		0.000015	0.000015		0.0002	0.0034			0.0001	0.1
Endosulfan	0.05	0.05	5.9						0.56	230
Endrin	0.05	0.05	2						0.36	130
Ethylbenzene	0.5	0.5	2.4	31	54	270	78000	460000	1800	85000
Ethylene dibromide	0.2	0.2	0.05	7300	0.0033	0.053	27000000	170000000	96000	2000000

Groundwater Components for Potable Water, Shallow Soil Scenario (Table 6) (µg/L)										
Coarse Textured Soil										
	MOE	Ont. GW		GW1	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW1	Odour	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Fluoranthene	0.4	0.4	0.41		44	700			73	130
Fluorene	0.5	120	120						290	950
Heptachlor	0.01	0.01	1.5	25			360000	2600000	0.038	90
Heptachlor Epoxide	0.01	0.01	1.5	350			1100000	9200000	0.038	100
Hexachlorobenzene	0.01	0.01	1						230	3.1
Hexachlorobutadiene	0.01	0.01	0.6	29	0.012	0.2	110000	630000	93	1600
Hexachlorocyclohexane Gamma-	0.01	0.01	4						0.95	4000
Hexachloroethane	0.01	0.01	2.1	9.4	0.17	2.7	510000	3400000	5400	25000
Hexane (n)	5	5			0.34	5.9			2500	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	0.1		190	3100			1.4	0.095
Lead	1	1.9	10						20	4800000
Mercury	0.1	0.1	1		0.0047	0.081			7.7	30
Methoxychlor	0.05	0.05	900						0.3	50
Methyl Ethyl Ketone	20	400	1800	20000	21000	100000	22000000	140000000	1200000	110000000
Methyl Isobutyl Ketone	20	640	3000	640	5200	26000	820000	5000000	460000	9500000
Methyl Mercury **		0.12	0.3						0.12	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	15		8.6	140			1000000	26000000
Methylene Chloride	5	5	50	4100	26	420	6900000	41000000	13000	6500000
Methlynaphthalene, 2-(1-) ***	2	2	12	3.2			6200	38000	1500	12000
Molybdenum	0.5	23	70						7300	38000000
Naphthalene	2	7	59	11	4.4	75	37000	230000	6200	16000
Nickel	1	14	100						390	210000000
Pentachlorophenol	0.5	0.5	30						50	7000
Petroleum Hydrocarbons F1****	25	420	820		3.4	58			420	1900
Petroleum Hydrocarbons F2	100	150	300		5.7	97			170	150
Petroleum Hydrocarbons F3	500	500	1000							4.9E-08
Petroleum Hydrocarbons F4	500	500	1100							3.9E-12
Phenanthrene	0.1	0.1	1						380	580
Phenol	1	5	890	17000	48000	830000	17000000	110000000	9600	41000000
Polychlorinated Biphenyls	0.2	0.2	3		0.11	1.8			0.14	140
Pyrene	0.2	0.2	4.1		340	5400			5.7	68
Selenium	5	5	10						50	41000000
Silver	0.3	0.3	100						1.2	35000000
Styrene	0.5	0.5	100	5.4	43	740	14000	85000	7200	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	1.1		0.073	1.2			20000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	1	3300	0.11	1.8	8400000	51000000	24000	1400000
Tetrachloroethylene	0.5	0.5	20	440	0.072	1.2	1100000	6600000	8400	100000
Thallium	0.5	0.5	2						400	13000000
Toluene	0.5	0.8	24	22	320	5400	47000	280000	14000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	70	190	3	51	1200000	7300000	3400	25000
Trichloroethane, 1,1,1-	0.5	0.5	200	3000	23	390	6400000	38000000	9000	650000
Trichloroethane, 1,1,2-	0.5	0.5	5		0.17	2.8			94000	550000
Trichloroethylene	0.5	0.5	5	1100	0.072	1.2	2400000	14000000	220000	640000
Trichlorofluoromethane	5	150	150						2000	550000
Trichlorophenol, 2,4,5-	0.2	0.2	8.9						1300	600000
Trichlorophenol, 2,4,6-	0.2	0.2	2						180	400000
Uranium	2	8.9	20						330	
Vanadium	0.5	3.9	6.2						200	43000000
Vinyl Chloride	0.5	0.5	2	5300	0.0072	0.12	7600000	44000000	360000	4400000
Xylene Mixture	0.5	72	300	370	26	450	530000	3200000	3300	53000
Zinc	5	160	5000						890	170000000
Electrical Conductivity (mS/cm)	0.005	0.005								
Chloride	1000	790000	250000						1800000	21000000
Sodium Adsorption Ratio										
Sodium	5000	490000	200000						1800000	220000000
NOTE - GW1- odour is not used if GW1 is an ODWQS										

Groundwater Components for Potable Water Shallow Soil Scenario (Table 6)(µg/L)										
Medium - Fine Textured Soil										
	MOE	Ont. GW		GW1	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW1	Odour	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Acenaphthene	1	4.1	4.1	67	17	270	820000	3800000	5200	2000
Acenaphthylene	1	1	0.45		0.96	15			1.4	8100
Acetone	30	2700	2700	93000	120000	2000000	460000000	1900000000	100000	500000000
Aldrin	0.01	0.01	0.35	150			2300000	14000000	3	8.5
Anthracene	0.1	0.1	890						1	22
Antimony	0.5	1.5	6						16000	12000000
Arsenic	1	13	25						1500	17000000
Barium	2	610	1000						23000	27000000
Benzene	0.5	0.5	5	860	0.17	2.8	17000000	69000000	4600	900000
Benz[a]anthracene	0.2	0.2	1		3.8	61			1.8	4.7
Benzo[a]pyrene	0.01	0.01	0.01		14	220			2.1	0.81
Benzo[b]fluoranthene	0.1	0.1	0.1		81	1300			4.2	0.75
Benzo[ghi]perylene	0.2	0.2	1						0.2	0.13
Benzo[k]fluoranthene	0.1	0.1	0.1		100	1600			1.4	0.4
Beryllium	0.5	0.5	4						53	75000000
Biphenyl 1,1'-	0.5	0.5	110	0.49			4300	19000	1700	3500
Bis(2-chloroethyl)ether	5	5	0.012	410			2800000	12000000	240000	8600000
Bis(2-chloroisopropyl)ether	4	120	120	160			1600000	7100000	240000	20000
Bis(2-ethylhexyl)phthalate	10	10	6						30	140
Boron (Hot Water Soluble)*										
Boron (total)	10	1700	5000						36000	22000000
Bromodichloromethane	2	2	16						67000	1500000
Bromoform	5	5	25	590	4.2	68	10000000	50000000	29000	1600000
Bromomethane	0.5	0.89	0.89	310	0.19	0.95	4500000	19000000	3200	7600000
Cadmium	0.5	0.5	5						2.1	62000000
Carbon Tetrachloride	0.2	0.2	5	1300	0.028	0.48	30000000	130000000	2000	400000
Chlordane	0.06	0.06	7	4.2	0.85	14	65000	400000	0.043	28
Chloroaniline p-	10	10	5.9						320	2000000
Chlorobenzene	0.5	0.5	30	46	140	2400	1000000	4300000	500	250000
Chloroform	1	2	25	6400	0.1	1.7	100000000	420000000	12000	4000000
Chlorophenol, 2-	2	8.9	8.9						2600	14000000
Chromium Total	10	11	50						640	6000000
Chromium VI	10	25	25						110	6000000
Chrysene	0.1	0.1	0.1		95	1500			0.7	1
Cobalt	1	3.8	3						52	44000000
Copper	5	5	1000						69	210000000
Cyanide (CN-)	5	5	200						52	500000000
Dibenz[a h]anthracene	0.2	0.2	0.01		140	2300			0.4	0.52
Dibromochloromethane	2	2	25						65000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	3	54	150	2600	1200000	5100000	7600	40000
Dichlorobenzene, 1,3-	0.5	0.5	59						7600	63000
Dichlorobenzene, 1,4-	0.5	0.5	1	7.4	0.26	4.2	180000	740000	7600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5	0.025						500	1600
Dichlorodifluoromethane	2	590	590						3500	140000
DDD	0.05	1.8	10						1.8	45
DDE	0.01	10	10						17	20
DDT	0.05	0.05	10						0.01	2.8
Dichloroethane, 1,1-	0.5	0.5	5	540	11	190	11000000	47000000	2000000	2500000
Dichloroethane, 1,2-	0.5	0.5	5	2300	0.07	1.1	31000000	130000000	200000	2600000
Dichloroethylene, 1,1-	0.5	0.5	14	710	0.072	1.2	13000000	55000000	12000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	20		0.072	1.2			140000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	20	170	0.072	1.2	2600000	11000000	220000	1800000
Dichlorophenol, 2,4-	20	20	0.3						3700	2300000
Dichloropropane, 1,2-	0.5	0.5	5	10	0.58	9.9	210000	860000	57000	1400000
Dichloropropene,1,3-	0.5	0.5	0.5	32	0.16	2.5	740000	3100000	2400	1400000
Dieldrin	0.05	0.05	0.35						0.56	130
Diethyl Phthalate	2	30	15000						30	540000
Dimethylphthalate	2	30	15000						30	2000000
Dimethylphenol, 2,4-	10	10	59						31000	3900000
Dinitrophenol, 2,4-	10	10	5.9						9000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5	0.044						2300	140000
Dioxane, 1,4	2	50	50		190000	3200000			5800000	500000000
Dioxin/Furan (TEQ)		0.000015	0.000015		0.0002	0.0034			0.0001	0.1
Endosulfan	0.05	0.05	5.9						0.56	230
Endrin	0.05	0.05	2						0.36	130
Ethylbenzene	0.5	0.5	2.4	31	54	270	780000	3300000	1800	85000
Ethylene dibromide	0.2	0.2	0.05	7300	0.0033	0.053	90000000	410000000	96000	2000000

Groundwater Components for Potable Water Shallow Soil Scenario (Table 6)(µg/L)										
Medium - Fine Textured Soil										
	MOE	Ont. GW		GW1	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW1	Odour	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Fluoranthene	0.4	0.4	0.41		44	700			73	130
Fluorene	0.5	120	120						290	950
Heptachlor	0.01	0.01	1.5	25			560000	3100000	0.038	90
Heptachlor Epoxide	0.01	0.01	1.5	350			1800000	10000000	0.038	100
Hexachlorobenzene	0.01	0.01	1						230	3.1
Hexachlorobutadiene	0.01	0.01	0.6	29	0.012	0.2	1100000	4500000	93	1600
Hexachlorocyclohexane Gamma-	0.01	0.01	4						0.95	4000
Hexachloroethane	0.01	0.01	2.1	9.4	0.17	2.7	1100000	5600000	5400	25000
Hexane (n)	5	5			0.34	5.9			2500	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	0.1		190	3100			1.4	0.095
Lead	1	1.9	10						20	4800000
Mercury	0.1	0.1	1		0.0047	0.081			7.7	30
Methoxychlor	0.05	0.05	900						0.3	50
Methyl Ethyl Ketone	20	400	1800	20000	21000	100000	79000000	340000000	1200000	110000000
Methyl Isobutyl Ketone	20	640	3000	640	5200	26000	3600000	15000000	460000	9500000
Methyl Mercury **		0.12	0.3						0.12	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	15		8.6	140			1000000	26000000
Methylene Chloride	5	5	50	4100	26	420	63000000	260000000	13000	6500000
Methlynaphthalene, 2-(1-) ***	2	2	12	3.2			35000	150000	1500	12000
Molybdenum	0.5	23	70						7300	38000000
Naphthalene	2	7	59	11	4.4	75	160000	710000	6200	16000
Nickel	1	14	100						390	210000000
Pentachlorophenol	0.5	0.5	30						50	7000
Petroleum Hydrocarbons F1****	25	420	820		3.4	58			420	1900
Petroleum Hydrocarbons F2	100	150	300		5.7	97			170	150
Petroleum Hydrocarbons F3	500	500	1000							4.9E-08
Petroleum Hydrocarbons F4	500	500	1100							3.9E-12
Phenanthrene	0.1	0.1	1						380	580
Phenol	1	5	890	17000	48000	830000	100000000	390000000	9600	41000000
Polychlorinated Biphenyls	0.2	0.2	3		0.11	1.8			0.14	140
Pyrene	0.2	0.2	4.1		340	5400			5.7	68
Selenium	5	5	10						50	41000000
Silver	0.3	0.3	100						1.2	35000000
Styrene	0.5	0.5	100	5.4	43	740	120000	520000	7200	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	1.1		0.073	1.2			20000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	1	3300	0.11	1.8	40000000	170000000	24000	1400000
Tetrachloroethylene	0.5	0.5	20	440	0.072	1.2	12000000	49000000	8400	100000
Thallium	0.5	0.5	2						400	13000000
Toluene	0.5	0.8	24	22	320	5400	470000	1900000	14000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	70	190	3	51	5600000	25000000	3400	25000
Trichloroethane, 1,1,1-	0.5	0.5	200	3000	23	390	67000000	280000000	9000	650000
Trichloroethane, 1,1,2-	0.5	0.5	5		0.17	2.8			94000	550000
Trichloroethylene	0.5	0.5	5	1100	0.072	1.2	24000000	100000000	220000	640000
Trichlorofluoromethane	5	150	150						2000	550000
Trichlorophenol, 2,4,5-	0.2	0.2	8.9						1300	600000
Trichlorophenol, 2,4,6-	0.2	0.2	2						180	400000
Uranium	2	8.9	20						330	
Vanadium	0.5	3.9	6.2						200	43000000
Vinyl Chloride	0.5	0.5	2	5300	0.0072	0.12	81000000	340000000	360000	4400000
Xylene Mixture	0.5	72	300	370	26	450	5400000	23000000	3300	53000
Zinc	5	160	5000						890	170000000
Electrical Conductivity (mS/cm)	0.005	0.005								
Chloride	1000	790000	250000						1800000	21000000
Sodium Adsorption Ratio										
Sodium	5000	490000	200000						1800000	220000000

Groundwater Components for Non-potable Water Shallow Soil Scenario (Table 7) (µg/L)								
Coarse Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Acenaphthene	1	4.1	17	270	300000	2000000	5200	2000
Acenaphthylene	1	1	0.96	15			1.4	8100
Acetone	30	2700	120000	2000000	110000000	680000000	100000	500000000
Aldrin	0.01	0.01			1500000	12000000	3	8.5
Anthracene	0.1	0.1					1	22
Antimony	0.5	1.5					16000	12000000
Arsenic	1	13					1500	17000000
Barium	2	610					23000	27000000
Benzene	0.5	0.5	0.17	2.8	1700000	10000000	4600	900000
Benz[a]anthracene	0.2	0.2	3.8	61			1.8	4.7
Benzo[a]pyrene	0.01	0.01	14	220			2.1	0.81
Benzo[b]fluoranthene	0.1	0.1	81	1300			4.2	0.75
Benzo[ghi]perylene	0.2	0.2					0.2	0.13
Benzo[k]fluoranthene	0.1	0.1	100	1600			1.4	0.4
Beryllium	0.5	0.5					53	75000000
Biphenyl 1,1'-	0.5	0.5			1000	6600	1700	3500
Bis(2-chloroethyl)ether	5	5			810000	5700000	240000	8600000
Bis(2-chloroisopropyl)ether	4	120			400000	2500000	240000	20000
Bis(2-ethylhexyl)phthalate	10	10					30	140
Boron (Hot Water Soluble)*								
Boron (total)	10	1700					36000	22000000
Bromodichloromethane	2	2					67000	1500000
Bromoform	5	5	4.2	68	4900000	34000000	29000	1600000
Bromomethane	0.5	0.89	0.19	0.95	450000	2700000	3200	7600000
Cadmium	0.5	0.5					2.1	62000000
Carbon Tetrachloride	0.2	0.2	0.028	0.48	2800000	17000000	2000	400000
Chlordane	0.06	0.06	0.85	14	44000	370000	0.043	28
Chloroaniline p-	10	10					320	2000000
Chlorobenzene	0.5	0.5	140	2400	120000	690000	500	250000
Chloroform	1	2	0.1	1.7	11000000	63000000	12000	4000000
Chlorophenol, 2-	2	8.9					2600	14000000
Chromium Total	10	11					640	6000000
Chromium VI	10	25					110	6000000
Chrysene	0.1	0.1	95	1500			0.7	1
Cobalt	1	3.8					52	44000000
Copper	5	5					69	210000000
Cyanide (CN-)	5	5					52	500000000
Dibenz[a h]anthracene	0.2	0.2	140	2300			0.4	0.52
Dibromochloromethane	2	2					65000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	150	2600	160000	930000	7600	40000
Dichlorobenzene, 1,3-	0.5	0.5					7600	63000
Dichlorobenzene, 1,4-	0.5	0.5	0.26	4.2	21000	130000	7600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5					500	1600
Dichlorodifluoromethane	2	590					3500	140000
DDD	0.05	1.8					1.8	45
DDE	0.01	10					17	20
DDT	0.05	0.05					0.01	2.8
Dichloroethane, 1,1-	0.5	0.5	11	190	1200000	7000000	2000000	2500000
Dichloroethane, 1,2-	0.5	0.5	0.07	1.1	4000000	24000000	200000	2600000
Dichloroethylene, 1,1-	0.5	0.5	0.072	1.2	1300000	7400000	12000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	0.072	1.2			140000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	0.072	1.2	260000	1500000	220000	1800000
Dichlorophenol, 2,4-	20	20					3700	2300000
Dichloropropane, 1,2-	0.5	0.5	0.58	9.9	23000	140000	57000	1400000
Dichloropropene,1,3-	0.5	0.5	0.16	2.5	86000	520000	2400	1400000
Dieldrin	0.05	0.05					0.56	130
Diethyl Phthalate	2	30					30	540000
Dimethylphthalate	2	30					30	2000000
Dimethylphenol, 2,4-	10	10					31000	3900000
Dinitrophenol, 2,4-	10	10					9000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5					2300	140000
Dioxane, 1,4	2	50	190000	3200000			5800000	500000000
Dioxin/Furan (TEQ)		0.000015	0.0002	0.0034			0.0001	0.1
Endosulfan	0.05	0.05					0.56	230
Endrin	0.05	0.05					0.36	130
Ethylbenzene	0.5	0.5	54	270	78000	460000	1800	85000
Ethylene dibromide	0.2	0.2	0.0033	0.053	27000000	170000000	96000	2000000

Groundwater Components for Non-potable Water Shallow Soil Scenario (Table 7) (µg/L)								
Coarse Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Fluoranthene	0.4	0.4	44	700			73	130
Fluorene	0.5	120					290	950
Heptachlor	0.01	0.01			360000	2600000	0.038	90
Heptachlor Epoxide	0.01	0.01			1100000	9200000	0.038	100
Hexachlorobenzene	0.01	0.01					230	3.1
Hexachlorobutadiene	0.01	0.01	0.012	0.2	110000	630000	93	1600
Hexachlorocyclohexane Gamma-	0.01	0.01					0.95	4000
Hexachloroethane	0.01	0.01	0.17	2.7	510000	3400000	5400	25000
Hexane (n)	5	5	0.34	5.9			2500	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	190	3100			1.4	0.095
Lead	1	1.9					20	4800000
Mercury	0.1	0.1	0.0047	0.081			7.7	30
Methoxychlor	0.05	0.05					0.3	50
Methyl Ethyl Ketone	20	400	21000	100000	22000000	140000000	1200000	110000000
Methyl Isobutyl Ketone	20	640	5200	26000	820000	5000000	460000	9500000
Methyl Mercury **		0.12					0.12	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	8.6	140			1000000	26000000
Methylene Chloride	5	5	26	420	6900000	41000000	13000	6500000
Methlynaphthalene, 2-(1-) ***	2	2			6200	38000	1500	12000
Molybdenum	0.5	23					7300	38000000
Naphthalene	2	7	4.4	75	37000	230000	6200	16000
Nickel	1	14					390	210000000
Pentachlorophenol	0.5	0.5					50	7000
Petroleum Hydrocarbons F1****	25	420	3.4	58			420	1900
Petroleum Hydrocarbons F2	100	150	5.7	97			170	150
Petroleum Hydrocarbons F3	500	500						4.9E-08
Petroleum Hydrocarbons F4	500	500						3.9E-12
Phenanthrene	0.1	0.1					380	580
Phenol	1	5	48000	830000	17000000	110000000	9600	41000000
Polychlorinated Biphenyls	0.2	0.2	0.11	1.8			0.14	140
Pyrene	0.2	0.2	340	5400			5.7	68
Selenium	5	5					50	41000000
Silver	0.3	0.3					1.2	35000000
Styrene	0.5	0.5	43	740	14000	85000	7200	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	0.073	1.2			20000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	0.11	1.8	8400000	51000000	24000	1400000
Tetrachloroethylene	0.5	0.5	0.072	1.2	1100000	6600000	8400	100000
Thallium	0.5	0.5					400	13000000
Toluene	0.5	0.8	320	5400	47000	280000	14000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	3	51	1200000	7300000	3400	25000
Trichloroethane, 1,1,1-	0.5	0.5	23	390	6400000	38000000	9000	650000
Trichloroethane, 1,1,2-	0.5	0.5	0.17	2.8			94000	550000
Trichloroethylene	0.5	0.5	0.072	1.2	2400000	14000000	220000	640000
Trichlorofluoromethane	5	150					2000	550000
Trichlorophenol, 2,4,5-	0.2	0.2					1300	600000
Trichlorophenol, 2,4,6-	0.2	0.2					180	400000
Uranium	2	8.9					330	
Vanadium	0.5	3.9					200	43000000
Vinyl Chloride	0.5	0.5	0.0072	0.12	7600000	44000000	360000	4400000
Xylene Mixture	0.5	72	26	450	530000	3200000	3300	53000
Zinc	5	160					890	170000000
Electrical Conductivity (mS/cm)	0.005	0.005						
Chloride	1000	790000					1800000	21000000
Sodium Adsorption Ratio								
Sodium	5000	490000					1800000	220000000

Groundwater Components for Non-potable Water Shallow Soil Scenario (Table 7) (µg/L)								
Medium - Fine Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Acenaphthene	1	4.1	17	270	820000	3800000	5200	2000
Acenaphthylene	1	1	0.96	15			1.4	8100
Acetone	30	2700	120000	2000000	460000000	1900000000	100000	500000000
Aldrin	0.01	0.01			2300000	14000000	3	8.5
Anthracene	0.1	0.1					1	22
Antimony	0.5	1.5					16000	12000000
Arsenic	1	13					1500	17000000
Barium	2	610					23000	27000000
Benzene	0.5	0.5	0.17	2.8	17000000	69000000	4600	900000
Benz[a]anthracene	0.2	0.2	3.8	61			1.8	4.7
Benzo[a]pyrene	0.01	0.01	14	220			2.1	0.81
Benzo[b]fluoranthene	0.1	0.1	81	1300			4.2	0.75
Benzo[ghi]perylene	0.2	0.2					0.2	0.13
Benzo[k]fluoranthene	0.1	0.1	100	1600			1.4	0.4
Beryllium	0.5	0.5					53	75000000
Biphenyl 1,1'-	0.5	0.5			4300	19000	1700	3500
Bis(2-chloroethyl)ether	5	5			2800000	12000000	240000	8600000
Bis(2-chloroisopropyl)ether	4	120			1600000	7100000	240000	20000
Bis(2-ethylhexyl)phthalate	10	10					30	140
Boron (Hot Water Soluble)*								
Boron (total)	10	1700					36000	22000000
Bromodichloromethane	2	2					67000	1500000
Bromoform	5	5	4.2	68	10000000	50000000	29000	1600000
Bromomethane	0.5	0.89	0.19	0.95	4500000	19000000	3200	7600000
Cadmium	0.5	0.5					2.1	62000000
Carbon Tetrachloride	0.2	0.2	0.028	0.48	30000000	130000000	2000	400000
Chlordane	0.06	0.06	0.85	14	65000	400000	0.043	28
Chloroaniline p-	10	10					320	2000000
Chlorobenzene	0.5	0.5	140	2400	1000000	4300000	500	250000
Chloroform	1	2	0.1	1.7	100000000	420000000	12000	4000000
Chlorophenol, 2-	2	8.9					2600	14000000
Chromium Total	10	11					640	6000000
Chromium VI	10	25					110	6000000
Chrysene	0.1	0.1	95	1500			0.7	1
Cobalt	1	3.8					52	44000000
Copper	5	5					69	210000000
Cyanide (CN-)	5	5					52	500000000
Dibenz[a h]anthracene	0.2	0.2	140	2300			0.4	0.52
Dibromochloromethane	2	2					65000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	150	2600	1200000	5100000	7600	40000
Dichlorobenzene, 1,3-	0.5	0.5					7600	63000
Dichlorobenzene, 1,4-	0.5	0.5	0.26	4.2	180000	740000	7600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5					500	1600
Dichlorodifluoromethane	2	590					3500	140000
DDD	0.05	1.8					1.8	45
DDE	0.01	10					17	20
DDT	0.05	0.05					0.01	2.8
Dichloroethane, 1,1-	0.5	0.5	11	190	11000000	47000000	2000000	2500000
Dichloroethane, 1,2-	0.5	0.5	0.07	1.1	31000000	130000000	200000	2600000
Dichloroethylene, 1,1-	0.5	0.5	0.072	1.2	13000000	55000000	12000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	0.072	1.2			140000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	0.072	1.2	2600000	11000000	220000	1800000
Dichlorophenol, 2,4-	20	20					3700	2300000
Dichloropropane, 1,2-	0.5	0.5	0.58	9.9	210000	860000	57000	1400000
Dichloropropene,1,3-	0.5	0.5	0.16	2.5	740000	3100000	2400	1400000
Dieldrin	0.05	0.05					0.56	130
Diethyl Phthalate	2	30					30	540000
Dimethylphthalate	2	30					30	2000000
Dimethylphenol, 2,4-	10	10					31000	3900000
Dinitrophenol, 2,4-	10	10					9000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5					2300	140000
Dioxane, 1,4	2	50	190000	3200000			5800000	500000000
Dioxin/Furan (TEQ)		0.000015	0.0002	0.0034			0.0001	0.1
Endosulfan	0.05	0.05					0.56	230
Endrin	0.05	0.05					0.36	130
Ethylbenzene	0.5	0.5	54	270	780000	3300000	1800	85000
Ethylene dibromide	0.2	0.2	0.0033	0.053	90000000	410000000	96000	2000000

Groundwater Components for Non-potable Water Shallow Soil Scenario (Table 7) (µg/L)								
Medium - Fine Textured Soil								
	MOE	Ont. GW	Residential	Industrial	Residential	Industrial		1/2
Chemical Parameter	Water RL	Bkgrd	GW2	GW2	GW2 Odour	GW2 Odour	GW3	Solubility
Fluoranthene	0.4	0.4	44	700			73	130
Fluorene	0.5	120					290	950
Heptachlor	0.01	0.01			560000	3100000	0.038	90
Heptachlor Epoxide	0.01	0.01			1800000	10000000	0.038	100
Hexachlorobenzene	0.01	0.01					230	3.1
Hexachlorobutadiene	0.01	0.01	0.012	0.2	1100000	4500000	93	1600
Hexachlorocyclohexane Gamma-	0.01	0.01					0.95	4000
Hexachloroethane	0.01	0.01	0.17	2.7	1100000	5600000	5400	25000
Hexane (n)	5	5	0.34	5.9			2500	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	190	3100			1.4	0.095
Lead	1	1.9					20	4800000
Mercury	0.1	0.1	0.0047	0.081			7.7	30
Methoxychlor	0.05	0.05					0.3	50
Methyl Ethyl Ketone	20	400	21000	100000	79000000	340000000	1200000	110000000
Methyl Isobutyl Ketone	20	640	5200	26000	3600000	15000000	460000	9500000
Methyl Mercury **		0.12					0.12	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	8.6	140			1000000	26000000
Methylene Chloride	5	5	26	420	63000000	260000000	13000	6500000
Methlynaphthalene, 2-(1-) ***	2	2			35000	150000	1500	12000
Molybdenum	0.5	23					7300	38000000
Naphthalene	2	7	4.4	75	160000	710000	6200	16000
Nickel	1	14					390	210000000
Pentachlorophenol	0.5	0.5					50	7000
Petroleum Hydrocarbons F1****	25	420	3.4	58			420	1900
Petroleum Hydrocarbons F2	100	150	5.7	97			170	150
Petroleum Hydrocarbons F3	500	500						4.9E-08
Petroleum Hydrocarbons F4	500	500						3.9E-12
Phenanthrene	0.1	0.1					380	580
Phenol	1	5	48000	830000	100000000	390000000	9600	41000000
Polychlorinated Biphenyls	0.2	0.2	0.11	1.8			0.14	140
Pyrene	0.2	0.2	340	5400			5.7	68
Selenium	5	5					50	41000000
Silver	0.3	0.3					1.2	35000000
Styrene	0.5	0.5	43	740	120000	520000	7200	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	0.073	1.2			20000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	0.11	1.8	40000000	170000000	24000	1400000
Tetrachloroethylene	0.5	0.5	0.072	1.2	12000000	49000000	8400	100000
Thallium	0.5	0.5					400	13000000
Toluene	0.5	0.8	320	5400	470000	1900000	14000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	3	51	5600000	25000000	3400	25000
Trichloroethane, 1,1,1-	0.5	0.5	23	390	67000000	280000000	9000	650000
Trichloroethane, 1,1,2-	0.5	0.5	0.17	2.8			94000	550000
Trichloroethylene	0.5	0.5	0.072	1.2	24000000	100000000	220000	640000
Trichlorofluoromethane	5	150					2000	550000
Trichlorophenol, 2,4,5-	0.2	0.2					1300	600000
Trichlorophenol, 2,4,6-	0.2	0.2					180	400000
Uranium	2	8.9					330	
Vanadium	0.5	3.9					200	43000000
Vinyl Chloride	0.5	0.5	0.0072	0.12	81000000	340000000	360000	4400000
Xylene Mixture	0.5	72	26	450	5400000	23000000	3300	53000
Zinc	5	160					890	170000000
Electrical Conductivity (mS/cm)	0.005	0.005						
Chloride	1000	790000					1800000	21000000
Sodium Adsorption Ratio								
Sodium	5000	490000					1800000	220000000

Groundwater Components for Within 30 M of a Water Body (Table 8) (µg/L)							
Potable Scenario							
	MOE	Ont. GW		GW1	Residential	GW3	1/2
Chemical Parameter	Water RL	Bkgrd	GW1	Odour	GW2	(10xAPV)	Solubility
Acenaphthene	1	4.1	4.1	67	600	5200	2000
Acenaphthylene	1	1	0.45		36	1.4	8100
Acetone	30	2700	2700	93000	1800000	100000	500000000
Aldrin	0.01	0.01	0.35	150		3	8.5
Anthracene	0.1	0.1	890			1	22
Antimony	0.5	1.5	6			16000	12000000
Arsenic	1	13	25			1500	17000000
Barium	2	610	1000			23000	27000000
Benzene	0.5	0.5	5	860	44	4600	900000
Benz[a]anthracene	0.2	0.2	1		70	1.8	4.7
Benzo[a]pyrene	0.01	0.01	0.01		130	2.1	0.81
Benzo[b]fluoranthene	0.1	0.1	0.1		1100	4.2	0.75
Benzo[ghi]perylene	0.2	0.2	1			0.2	0.13
Benzo[k]fluoranthene	0.1	0.1	0.1		1300	1.4	0.4
Beryllium	0.5	0.5	4			53	75000000
Biphenyl 1,1'-	0.5	0.5	110	0.49		1700	3500
Bis(2-chloroethyl)ether	5	5	0.012	410		240000	8600000
Bis(2-chloroisopropyl)ether	4	120	120	160		240000	20000
Bis(2-ethylhexyl)phthalate	10	10	6			30	140
Boron (Hot Water Soluble)*							
Boron (total)	10	1700	5000			36000	22000000
Bromodichloromethane	2	2	16			67000	1500000
Bromoform	5	5	25	590	380	29000	1600000
Bromomethane	0.5	0.89	0.89	310	5.6	3200	7600000
Cadmium	0.5	0.5	5			2.1	62000000
Carbon Tetrachloride	0.2	0.2	5	1300	0.79	2000	400000
Chlordane	0.06	0.06	7	4.2	58	0.043	28
Chloroaniline p-	10	10	5.9			320	2000000
Chlorobenzene	0.5	0.5	30	46	4100	500	250000
Chloroform	1	2	25	6400	2.4	12000	4000000
Chlorophenol, 2-	2	8.9	8.9			2600	14000000
Chromium Total	10	11	50			640	6000000
Chromium VI	10	25	25			110	6000000
Chrysene	0.1	0.1	0.1		2400	0.7	1
Cobalt	1	3.8	3			52	44000000
Copper	5	5	1000			69	210000000
Cyanide (CN-)	5	5	200			52	500000000
Dibenz[a h]anthracene	0.2	0.2	0.01		1300	0.4	0.52
Dibromochloromethane	2	2	25			65000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	3	54	4600	7600	40000
Dichlorobenzene, 1,3-	0.5	0.5	59			7600	63000
Dichlorobenzene, 1,4-	0.5	0.5	1	7.4	8	7600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5	0.025			500	1600
Dichlorodifluoromethane	2	590	590			3500	140000
DDD	0.05	1.8	10			1.8	45
DDE	0.01	10	10			17	20
DDT	0.05	0.05	10			0.01	2.8
Dichloroethane, 1,1-	0.5	0.5	5	540	320	2000000	2500000
Dichloroethane, 1,2-	0.5	0.5	5	2300	1.6	200000	2600000
Dichloroethylene, 1,1-	0.5	0.5	14	710	1.6	12000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	20		1.6	140000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	20	170	1.6	220000	1800000
Dichlorophenol, 2,4-	20	20	0.3			3700	2300000
Dichloropropane, 1,2-	0.5	0.5	5	10	16	57000	1400000
Dichloropropene,1,3-	0.5	0.5	0.5	32	5.2	2400	1400000
Dieldrin	0.05	0.05	0.35			0.56	130
Diethyl Phthalate	2	30	15000			30	540000
Dimethylphthalate	2	30	15000			30	2000000
Dimethylphenol, 2,4-	10	10	59			31000	3900000
Dinitrophenol, 2,4-	10	10	5.9			9000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5	0.044			2300	140000
Dioxane, 1,4	2	50	50		1900000	5800000	500000000
Dioxin/Furan (TEQ)		0.000015	0.000015		0.014	0.0001	0.1
Endosulfan	0.05	0.05	5.9			0.56	230
Endrin	0.05	0.05	2			0.36	130
Ethylbenzene	0.5	0.5	2.4	31	16000	1800	85000
Ethylene dibromide	0.2	0.2	0.05	7300	0.25	96000	2000000

Groundwater Components for Within 30 M of a Water Body (Table 8) (µg/L)							
Potable Scenario							
	MOE	Ont. GW		GW1	Residential	GW3	1/2
Chemical Parameter	Water RL	Bkgrd	GW1	Odour	GW2	(10xAPV)	Solubility
Fluoranthene	0.4	0.4	0.41		1100	73	130
Fluorene	0.5	120	120			290	950
Heptachlor	0.01	0.01	1.5	25		0.038	90
Heptachlor Epoxide	0.01	0.01	1.5	350		0.038	100
Hexachlorobenzene	0.01	0.01	1			230	3.1
Hexachlorobutadiene	0.01	0.01	0.6	29	0.44	93	1600
Hexachlorocyclohexane Gamma-	0.01	0.01	4			0.95	4000
Hexachloroethane	0.01	0.01	2.1	9.4	94	5400	25000
Hexane (n)	5	5			51	2500	4800
Indeno[1 2 3-cd]pyrene	0.2	0.2	0.1		2200	1.4	0.095
Lead	1	1.9	10			20	4800000
Mercury	0.1	0.1	1		0.29	7.7	30
Methoxychlor	0.05	0.05	900			0.3	50
Methyl Ethyl Ketone	20	400	1800	20000	470000	1200000	110000000
Methyl Isobutyl Ketone	20	640	3000	640	140000	460000	9500000
Methyl Mercury **		0.12	0.3			0.12	16000000
Methyl tert-Butyl Ether (MTBE)	2	15	15		190	1000000	26000000
Methylene Chloride	5	5	50	4100	610	13000	6500000
Methlynaphthalene, 2-(1-) ***	2	2	12	3.2		1500	12000
Molybdenum	0.5	23	70			7300	38000000
Naphthalene	2	7	59	11	1400	6200	16000
Nickel	1	14	100			390	210000000
Pentachlorophenol	0.5	0.5	30			50	7000
Petroleum Hydrocarbons F1****	25	420	820		1400	420	1900
Petroleum Hydrocarbons F2	100	150	300		2300	170	150
Petroleum Hydrocarbons F3	500	500	1000				4.9E-08
Petroleum Hydrocarbons F4	500	500	1100				3.9E-12
Phenanthrene	0.1	0.1	1			380	580
Phenol	1	5	890	17000	470000	9600	41000000
Polychlorinated Biphenyls	0.2	0.2	3		7.8	0.14	140
Pyrene	0.2	0.2	4.1		9300	5.7	68
Selenium	5	5	10			50	41000000
Silver	0.3	0.3	100			1.2	35000000
Styrene	0.5	0.5	100	5.4	1300	7200	160000
Tetrachloroethane, 1,1,1,2-	0.5	1.1	1.1		3.3	20000	540000
Tetrachloroethane, 1,1,2,2-	0.5	0.5	1	3300	3.2	24000	1400000
Tetrachloroethylene	0.5	0.5	20	440	1.6	8400	100000
Thallium	0.5	0.5	2			400	13000000
Toluene	0.5	0.8	24	22	82000	14000	260000
Trichlorobenzene, 1,2,4-	0.5	0.5	70	190	180	3400	25000
Trichloroethane, 1,1,1-	0.5	0.5	200	3000	640	9000	650000
Trichloroethane, 1,1,2-	0.5	0.5	5		4.7	94000	550000
Trichloroethylene	0.5	0.5	5	1100	1.6	220000	640000
Trichlorofluoromethane	5	150	150			2000	550000
Trichlorophenol, 2,4,5-	0.2	0.2	8.9			1300	600000
Trichlorophenol, 2,4,6-	0.2	0.2	2			180	400000
Uranium	2	8.9	20			330	
Vanadium	0.5	3.9	6.2			200	43000000
Vinyl Chloride	0.5	0.5	2	5300	0.16	360000	4400000
Xylene Mixture	0.5	72	300	370	7800	3300	53000
Zinc	5	160	5000			890	170000000
Electrical Conductivity (mS/cm)	0.005	0.005					
Chloride	1000	790000	250000			1800000	21000000
Sodium Adsorption Ratio							
Sodium	5000	490000	200000			1800000	220000000

Groundwater Components for Within 30 M of a Water Body (Table 9) (µg/L)

Non-Potable Scenario

Chemical Parameter	MOE Water RL	Ont. GW Bkgrd	Residential GW2	GW3 (10xAPV)	1/2 Solubility
Acenaphthene	1	4.1	600	5200	2000
Acenaphthylene	1	1	36	1.4	8100
Acetone	30	2700	1800000	100000	500000000
Aldrin	0.01	0.01		3	8.5
Anthracene	0.1	0.1		1	22
Antimony	0.5	1.5		16000	12000000
Arsenic	1	13		1500	17000000
Barium	2	610		23000	27000000
Benzene	0.5	0.5	44	4600	900000
Benz[a]anthracene	0.2	0.2	70	1.8	4.7
Benzo[a]pyrene	0.01	0.01	130	2.1	0.81
Benzo[b]fluoranthene	0.1	0.1	1100	4.2	0.75
Benzo[ghi]perylene	0.2	0.2		0.2	0.13
Benzo[k]fluoranthene	0.1	0.1	1300	1.4	0.4
Beryllium	0.5	0.5		53	75000000
Biphenyl 1,1'-	0.5	0.5		1700	3500
Bis(2-chloroethyl)ether	5	5		240000	8600000
Bis(2-chloroisopropyl)ether	4	120		240000	20000
Bis(2-ethylhexyl)phthalate	10	10		30	140
Boron (Hot Water Soluble)*					
Boron (total)	10	1700		36000	22000000
Bromodichloromethane	2	2		67000	1500000
Bromoform	5	5	380	29000	1600000
Bromomethane	0.5	0.89	5.6	3200	7600000
Cadmium	0.5	0.5		2.1	62000000
Carbon Tetrachloride	0.2	0.2	0.79	2000	400000
Chlordane	0.06	0.06	58	0.043	28
Chloroaniline p-	10	10		320	2000000
Chlorobenzene	0.5	0.5	4100	500	250000
Chloroform	1	2	2.4	12000	4000000
Chlorophenol, 2-	2	8.9		2600	14000000
Chromium Total	10	11		640	6000000
Chromium VI	10	25		110	6000000
Chrysene	0.1	0.1	2400	0.7	1
Cobalt	1	3.8		52	44000000
Copper	5	5		69	210000000
Cyanide (CN-)	5	5		52	500000000
Dibenz[a h]anthracene	0.2	0.2	1300	0.4	0.52
Dibromochloromethane	2	2		65000	1400000
Dichlorobenzene, 1,2-	0.5	0.5	4600	7600	40000
Dichlorobenzene, 1,3-	0.5	0.5		7600	63000
Dichlorobenzene, 1,4-	0.5	0.5	8	7600	41000
Dichlorobenzidine, 3,3'-	0.5	0.5		500	1600
Dichlorodifluoromethane	2	590		3500	140000
DDD	0.05	1.8		1.8	45
DDE	0.01	10		17	20
DDT	0.05	0.05		0.01	2.8
Dichloroethane, 1,1-	0.5	0.5	320	2000000	2500000
Dichloroethane, 1,2-	0.5	0.5	1.6	200000	2600000
Dichloroethylene, 1,1-	0.5	0.5	1.6	12000	1200000
Dichloroethylene, 1,2-cis-	0.5	1.6	1.6	140000	1800000
Dichloroethylene, 1,2-trans-	0.5	1.6	1.6	220000	1800000
Dichlorophenol, 2,4-	20	20		3700	2300000
Dichloropropane, 1,2-	0.5	0.5	16	57000	1400000
Dichloropropene,1,3-	0.5	0.5	5.2	2400	1400000
Dieldrin	0.05	0.05		0.56	130
Diethyl Phthalate	2	30		30	540000
Dimethylphthalate	2	30		30	2000000
Dimethylphenol, 2,4-	10	10		31000	3900000
Dinitrophenol, 2,4-	10	10		9000	1400000
Dinitrotoluene, 2,4 & 2,6-	5	5		2300	140000
Dioxane, 1,4	2	50	1900000	5800000	500000000
Dioxin/Furan (TEQ)		0.000015	0.014	0.0001	0.1
Endosulfan	0.05	0.05		0.56	230
Endrin	0.05	0.05		0.36	130
Ethylbenzene	0.5	0.5	16000	1800	85000
Ethylene dibromide	0.2	0.2	0.25	96000	2000000

Groundwater Components for Within 30 M of a Water Body (Table 9) (µg/L)						
Non-Potable Scenario						
	MOE	Ont. GW	Residential	GW3	1/2	
Chemical Parameter	Water RL	Bkgrd	GW2	(10xAPV)	Solubility	
Fluoranthene	0.4	0.4	1100	73	130	
Fluorene	0.5	120		290	950	
Heptachlor	0.01	0.01		0.038	90	
Heptachlor Epoxide	0.01	0.01		0.038	100	
Hexachlorobenzene	0.01	0.01		230	3.1	
Hexachlorobutadiene	0.01	0.01	0.44	93	1600	
Hexachlorocyclohexane Gamma-	0.01	0.01		0.95	4000	
Hexachloroethane	0.01	0.01	94	5400	25000	
Hexane (n)	5	5	51	2500	4800	
Indeno[1 2 3-cd]pyrene	0.2	0.2	2200	1.4	0.095	
Lead	1	1.9		20	4800000	
Mercury	0.1	0.1	0.29	7.7	30	
Methoxychlor	0.05	0.05		0.3	50	
Methyl Ethyl Ketone	20	400	470000	1200000	110000000	
Methyl Isobutyl Ketone	20	640	140000	460000	9500000	
Methyl Mercury **		0.12		0.12	16000000	
Methyl tert-Butyl Ether (MTBE)	2	15	190	1000000	26000000	
Methylene Chloride	5	5	610	13000	6500000	
Methlynaphthalene, 2-(1-) ***	2	2		1500	12000	
Molybdenum	0.5	23		7300	38000000	
Naphthalene	2	7	1400	6200	16000	
Nickel	1	14		390	210000000	
Pentachlorophenol	0.5	0.5		50	7000	
Petroleum Hydrocarbons F1****	25	420	1400	420	1900	
Petroleum Hydrocarbons F2	100	150	2300	170	150	
Petroleum Hydrocarbons F3	500	500			4.9E-08	
Petroleum Hydrocarbons F4	500	500			3.9E-12	
Phenanthrene	0.1	0.1		380	580	
Phenol	1	5	470000	9600	41000000	
Polychlorinated Biphenyls	0.2	0.2	7.8	0.14	140	
Pyrene	0.2	0.2	9300	5.7	68	
Selenium	5	5		50	41000000	
Silver	0.3	0.3		1.2	35000000	
Styrene	0.5	0.5	1300	7200	160000	
Tetrachloroethane, 1,1,1,2-	0.5	1.1	3.3	20000	540000	
Tetrachloroethane, 1,1,2,2-	0.5	0.5	3.2	24000	1400000	
Tetrachloroethylene	0.5	0.5	1.6	8400	100000	
Thallium	0.5	0.5		400	13000000	
Toluene	0.5	0.8	82000	14000	260000	
Trichlorobenzene, 1,2,4-	0.5	0.5	180	3400	25000	
Trichloroethane, 1,1,1-	0.5	0.5	640	9000	650000	
Trichloroethane, 1,1,2-	0.5	0.5	4.7	94000	550000	
Trichloroethylene	0.5	0.5	1.6	220000	640000	
Trichlorofluoromethane	5	150		2000	550000	
Trichlorophenol, 2,4,5-	0.2	0.2		1300	600000	
Trichlorophenol, 2,4,6-	0.2	0.2		180	400000	
Uranium	2	8.9		330		
Vanadium	0.5	3.9		200	43000000	
Vinyl Chloride	0.5	0.5	0.16	360000	4400000	
Xylene Mixture	0.5	72	7800	3300	53000	
Zinc	5	160		890	170000000	
Electrical Conductivity (mS/cm)	0.005	0.005				
Chloride	1000	790000		1800000	21000000	
Sodium Adsorption Ratio						
Sodium	5000	490000		1800000	220000000	

CHEMICAL NAME	CAS RN (Chemical Abstracts Service Registry Number)	Oral Chronic TRV (mg/kg-day)	Ref.	Is the oral chronic non-cancer TRV based on reproductive or developmental effects?	Oral Sub-chronic TRV (mg/kg-day)	Ref.	Inhalation Chronic TRV (mg/m^3)	Ref.	Is the inhalation chronic non-cancer TRV based on reproductive or developmental effects?	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Ref.
Acenaphthene	83329	6.00E-02	IRIS 1994		6.0E-01	ATSDR 1995		none selected		7.30E-03	Kalberlah et al 1995 (TEF=0.001) & IRIS 1992
Acenaphthylene	208968	6.00E-02	IRIS 1994 (proxy)		6.0E-01	ATSDR 1995 (proxy)		none selected		7.30E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992
Acetone	67641	9.00E-01	IRIS 2003		3.0E+00	modified from IRIS 2003	1.20E+01	MOE 24-h AAQC 2005			none selected
Aldrin	309002	3.00E-05	IRIS 1988; ATSDR 2002		4.0E-05	US EPA PPRTV 2005		none selected			none selected
Anthracene	120127	3.00E-01	IRIS 1993		3.0E+00	modified from IRIS 1993		none selected			Kalberlah et al 1995 (no TEF) & IRIS 1992
Antimony	7440360	4.00E-04	IRIS 1991			none selected	2.00E-04	IRIS 1995			none selected
Arsenic	7440382	3.00E-04	IRIS 1993; CalEPA ChREL 2000; ATSDR (Sept. 2005 draft)			none selected	3.00E-05	CalEPA ChREL 2000	D	1.50E+00	CalEPA ATH 2005
Barium	7440393	2.00E-01	IRIS 2005			none selected	1.00E-03	RIVM 2001			none selected
Benzene	71432	4.00E-03	IRIS 2003			none selected	3.00E-02	IRIS 2003		8.50E-02	HC DW (Sept. 2007 draft)
Benz[a]anthracene	56553		none selected			none selected		none selected		7.30E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992
Benzo[a]pyrene	50328		none selected			none selected		none selected		7.30E+00	Kalberlah et al 1995 (TEF=1) & IRIS 1992
Benzo[b]fluoranthene	205992		none selected			none selected		none selected		7.30E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992
Benzo[ghi]perylene	191242		none selected			none selected		none selected		7.30E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992
Benzo[k]fluoranthene	207089		none selected			none selected		none selected		7.30E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992
Beryllium	7440417	2.00E-03	IRIS 1998; CalEPA chREL 2001; ATSDR 2002; WHO CICAD 2001			none selected	7.00E-06	CalEPA chREL 2001			none selected
Biphenyl 1,1'-	92524	3.80E-02	WHO CICAD 1999			none selected		none selected			none selected
Bis(2-chloroethyl)ether	111444		none selected			none selected		none selected		2.50E+00	CalEPA ATH 2005
Bis(2-chloroisopropyl)ether	108601	4.00E-02	IRIS 1990			none selected		none selected			none selected
Bis(2-ethylhexyl)phthalate	117817	6.00E-02	ATSDR 2002		**1.0E-01**	ATSDR 2002		none selected			none selected
Boron (Hot Water Soluble)*	7440428-HWS										
Boron (total)	7440428	2.00E-01	IRIS 2004	D		none selected		none selected			none selected
Bromodichloromethane	75274	2.00E-02	IRIS 1991; ATSDR 1989			none selected		none selected		6.20E-02	IRIS 1993
Bromoform	75252	2.00E-02	IRIS 1991		3.0E-02	US EPA PPRTV 2005		none selected		7.90E-03	IRIS 1991
Bromomethane	74839	3.00E-04	modified from ATSDR 1992		3.0E-03	ATSDR 1992	5.00E-03	IRIS 1992; CalEPA chREL 2000	D		none selected
Cadmium	7440439	3.20E-05	modified from CalEPA DW 2006			**none selected**	3.00E-05	modified from MOE 24 hour AAQC 2007			none selected
Carbon Tetrachloride	56235	7.00E-04	IRIS 1991; CalEPA DW 2000		7.0E-03	ATSDR 2005	2.00E-03	USEPA Region III 2004			none selected
Chlordane	57749	3.30E-05	CalEPA chRD 2005	D	6.00E-04	ATSDR 1994	7.00E-04	IRIS 1998		1.30E+00	CalEPA DW 1997
Chloroaniline p-	106478	2.00E-03	WHO CICAD 2003			none selected		none selected			none selected
Chlorobenzene	108907	6.00E-02	CalEPA DW 2003		1.9E-01	modified from CalEPA DW 2003	1.00E+00	CalEPA ChREL 2000			none selected
Chloroform	67663	1.00E-02	IRIS 2001		1.0E-01	ATSDR 1997	9.80E-02	ATSDR 1997		3.10E-02	CalEPA ARB 1990
Chlorophenol, 2-	95578	3.00E-03	RIVM 2001		3.0E-03	ATSDR 1999		none selected			none selected

CHEMICAL NAME	CAS RN (Chemical Abstracts Service Registry Number)	Oral Chronic TRV (mg/kg-day)	Ref.	Is the oral chronic non-cancer TRV based on reproductive or developmental effects?	Oral Sub-chronic TRV (mg/kg-day)	Ref.	Inhalation Chronic TRV (mg/m^3)	Ref.	Is the inhalation chronic non-cancer TRV based on reproductive or developmental effects?	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Ref.
Chromium Total	16065831	1.50E+00	IRIS 1998			none selected	6.00E-02	RIVM 2001			none selected
Chromium VI	18540299	8.30E-03	modified from IRIS 1998			none selected	1.00E-04	IRIS 1998			none selected
Chrysene	218019		none selected			none selected		none selected		7.30E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992
Cobalt	7440484	1.00E-03	modified from ATSDR 2004		1.00E-02	ATSDR 2004	5.00E-04	RIVM 2001			none selected
Copper	7440508	3.00E-02	HC DWQ 1992			none selected		none selected			none selected
Cyanide (CN`)	57125	2.00E-02	CalEPA DW 1997; IRIS 1993; CCME 1997		5.0E-02	ATSDR 2006	8.00E-03	MOE 24-hr 2005			none selected
Dibenz[a h]anthracene	53703		none selected			none selected		none selected		7.30E+00	Kalberlah et al 1995 (TEF=1) & IRIS 1992
Dibromochloromethane	124481	2.00E-02	IRIS 1991		2.0E-01	modified from IRIS 1991		none selected		8.40E-02	IRIS 1992
Dichlorobenzene, 1,2-	95501	3.00E-01	ATSDR 2006		6.0E-01	ATSDR 2006	6.00E-01	RIVM 2001			none selected
Dichlorobenzene, 1,3-	541731	2.00E-02	ATSDR 2006 (proxy)		2.0E-02	ATSDR 2006		none selected			none selected
Dichlorobenzene, 1,4-	106467	3.00E-02	IRIS (May 2006 draft)		7.0E-02	ATSDR 2006	6.00E-02	ATSDR 2006		1.70E-02	IRIS (May 2006 draft); HC DWQ 1987
Dichlorobenzidine, 3,3'-	91941		none selected			none selected		none selected		1.20E+00	CalEPA ATH 2005
Dichlorodifluoromethane	75718	2.00E-01	IRIS 1995			none selected		none selected			none selected
DDD	72548	5.00E-04	RIVM 2001			none selected		none selected		2.40E-01	IRIS 1988
DDE	72559	5.00E-04	RIVM 2001			none selected		none selected		3.40E-01	IRIS 1988
DDT	50293	5.00E-04	RIVM 2001; IRIS 1996			none selected		none selected		3.40E-01	IRIS 1991
Dichloroethane, 1,1-	75343	4.00E-02	CalEPA DW 2003		4.0E-01	modified from CalEPA DW 2003	1.65E-01	modified from HEAST 1984			none selected
Dichloroethane, 1,2-	107062	2.00E-02	modified from ATSDR 2001		2.0E-01	ATSDR 2001	4.00E-01	CalEPA chREL 2000		9.10E-02	IRIS 1991
Dichloroethylene, 1,1-	75354	5.00E-02	IRIS 2002			none selected	7.00E-02	CalEPA chREL 2000			none selected
Dichloroethylene, 1,2-cis-	156592	3.00E-02	modified from RIVM 2001		3.0E-01	ATSDR 1996; modified from RIVM 2001	1.50E-01	modified from RIVM 2001			none selected
Dichloroethylene, 1,2-trans-	156605	2.00E-02	IRIS 1989		2.0E-01	ATSDR 1996; modified from IRIS 1989	6.00E-02	RIVM 2001			none selected
Dichlorophenol, 2,4-	120832	3.00E-03	RIVM 2001		3.0E-03	ATSDR 1999		none selected			none selected
Dichloropropane, 1,2-	78875	9.00E-02	ATSDR 1989; CalEPA DW 1999			none selected	4.00E-03	IRIS 1991		3.60E-02	CalEPA DW 1999
Dichloropropene,1,3-	542756	3.00E-02	IRIS 2000; ATSDR (Sept. 2006 draft)		4.00E-02	ATSDR (Sept. 2006 draft)	2.00E-02	IRIS 2000		9.10E-02	CalEPA DW 1999
Dieldrin	60571	5.00E-05	IRIS 1990; ATSDR 2002		1.0E-04	ATSDR 2002		none selected			none selected
Diethyl Phthalate	84662	5.00E+00	WHO CICAD 2003		8.0E+00	modified from IRIS 1993		none selected			none selected
Dimethylphthalate	131113	5.00E+00	WHO CICAD 2003 (proxy)			none selected		none selected			none selected
Dimethylphenol, 2,4-	105679	2.00E-02	IRIS 1990		2.0E-01	modified from IRIS 1990		none selected			none selected
Dinitrophenol, 2,4-	51285	2.00E-03	IRIS 1991		2.0E-02	modified from IRIS 1991		none selected			none selected
Dinitrotoluene, 2,4 & 2,6-	121142	2.00E-03	IRIS 1993; ATSDR 1998		4.0E-03	ATSDR 1998		none selected		6.80E-01	IRIS 1990
Dioxane, 1,4	123911	1.00E-01	ATSDR 2006		6.0E-01	ATSDR 2006	3.60E+00	ATSDR 2006		1.10E-02	IRIS 1990
Dioxin/Furan (TEQ)	1746016	2.30E-09	WHO JECFA 2002		2.00E-08	ATSDR 1998	4.00E-08	CalEPA ChREL 2000			none selected
Endosulfan	115297	2.00E-03	ATSDR 2000		5.0E-03	ATSDR 2000		none selected			none selected
Endrin	72208	2.50E-04	CalEPA DW 1999		2.0E-03	ATSDR 1996		none selected			none selected

CHEMICAL NAME	CAS RN (Chemical Abstracts Service Registry Number)	Oral Chronic TRV (mg/kg-day)	Ref.	Is the oral chronic non-cancer TRV based on reproductive or developmental effects?	Oral Sub-chronic TRV (mg/kg-day)	Ref.	Inhalation Chronic TRV (mg/m^3)	Ref.	Is the inhalation chronic non-cancer TRV based on reproductive or developmental effects?	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Ref.
Ethylbenzene	100414	1.00E-01	IRIS 1991; RIVM 2001; WHO DW 2003			none selected	1.00E+00	IRIS 1991	D		none selected
Ethylene dibromide	106934	9.00E-03	IRIS 2004		2.5E-02	modified from CalEPA DW 2003	8.00E-04	CalEPA ChREL 2001		3.60E+00	CalEPA DW 2003
Fluoranthene	206440	4.00E-02	IRIS 1993		4.0E-01	modified from IRIS 1993		none selected		7.30E-02	Kalberlah et al 1995 (TEF=0.01) & IRIS 1992
Fluorene	86737	4.00E-02	IRIS 1990		4.0E-01	modified from IRIS 1990		none selected			Kalberlah et al 1995 (TEF=0) & IRIS 1992
Heptachlor	76448	3.00E-05	CalEPA chRD 2005	D		none selected		none selected		4.10E+00	CalEPA DW 1999
Heptachlor Epoxide	1024573		none selected			none selected		none selected		5.50E+00	CalEPA DW 1999
Hexachlorobenzene	118741	3.00E-05	modified from ATSDR (int) 2002		1.0E-04	ATSDR 2002		none selected		1.19E+00	CalEPA DW 2003
Hexachlorobutadiene	87683	3.40E-04	HC PSL2 2000			none selected		none selected		7.80E-02	IRIS 1991
Hexachlorocyclohexane Gamma-	58899	1.20E-05	CalEPA DW 1999			none selected		none selected			none selected
Hexachloroethane	67721	1.00E-03	IRIS 1991		1.0E-02	ATSDR 1997		none selected		1.40E-02	IRIS 1994
Hexane (n)	11053		none selected			none selected	2.50E+00	MOE 24-h AAQC 2005			none selected
Indeno[1 2 3-cd]pyrene	193395		none selected			none selected		none selected		7.30E-01	Kalberlah et al 1995 (TEF=0.1) & IRIS 1992
Lead	7439921		none selected			none selected		none selected			none selected
Mercury	7439976	3.00E-04	IRIS 1995		3.0E-03	modified from IRIS 1995	9.00E-05	CalEPA ChREL 2000			none selected
Methoxychlor	72435	2.00E-05	CalEPA chRD 2005	D		none selected		none selected			none selected
Methyl Ethyl Ketone	78933	6.00E-01	IRIS 2003	D		none selected	5.00E+00	IRIS 2003	D		none selected
Methyl Isobutyl Ketone	108101	1.00E+00	modified from IRIS 2003	D		none selected	3.00E+00	IRIS 2003	D		none selected
Methyl Mercury **	22967926	1.00E-04	IRIS 2001	D		none selected		none selected			none selected
Methyl tert-Butyl Ether (MTBE)	1634044	3.00E-02	modified from HC 1996		3.0E-01	ATSDR 1996; modified from HC 1996	3.00E+00	IRIS 1993		1.80E-03	CalEPA DW 1999; CalEPA ATH 2005
Methylene Chloride	75092	6.00E-02	IRIS 1988; ATSDR 2000; RIVM 2001			none selected	4.00E-01	CalEPA chREL 2000		7.50E-03	IRIS 1995
Methlynaphthalene, 2-(1-) ***	91576	4.00E-03	IRIS 2003			none selected		none selected			Kalberlah et al 1995 (no TEF) & IRIS 1992
Molybdenum	7439987	5.00E-03	IRIS 1993			none selected	1.20E-02	RIVM 2001			none selected

CHEMICAL NAME	CAS RN (Chemical Abstracts Service Registry Number)	Oral Chronic TRV (mg/kg-day)	Ref.	Is the oral chronic non-cancer TRV based on reproductive or developmental effects?	Oral Sub-chronic TRV (mg/kg-day)	Ref.	Inhalation Chronic TRV (mg/m^3)	Ref.	Is the inhalation chronic non-cancer TRV based on reproductive or developmental effects?	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Ref.
Naphthalene	91203	2.00E-02	IRIS 1998		2.0E-01	modified from IRIS 1998	3.70E-03	ATSDR 2005			Kalberlah et al 1995 (no TEF) & IRIS 1992
Nickel	7440020	2.00E-02	IRIS 1996			none selected	6.00E-05	modified from TERA 1999			none selected
Pentachlorophenol	87865	1.00E-03	ATSDR 2001	D	1.00E-03	ATSDR 2001		none selected		1.20E-01	IRIS 1993
Petroleum Hydrocarbons F1****	PHCF1										
Aliphatic C6-C8	PHCAL0608	5.00E+00	TPHCWG 1997; CCME 2000			none selected	1.84E+01	TPHCWG 1997; CCME 2000			none selected
Aliphatic C>8-C10	PHCAL0810	1.00E-01	TPHCWG 1997; CCME 2000		1.00E+00	modified from TPHCWG 1997 & CCME 2000.	1.00E+00	TPHCWG 1997; CCME 2000			none selected
Aromatic C>8-C10	PHCAR0810	4.00E-02	TPHCWG 1997; CCME 2000			none selected	2.00E-01	TPHCWG 1997; CCME 2000			none selected
Petroleum Hydrocarbons F2	PHCF2							0			
Aliphatic C>10-C12	PHCAL1012	1.00E-01	TPHCWG 1997; CCME 2000		1.00E+00	modified from TPHCWG 1997 & CCME 2000.	1.00E+00	TPHCWG 1997; CCME 2000			none selected
Aliphatic C>12-C16	PHCAL1216	1.00E-01	TPHCWG 1997; CCME 2000		1.00E+00	modified from TPHCWG 1997 & CCME 2000.	1.00E+00	TPHCWG 1997; CCME 2000			none selected
Aromatic C>10-C12	PHCAR1012	4.00E-02	TPHCWG 1997; CCME 2000			none selected	2.00E-01	TPHCWG 1997; CCME 2000			none selected
Aromatic C>12-C16	PHCAR1216	4.00E-02	TPHCWG 1997; CCME 2000			none selected	2.00E-01	TPHCWG 1997; CCME 2000			none selected
Petroleum Hydrocarbons F3	PHCF3										
Aliphatic C>16-C21	PHCAL1621	2.00E+00	TPHCWG 1997; CCME 2000			none selected		none selected			none selected
Aliphatic C>21-C34	PHCAL2134	2.00E+00	TPHCWG 1997; CCME 2000			none selected		none selected			none selected
Aromatic C>16-C21	PHCAR1621	3.00E-02	TPHCWG 1997; CCME 2000		3.00E-01	modified from TPHCWG 1997 & CCME 2000.		none selected			none selected
Aromatic C>21-C34	PHCAR2134	3.00E-02	TPHCWG 1997; CCME 2000		3.00E-01	modified from TPHCWG 1997 & CCME 2000.		none selected			none selected
Petroleum Hydrocarbons F4	PHCF4										
Aliphatic C>34	PHCAL3499	2.00E+01	TPHCWG 1997; CCME 2000			*none selected*		none selected			*none selected*
Aromatic C>34	PHCAR3499	3.00E-02	TPHCWG 1997; CCME 2000		3.0E-01	*modified from TPHCWG 1997 & CCME 2000.*		none selected			*none selected*
Phenanthrene	85018		none selected			none selected		none selected			Kalberlah et al 1995 (TEF=0) & IRIS 1992
Phenol	108952	3.00E-01	IRIS 2002		3.00E-01	IRIS 2002	3.00E-02	MOE 24-h AAQC 2004			none selected
Polychlorinated Biphenyls	1336363	2.00E-05	ATSDR 2000; WHO CICAD 2003		3.0E-05	ATSDR 2000	5.00E-04	RIVM 2001			IRIS 1997; CalEPA DW 2007; CalEPA ATH 1999; 2005.
Pyrene	129000	3.00E-02	IRIS 1993		3.0E-01	modified from IRIS 1993		none selected		7.30E-03	Kalberlah et al 1995 (TEF=0.001) & IRIS 1992
Selenium	7782492	5.00E-03	IRIS 1991; CalEPA ChREL 2001			none selected		none selected			none selected
Silver	7440224	5.00E-03	IRIS 1996			none selected		none selected			none selected
Styrene	100425	1.20E-01	RIVM 2001; HC PSL1 1993; HC 1996			none selected	2.60E-01	modified from WHO Air 2000			none selected
Tetrachloroethane, 1,1,1,2-	630206	3.00E-02	IRIS 1996			none selected		none selected		2.60E-02	IRIS 1991

CHEMICAL NAME	CAS RN (Chemical Abstracts Service Registry Number)	Oral Chronic TRV (mg/kg-day)	Ref.	Is the oral chronic non-cancer TRV based on reproductive or developmental effects?	Oral Sub-chronic TRV (mg/kg-day)	Ref.	Inhalation Chronic TRV (mg/m^3)	Ref.	Is the inhalation chronic non-cancer TRV based on reproductive or developmental effects?	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Ref.
Tetrachloroethane, 1,1,2,2-	79345	1.00E-02	US EPA HESD (Sept. 2006 draft)		5.00E-01	ATSDR (Sept. 2006 draft)		none selected		2.00E-01	IRIS 1994
Tetrachloroethylene	127184	1.40E-02	HC 1996; WHO DW 2003		1.4E-01	modifed from HC 1996 & from WHO DW 2003	2.50E-01	WHO Air 2000			none selected
Thallium	7440280	1.35E-05	CalEPA DW 1999		1.4E-04	modified from CalEPA DW 1999		none selected			none selected
Toluene	108883	8.00E-02	IRIS 2005		8.0E-01	modified from IRIS 2005	5.00E+00	IRIS 2005			none selected
Trichlorobenzene, 1,2,4-	120821	1.00E-02	IRIS 1996		1.0E-01	modified from IRIS 1996	8.00E-03	modified from WHO EHC 1991			none selected
Trichloroethane, 1,1,1-	71556	2.00E+00	IRIS 2007		7.0E+00	IRIS 2007	1	CalEPA chREL 2000			none selected
Trichloroethane, 1,1,2-	79005	4.00E-03	IRIS 1995		4.0E-02	modified from IRIS 1995		none selected		5.70E-02	IRIS 1994
Trichloroethylene	79016	1.46E-03	HC DWQ 2005	D		none selected	4.00E-02	USEPA NCEA (Aug 2001 draft)		1.30E-02	CalEPA DW 1999
Trichlorofluoromethane	75694	3.00E-01	IRIS 1992			none selected		none selected			none selected
Trichlorophenol, 2,4,5-	95954	3.00E-03	RIVM 2001		3.0E-03	ATSDR 1999		none selected			none selected
Trichlorophenol, 2,4,6-	88062	3.00E-03	RIVM 2001		3.0E-03	ATSDR 1999		none selected		1.10E-02	IRIS 1994
Uranium	7440611	6.00E-04	HC DWQ 1999		6.00E-04	HC DWQ 1999	3.00E-04	ATSDR 1999			none selected
Vanadium	7440622	2.10E-03	CalEPA DW 2000	D	2.1E-03	CalEPA DW 2000	1.00E-03	WHO Air 2000			none selected
Vinyl Chloride	75014	3.00E-03	ATSDR 2006; IRIS 2000			none selected	1.00E-01	IRIS 2000		1.40E+00	IRIS 2000
Xylene Mixture	1330207	2.00E-01	IRIS 2003; ATSDR 2007		4.0E-01	ATSDR 2007	7.00E-01	CalEPA chREL 2005			none selected
Zinc	7440666	3.00E-01	IRIS 2005			none selected		none selected			none selected
Electrical Conductivity (mS/cm)	EC										
Chloride	16887006										
Sodium Adsorption Ratio	SAR										
Sodium	7440235										

CHEMICAL NAME	Inhalation Unit Risk $(mg/m^3)^{-1}$	Ref.	subchronic inhal TRV (mg/m3)	basis	SOIL		WATER		Ref.	EPA Class	Date Withdrawn	Last Update	Soil Allocation Factor
					GI Absorption Factor	Dermal Absorption Factor	GI Absorption Factor	Dermal Absorption Factor					
Acenaphthene	1.10E-03	Kalberlah et al 1995 (TEF=0.001) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		DSF			0.20
Acenaphthylene	1.10E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993			1.00	0.13	0.91	1.00		NA			0.20
Acetone		none selected			1.00	0.03	1.00	1.00		Da			0.20
Aldrin		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Anthracene		Kalberlah et al 1995 (no TEF) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		Da			0.20
Antimony		none selected			1.00	0.10	1.00	1.00		NA			0.20
Arsenic	1.50E+00	WHO Air 2000			0.50	0.03	1.00	1.00		Aa	01/98		0.20
Barium		none selected			1.00	0.10	1.00	1.00		Da			0.20
Benzene	2.20E-03	IRIS 2000			1.00	0.03	1.00	1.00		Aa			0.20
Benz[a]anthracene	1.10E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		B2a			0.20
Benzo[a]pyrene	1.10E+00	Kalberlah et al 1995 (TEF=1) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		B2a			0.20
Benzo[b]fluoranthene	1.10E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		B2a			0.20
Benzo[ghi]perylene	1.10E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		Da			0.20
Benzo[k]fluoranthene	1.10E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		B2a			0.20
Beryllium	2.40E+00	IRIS 1998; CalEPA ATH 2005; WHO CICAD 2001			1.00	0.10	1.00	1.00		B1a	4/98		0.20
Biphenyl 1,1'-		none selected			1.00	0.10	1.00	1.00		Da			0.20
Bis(2-chloroethyl)ether		none selected			1.00	0.03	1.00	1.00		B2			0.20
Bis(2-chloroisopropyl)ether		none selected			1.00	0.03	1.00	1.00		NA			0.20
Bis(2-ethylhexyl)phthalate		none selected			1.00	0.10	1.00	1.00		B2a	7/97		0.20
Boron (Hot Water Soluble)*													
Boron (total)		none selected			1.00	0.01	1.00	1.00		NA	01/98		0.20
Bromodichloromethane		none selected			1.00	0.03	1.00	1.00		B2a			0.20
Bromoform	1.10E-03	IRIS 1991			1.00	0.03	1.00	1.00		B2a			0.20
Bromomethane		none selected			1.00	0.03	1.00	1.00		Da			0.20
Cadmium	9.80E+00	Health Canada 1996			1.00	0.01	1.00	1.00		B1a	7/97		0.20
Carbon Tetrachloride		none selected			1.00	0.03	1.00	1.00		B2a			0.20
Chlordane	1.00E-01	IRIS 1998			1.00	0.04	1.00	1.00		B2a			0.20
Chloroaniline p-		none selected			1.00	0.10	1.00	1.00		NA			0.20
Chlorobenzene		none selected			1.00	0.03	1.00	1.00		Da	01/98		0.20
Chloroform	5.30E-03	CalEPA ATH 2005			1.00	0.03	1.00	1.00		B1a	01/10/02		0.20
Chlorophenol, 2-		none selected			1.00	0.03	1.00	1.00		NA			0.20

CHEMICAL NAME	Inhalation Unit Risk $(mg/m^3)^{-1}$	Ref.	subchronic inhal TRV (mg/m3)	basis	SOIL		WATER		Ref.	EPA Class	Date Withdrawn	Last Update	Soil Allocation Factor
					GI Absorption Factor	Dermal Absorption Factor	GI Absorption Factor	Dermal Absorption Factor					
Chromium Total		none selected			1.00	0.10	1.00	1.00		Da			0.20
Chromium VI	4.00E+01	WHO Air 2000			1.00	0.10	1.00	1.00		Aa			0.20
Chrysene	1.10E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		B2a			0.20
Cobalt		none selected			1.00	0.01	1.00	1.00		NA			0.20
Copper		none selected			1.00	0.06	1.00	1.00		Da			0.20
Cyanide (CN`)		none selected			1.00	0.10	1.00	1.00		Da			0.20
Dibenz[a h]anthracene	1.10E+00	Kalberlah et al 1995 (TEF=1) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		B2a			0.20
Dibromochloromethane		none selected			1.00	0.03	1.00	1.00		Ca			0.20
Dichlorobenzene, 1,2-		none selected			1.00	0.03	1.00	1.00		Da	9/95		0.20
Dichlorobenzene, 1,3-		none selected			1.00	0.03	1.00	1.00		Da			0.20
Dichlorobenzene, 1,4-	4.00E-03	IRIS (May 2006 draft)	1.20E+00	ATSDR 2006	1.00	0.03	1.00	1.00		Cb			0.20
Dichlorobenzidine, 3,3'-		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Dichlorodifluoromethane		none selected			1.00	0.03	1.00	1.00					0.20
DDD		none selected			1.00	0.03	1.00	1.00					0.20
DDE		none selected			1.00	0.03	1.00	1.00					0.20
DDT		none selected			1.00	0.03	1.00	1.00					0.20
Dichloroethane, 1,1-		none selected			1.00	0.03	1.00	1.00		Ca		provisional	0.20
Dichloroethane, 1,2-	2.60E-02	IRIS 1991			1.00	0.03	1.00	1.00		B2a	01/98		0.20
Dichloroethylene, 1,1-		none selected	7.93E-02	ATSDR 1994	1.00	0.03	1.00	1.00		Ca	02/08/02	08/2002	0.20
Dichloroethylene, 1,2-cis-		none selected			1.00	0.03	1.00	1.00		Da			0.20
Dichloroethylene, 1,2-trans-		none selected	7.93E-01	ATSDR 1996	1.00	0.03	1.00	1.00		NA			0.20
Dichlorophenol, 2,4-		none selected			1.00	0.03	1.00	1.00		NA			0.20
Dichloropropane, 1,2-		none selected	1.30E-02	mod from IRIS 1991	1.00	0.03	1.00	1.00		B2b			0.20
Dichloropropene,1,3-	4.00E-03	IRIS 2000	3.60E-02	ATSDR int (Sep. 2006 draft)	1.00	0.03	1.00	1.00		B2a		06/2000	0.20
Dieldrin		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Diethyl Phthalate		none selected			1.00	0.10	1.00	1.00		Da			0.20
Dimethylphthalate		none selected			1.00	0.10	1.00	1.00		Da	11/94		0.20
Dimethylphenol, 2,4-		none selected			1.00	0.03	1.00	1.00		NA			0.20
Dinitrophenol, 2,4-		none selected			1.00	0.10	1.00	1.00		NA			0.20
Dinitrotoluene, 2,4 & 2,6-		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Dioxane, 1,4		none selected			1.00	0.03	1.00	1.00		B2		01/09/90	0.20
Dioxin/Furan (TEQ)		none selected			1.00	0.03	1.00	1.00					0.20
Endosulfan		none selected			1.00	0.10	1.00	1.00		NA			0.20
Endrin		none selected			1.00	0.10	1.00	1.00		Da			0.20

CHEMICAL NAME	Inhalation Unit Risk $(mg/m^3)^{-1}$	Ref.	subchronic inhal TRV (mg/m3)	basis	SOIL		WATER		Ref.	EPA Class	Date Withdrawn	Last Update	Soil Allocation Factor
					GI Absorption Factor	Dermal Absorption Factor	GI Absorption Factor	Dermal Absorption Factor					
Ethylbenzene		none selected	1.00E+00	IRIS 1991 ch NC. Chronic TRV is based on developmental effects, thus SDF should not be applied.	1.00	0.03	1.00	1.00		Da			0.20
Ethylene dibromide	6.00E-01	IRIS 2004			1.00	0.03	1.00	1.00		B2a			0.20
Fluoranthene	1.10E-02	Kalberlah et al 1995 (TEF=0.01) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		Da			0.20
Fluorene		Kalberlah et al 1995 (TEF=0) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		Da			0.20
Heptachlor		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Heptachlor Epoxide		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Hexachlorobenzene		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Hexachlorobutadiene	2.20E-02	IRIS 1991			1.00	0.03	1.00	1.00		Ca			0.20
Hexachlorocyclohexane Gamma-		none selected			1.00	0.04	1.00	1.00		B2b			0.20
Hexachloroethane	4.00E-03	IRIS 1994			1.00	0.03	1.00	1.00		Ca			0.20
Hexane (n)		none selected			1.00	1.00	1.00	1.00					0.20
Indeno[1 2 3-cd]pyrene	1.10E-01	Kalberlah et al 1995 (TEF=0.1) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		B2a			0.20
Lead		none selected			1.00	1.00	1.00	1.00		B2a			0.20
Mercury		none selected		no subchronic inhalation TRV available	0.50	0.10	1.00	1.00		Da			0.20
Methoxychlor		none selected			1.00	0.10	1.00	1.00		Da			0.20
Methyl Ethyl Ketone		none selected	5.00E+00	IRIS 2003 ch NC. Chronic TRV is based on developmental effects, thus SDF should not be applied.	1.00	0.03	1.00	1.00		Da			0.20
Methyl Isobutyl Ketone		none selected	3.00E+00	IRIS 2003 ch NC. Chronic TRV is based on developmental effects, thus SDF should not be applied.	1.00	0.03	1.00	1.00		NA	15/06/05		0.20
Methyl Mercury **		none selected			1.00	0.06	1.00	1.00		Ca			0.20
Methyl tert-Butyl Ether (MTBE)	2.60E-04	CalEPA DW 1999; CalEPA ATH 2005	2.50E+00	ATSDR int 1996	1.00	0.03	1.00	1.00		NA			0.20
Methylene Chloride	2.30E-05	HC 1996	4.00E-01	CalEPA chREL 2000. Since exposure duration for ch NC TRV is not necessarily long-term, SDF should not be applied.	1.00	0.03	1.00	1.00		B2a			0.20
Methlynaphthalene, 2-(1-) ***		Kalberlah et al 1995 (no TEF) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00					0.20
Molybdenum		none selected			1.00	0.01	1.00	1.00		NA			0.20

CHEMICAL NAME	Inhalation Unit Risk $(mg/m^3)^{-1}$	Ref.	subchronic inhal TRV (mg/m3)	basis	SOIL		WATER		Ref.	EPA Class	Date Withdrawn	Last Update	Soil Allocation Factor
					GI Absorption Factor	Dermal Absorption Factor	GI Absorption Factor	Dermal Absorption Factor					
Naphthalene		Kalberlah et al 1995 (no TEF) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		Ca			0.20
Nickel	2.40E-01	IRIS 1991			1.00	0.20	1.00	1.00		NA			0.20
Pentachlorophenol		none selected			1.00	0.25	1.00	1.00		B2a			0.20
Petroleum Hydrocarbons F1****					1.00	0.20	1.00	1.00					0.50
Aliphatic C6-C8		none selected			1.00	0.20	1.00	1.00					0.50
Aliphatic C>8-C10		none selected			1.00	0.20	1.00	1.00					0.50
Aromatic C>8-C10		none selected			1.00	0.20	1.00	1.00					0.50
Petroleum Hydrocarbons F2					1.00	0.20	1.00	1.00					0.50
Aliphatic C>10-C12		none selected			1.00	0.20	1.00	1.00					0.50
Aliphatic C>12-C16		none selected			1.00	0.20	1.00	1.00					0.50
Aromatic C>10-C12		none selected			1.00	0.20	1.00	1.00					0.50
Aromatic C>12-C16		none selected			1.00	0.20	1.00	1.00					0.50
Petroleum Hydrocarbons F3					1.00	0.20	1.00	1.00					0.50
Aliphatic C>16-C21		none selected			1.00	0.20	1.00	1.00					0.50
Aliphatic C>21-C34		none selected			1.00	0.20	1.00	1.00					0.50
Aromatic C>16-C21		none selected			1.00	0.20	1.00	1.00					0.50
Aromatic C>21-C34		none selected			1.00	0.20	1.00	1.00					0.50
Petroleum Hydrocarbons F4					1.00	0.20	1.00	1.00					0.50
Aliphatic C>34		*none selected*			1.00	0.20	1.00	1.00					0.50
Aromatic C>34		*none selected*			1.00	0.20	1.00	1.00					0.50
Phenanthrene		Kalberlah et al 1995 (TEF=0) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		Da			0.20
Phenol		none selected			1.00	0.13	1.00	1.00		Da			0.20
Polychlorinated Biphenyls	1.00E-01	IRIS 1997			1.00	0.14	1.00	1.00		B2a			0.20
Pyrene	1.10E-03	Kalberlah et al 1995 (TEF=0.001) & CalEPA ATH 2005/1993			1.00	0.13	1.00	1.00		Da			0.20
Selenium		none selected			1.00	0.01	1.00	1.00		Da			0.20
Silver		none selected			1.00	0.25	1.00	1.00		Da			0.20
Styrene		none selected			1.00	0.03	1.00	1.00		NAe			0.20
Tetrachloroethane, 1,1,1,2-	7.40E-03	IRIS 1991		No chronic or subchronic inhalation TRVs were selected.	1.00	0.03	1.00	0.80		C			0.20

CHEMICAL NAME	Inhalation Unit Risk $(mg/m^3)^{-1}$	Ref.	subchronic inhal TRV (mg/m3)	basis	SOIL		WATER		Ref.	EPA Class	Date Withdrawn	Last Update	Soil Allocation Factor
					GI Absorption Factor	Dermal Absorption Factor	GI Absorption Factor	Dermal Absorption Factor					
Tetrachloroethane, 1,1,2,2-	5.80E-02	IRIS 1994		No chronic or subchronic inhalation TRVs were selected.	1.00	0.03	1.00	1.00		Ca			0.20
Tetrachloroethylene		none selected	1.36E+00	ATSDR 1997	1.00	0.03	1.00	1.00		NAe		provisional	0.20
Thallium		none selected			1.00	0.01	1.00	1.00		NA			0.20
Toluene		none selected	5.00E+00	IRIS 2005 ch NC. Short-term & long-term effects are in same range (IRIS 2005), thus SDF should not be applied.	1.00	0.03	1.00	1.00		Da			0.20
Trichlorobenzene, 1,2,4-		none selected			1.00	0.03	1.00	1.00		Da			0.20
Trichloroethane, 1,1,1-		none selected	3.82E+00	ATSDR 2006	1.00	0.03	1.00	1.00		Da	9/93	provisional	0.20
Trichloroethane, 1,1,2-	1.60E-02	IRIS 1994			1.00	0.03	1.00	1.00		Ca			0.20
Trichloroethylene	2.00E-03	CalEPA ATH 2005			1.00	0.03	1.00	1.00		NAe	9/94	provisional	0.20
Trichlorofluoromethane		none selected			1.00	0.03	1.00	1.00					0.20
Trichlorophenol, 2,4,5-		none selected			1.00	0.10	1.00	1.00		NA			0.20
Trichlorophenol, 2,4,6-		none selected			1.00	0.10	1.00	1.00		B2a			0.20
Uranium		none selected			1.00	0.10	1.00	1.00					0.20
Vanadium		none selected			1.00	0.10	1.00	1.00		NA			0.20
Vinyl Chloride	8.80E-03	IRIS 2000			1.00	0.03	1.00	1.00		Ab		08/2000	0.20
Xylene Mixture		none selected	2.60E+00	ATSDR int 2007	1.00	0.03	1.00	1.00		Da			0.20
Zinc		none selected			1.00	0.10	1.00	1.00		Da			0.20
Electrical Conductivity (mS/cm)													0.20
Chloride													0.20
Sodium Adsorption Ratio													0.20
Sodium													0.20

CHEMICAL NAME	Soil MOE-LSB Reporting Limit (RL) (mg/kg)	Soil MASS. PQL (mg/kg)	OTR98 Value Rural mg/kg	OTR98 Value Urban mg/kg	Water MOE-LSB Reporting Limit (RL) (ug/L)	Water MASS PDL (ug/L)	Water MOE Reg 153/04 RL (ug/L)	Ontario Drinking Water Standard or Substitute (mg/L)	Ref.	Odour Threshold in Air (mg/m^3)	Basis	Log of Octanol-Water Partition Coef.	Molecular Weight (g/mol)	Vapour Pressure (mm Hg)	Organic carbon partition coefficient, K_{oc} (cm^3/g)
Acenaphthene	5.00E-02	6.60E-01	6.00E-03	3.20E-02	1.00E+00	1.00E+01	1.00E+00			0.50	ATSDR (1995)	3.92E+00	1.54E+02	2.50E-03	6123
Acenaphthylene	5.00E-02	6.60E-01	9.30E-02	4.70E-02	1.00E+00	3.18E-01	1.00E+00					3.94E+00	1.52E+02	9.12E-04	6123
Acetone	5.00E-01	5.00E-03			3.00E+01	5.00E+00	3.00E+01			150.00	AIHA	-2.40E-01	5.81E+01	2.31E+02	1.981
Aldrin	5.00E-02	7.00E-03	1.00E-03	1.00E-03	1.00E-02	2.39E-01	1.00E-02	3.50E-04	ODWQS	0.26	MDEP	6.50E+00	3.65E+02	1.20E-04	106000
Anthracene	5.00E-02	6.60E-01	6.00E-03	5.80E-02	1.00E-01	3.18E-01	1.00E-01					4.45E+00	1.78E+02	2.67E-06	20400
Antimony	1.00E+00		4.45E-01	9.87E-01	5.00E-01	3.00E+00	5.00E-01	6.00E-03	ODWQS				1.25E+02	0.00E+00	0
Arsenic	1.00E+00		1.10E+01	1.77E+01	1.00E+00	1.00E+00	1.00E+00	2.50E-02	ODWQS				7.80E+01	1.01E+04	0
Barium	5.00E+00		1.70E+02	1.79E+02	2.00E+00	2.00E+00	2.00E+00	1.00E+00	ODWQS				1.37E+02	0.00E+00	0
Benzene	2.00E-02	5.00E-03	5.00E-03	6.00E-03	5.00E-01	1.27E-01	5.00E-01	5.00E-03	ODWQS	195.00	AIHA	2.13E+00	7.81E+01	9.48E+01	165.5
Benz[a]anthracene	5.00E-02	6.60E-01	4.90E-02	3.60E-01	2.00E-01	6.36E-01	2.00E-01	1.00E-03	Modified BaP			5.76E+00	2.28E+02	1.90E-06	231000
Benzo[a]pyrene	5.00E-02	6.60E-01	3.90E-02	3.00E-01	1.00E-02	3.18E-01	1.00E-02	1.00E-05	ODWQS			6.13E+00	2.52E+02	5.49E-09	787000
Benzo[b]fluoranthene	5.00E-02	6.60E-01	1.50E-01	3.00E-01	1.00E-01	1.00E+01	1.00E-01	1.00E-04	Modified BaP			5.78E+00	2.52E+02	5.00E-07	803000
Benzo[ghi]perylene	1.00E-01	6.60E-01	8.10E-02	2.80E-01	2.00E-01	3.18E-01	2.00E-01	1.00E-03	Modified BaP			6.63E+00	2.76E+02	1.00E-10	2680000
Benzo[k]fluoranthene	5.00E-02	6.60E-01	6.00E-03	2.60E-01	1.00E-01	9.54E-01	1.00E-01	1.00E-04	Modified BaP			6.11E+00	2.52E+02	9.65E-10	787000
Beryllium	2.00E+00		2.50E+00	2.50E+00	5.00E-01	3.00E-01	5.00E-01	4.00E-03	USEPA				9.01E+00	2.59E-20	0
Biphenyl 1,1'-	5.00E-02				5.00E-01		5.00E-01			0.01	Amoore - Hautala	3.98E+00	1.54E+02	8.93E-03	6250
Bis(2-chloroethyl)ether	5.00E-01	6.60E-01			5.00E+00	1.00E+01	5.00E+00			0.29	MDEP	1.29E+00	1.43E+02	1.55E+00	14.95
Bis(2-chloroisopropyl)ether	5.00E-01	6.60E-01			4.00E+00	1.00E+01	4.00E+00			2.24	MDEP	3.73E+00	1.71E+02	1.26E+01	21.4
Bis(2-ethylhexyl)phthalate	5.00E+00	6.60E-01			1.00E+01	2.54E+00	1.00E+01	6.00E-03	USEPA			7.60E+00	3.91E+02	1.42E-07	165000
Boron (Hot Water Soluble)*	5.00E-01														0
Boron (total)	5.00E+00				1.00E+01		1.00E+01	5.00E+00	ODWQS				1.38E+01	1.24E-07	14.3
Bromodichloromethane	5.00E-02	5.00E-03			2.00E+00	2.54E-01	2.00E+00	1.60E-02	CDWQS			2.00E+00	1.64E+02	5.74E+01	35.04
Bromoform	5.00E-02	5.00E-03	2.70E-04	1.60E-04	5.00E+00	3.82E-01	5.00E+00	2.50E-02	ODWQS	13.00	Amoore - Hautala	2.40E+00	2.53E+02	5.40E+00	35.04
Bromomethane	5.00E-02	5.00E-03	1.10E-03	1.20E-03	5.00E-01	3.50E-01	5.00E-01			80.00	MDEP	1.19E+00	9.49E+01	1.62E+03	14.3
Cadmium	1.00E+00		6.95E-01	1.20E+00	5.00E-01	1.00E-01	5.00E-01	5.00E-03	ODWQS				1.12E+02	8.98E-18	0
Carbon Tetrachloride	5.00E-02	5.00E-03	1.50E-04	1.50E-04	2.00E-01	6.67E-01	2.00E-01	5.00E-03	ODWQS	1500.00	AIHA	2.83E+00	1.54E+02	1.15E+02	48.64
Chlordane	5.00E-02	7.00E-01	2.00E-03	2.00E-03	6.00E-02	6.36E-01	6.00E-02	7.00E-03	ODWQS	0.01	MDEP	6.22E+00	4.10E+02	9.98E-06	86700
Chloroaniline p-	5.00E-01	1.30E+00			1.00E+01	2.00E+01	1.00E+01					1.83E+00	1.28E+02	2.70E-02	72.53
Chlorobenzene	5.00E-02	5.00E-03	8.10E-05	6.30E-05	5.00E-01	1.27E-01	5.00E-01	3.00E-02	ODWQAO	5.90	AIHA	2.84E+00	1.13E+02	1.20E+01	268
Chloroform	5.00E-02	5.00E-03	2.20E-03	2.70E-03	1.00E+00	9.54E-02	1.00E+00	2.50E-02	ODWQS	960.00	AIHA	1.97E+00	1.19E+02	1.97E+02	35.04
Chlorophenol, 2-	1.00E-01	6.60E-01	1.40E-02	1.40E-02	2.00E+00	1.00E+01	2.00E+00					2.15E+00	1.29E+02	2.53E+00	443.1

CHEMICAL NAME	Soil MOE-LSB Reporting Limit (RL) (mg/kg)	Soil MASS. PQL (mg/kg)	OTR98 Value Rural mg/kg	OTR98 Value Urban mg/kg	Water MOE-LSB Reporting Limit (RL) (ug/L)	Water MASS PDL (ug/L)	Water MOE Reg 153/04 RL (ug/L)	Ontario Drinking Water Standard or Substitute (mg/L)	Ref.	Odour Threshold in Air (mg/m^3)	Basis	Log of Octanol-Water Partition Coef.	Molecular Weight (g/mol)	Vapour Pressure (mm Hg)	Organic carbon partition coefficient, K_{oc} (cm^3/g)
Chromium Total	5.00E+00		5.82E+01	6.28E+01	1.00E+01	1.00E+00	1.00E+01	5.00E-02	ODWQS						0
Chromium VI	2.00E-01		5.00E-01	5.00E-01	1.00E+01	1.00E+00	1.00E+01								0
Chrysene	5.00E-02	6.60E-01	9.90E-02	9.40E-01	1.00E-01	9.54E-01	1.00E-01	1.00E-04	Modified BaP			5.81E+00	2.28E+02	6.23E-09	236000
Cobalt	2.00E+00		1.63E+01	1.72E+01	1.00E+00		1.00E+00						5.89E+01	0.00E+00	0
Copper	5.00E+00		4.57E+01	6.55E+01	5.00E+00		5.00E+00	1.00E+00	CDWQS				6.36E+01	0.00E+00	0
Cyanide (CN`)	5.00E-02		5.10E-02	2.00E-02	5.00E+00	5.00E+01	5.00E+00	2.00E-01	ODWQS				2.70E+01	7.42E+02	17
Dibenz[a h]anthracene	1.00E-01	6.60E-01	5.20E-02	7.70E-02	2.00E-01	3.18E-01	2.00E-01	1.00E-05	Modified BaP			6.54E+00	2.78E+02	1.39E-11	2620000
Dibromochloromethane	5.00E-02		1.90E-04	2.30E-04	2.00E+00		2.00E+00	2.50E-02	ODWQS			2.16E+00	2.08E+02	1.56E+01	35.04
Dichlorobenzene, 1,2-	5.00E-02	6.60E-01	3.00E-06	3.00E-06	5.00E-01	9.54E-02	5.00E-01	3.00E-03	ODWQAO	4.20	AIHA	3.43E+00	1.47E+02	1.47E+00	443.1
Dichlorobenzene, 1,3-	5.00E-02	6.60E-01	3.00E-06	3.00E-06	5.00E-01	3.82E-01	5.00E-01					3.53E+00	1.47E+02	2.15E+00	434
Dichlorobenzene, 1,4-	5.00E-02	6.60E-01	7.20E-04	1.10E-03	5.00E-01	9.54E-02	5.00E-01	1.00E-03	ODWQAO	0.73	AIHA	3.44E+00	1.47E+02	1.74E+00	434
Dichlorobenzidine, 3,3'-	1.00E+00	1.30E+00			5.00E-01	2.00E+01	5.00E-01					3.51E+00	2.53E+02	4.16E-06	7489
Dichlorodifluoromethane	5.00E-02				2.00E+00	2.00E+00	2.00E+00					2.16E+00	1.21E+02	4.85E+03	48.64
DDD	5.00E-02	1.30E-02			5.00E-02	7.95E-03	5.00E-02	1.00E-02	ODWQG			6.02E+00	3.20E+02	1.35E-06	153000
DDE	5.00E-02	8.00E-03			1.00E-02	3.18E-02	1.00E-02	1.00E-02	ODWQG			6.51E+00	3.18E+02	6.00E-06	153000
DDT	5.00E-02	1.10E-02	7.80E-02	1.40E+00	5.00E-02	1.91E-01	5.00E-02	1.00E-02	ODWQG			6.91E+00	3.54E+02	1.60E-07	220000
Dichloroethane, 1,1-	5.00E-02	5.00E-03	2.10E-06	2.00E-06	5.00E-01	1.27E-01	5.00E-01	5.00E-03	Cal EPA	125.00	MDEP	1.79E+00	9.90E+01	2.27E+02	35.04
Dichloroethane, 1,2-	5.00E-02	5.00E-03	7.50E-05	1.50E-05	5.00E-01	1.91E-01	5.00E-01	5.00E-03	ODWQS	110.00	AIHA	1.48E+00	9.90E+01	7.89E+01	43.79
Dichloroethylene, 1,1-	5.00E-02	5.00E-03	9.70E-05	7.40E-05	5.00E-01	3.82E-01	5.00E-01	1.40E-02	ODWQS	760.00	Amoore - Hautala	2.13E+00	9.69E+01	6.34E+02	35.04
Dichloroethylene, 1,2-cis-	5.00E-02	5.00E-03			5.00E-01	3.82E-01	5.00E-01	7.00E-02	USEPA			2.09E+00	9.69E+01	2.01E+02	43.79
Dichloroethylene, 1,2-trans-	5.00E-02	5.00E-03	3.00E-06	5.40E-06	5.00E-01	1.91E-01	5.00E-01	1.00E-01	USEPA	67.00	Amoore - Hautala	2.09E+00	9.69E+01	2.01E+02	43.79
Dichlorophenol, 2,4-	1.00E-01	6.60E-01	1.40E-02	1.40E-02	2.00E+01	1.00E+01	2.00E+01	3.00E-04	ODWQAO			3.06E+00	1.63E+02	1.16E-01	717.6
Dichloropropane, 1,2-	5.00E-02	5.00E-03	3.00E-06	5.20E-06	5.00E-01	1.27E-01	5.00E-01	5.00E-03	USEPA	1.20	AIHA	1.98E+00	1.13E+02	5.33E+01	67.7
Dichloropropene,1,3-	5.00E-02	5.00E-03	3.00E-06	3.00E-06	5.00E-01		5.00E-01	5.00E-04	Cal EPA	4.61	MDEP	2.03E+00	1.11E+02	3.40E+01	80.77
Dieldrin	5.00E-02		4.00E-03	4.00E-03	5.00E-02	6.36E-02	5.00E-02	3.50E-04	ODWQS			5.20E+00	3.81E+02	3.00E-06	10600
Diethyl Phthalate	5.00E-01	6.60E-01			2.00E+00	1.91E+00	2.00E+00					2.42E+00	2.22E+02	2.10E-03	126.2
Dimethylphthalate	5.00E-01				2.00E+00		2.00E+00					1.60E+00	1.94E+02	3.08E-03	37.09
Dimethylphenol, 2,4-	2.00E-01	6.60E-01	2.50E-02	2.50E-05	1.00E+01	1.00E+01	1.00E+01					2.30E+00	1.22E+02	1.02E-01	717.6
Dinitrophenol, 2,4-	2.00E+00	3.30E+00	1.60E-05	1.60E-02	1.00E+01	5.00E+01	1.00E+01					1.67E+00	1.84E+02	3.90E-04	363.8
Dinitrotoluene, 2,4 & 2,6-	5.00E-01	6.60E-01			5.00E+00	6.36E+00	5.00E+00					1.98E+00	1.82E+02	1.47E-04	363.8
Dioxane, 1,4	2.00E-01	5.00E-03			2.00E+00	5.00E+00	2.00E+00	5.00E-02	WHO			-2.70E-01	8.81E+01	3.81E+01	1
Dioxin/Furan (TEQ)		5.40E-07	4.80E-06					1.50E-08	ODWQS			6.80E+00	3.22E+02	1.50E-09	146000
Endosulfan	4.00E-02	1.40E+00			5.00E-02	4.77E-02	5.00E-02					3.83E+00	4.07E+02	6.00E-07	22000
Endrin	4.00E-02	2.40E+00	4.00E-03	4.00E-03	5.00E-02	4.77E-02	5.00E-02	2.00E-03	USEPA			5.20E+00	3.81E+02	3.00E-06	10600

CHEMICAL NAME	Soil MOE-LSB Reporting Limit (RL) (mg/kg)	Soil MASS. PQL (mg/kg)	OTR98 Value Rural mg/kg	OTR98 Value Urban mg/kg	Water MOE-LSB Reporting Limit (RL) (ug/L)	Water MASS PDL (ug/L)	Water MOE Reg 153/04 RL (ug/L)	Ontario Drinking Water Standard or Substitute (mg/L)	Ref.	Odour Threshold in Air (mg/m^3)	Basis	Log of Octanol-Water Partition Coef.	Molecular Weight (g/mol)	Vapour Pressure (mm Hg)	Organic carbon partition coefficient, K_{oc} (cm^3/g)
Ethylbenzene	5.00E-02	5.00E-03	5.00E-03	3.00E-03	5.00E-01	5.00E-03	5.00E-01	2.40E-03	CDWQS	10.00	Amoore - Hautala	3.15E+00	1.06E+02	9.60E+00	517.8
Ethylene dibromide	5.00E-02	5.00E-03			2.00E-01	2.00E-02	2.00E-01	5.00E-05	USEPA	200.00	MDEP	1.96E+00	1.88E+02	1.12E+01	43.79
Fluoranthene	5.00E-02	6.60E-01	1.40E-01	5.60E-01	4.00E-01	1.00E+01	4.00E-01					5.16E+00	2.02E+02	9.22E-06	70900
Fluorene	5.00E-02	6.60E-01	9.40E-03	3.90E-02	5.00E-01	3.18E-01	5.00E-01					4.18E+00	1.66E+02	8.42E-03	11300
Heptachlor	5.00E-02	1.30E+00	1.00E-03	1.00E-03	1.00E-02	3.18E-02	1.00E-02	1.50E-03	ODWQS	0.30	MDEP	6.10E+00	3.73E+02	4.00E-04	52400
Heptachlor Epoxide	5.00E-02	1.40E+00	1.00E-03	1.00E-03	1.00E-02	9.54E-01	1.00E-02	1.50E-03	ODWQS	0.30	MDEP	4.98E+00	3.89E+02	1.95E-05	5260
Hexachlorobenzene	1.00E-02	6.60E-01			1.00E-02	6.36E-01	1.00E-02	1.00E-03	USEPA			5.73E+00	2.85E+02	1.80E-05	3380
Hexachlorobutadiene	1.00E-02	6.60E-01			1.00E-02	3.50E-01	1.00E-02	6.00E-04	WHO	12.00	MDEP	4.78E+00	2.61E+02	2.20E-01	993.5
Hexachlorocyclohexane Gamma-	1.00E-02	2.00E-03	1.00E-03	1.00E-03	1.00E-02	4.77E-02	1.00E-02	4.00E-03	ODWQS			4.14E+00	2.91E+02	3.52E-05	3380
Hexachloroethane	1.00E-02	6.60E-01			1.00E-02	1.00E+01	1.00E-02			1.50	Amoore - Hautala	4.14E+00	2.37E+02	2.10E-01	224.7
Hexane (n)	5.00E-02				5.00E+00		5.00E+00					3.90E+00	8.62E+01	1.51E+02	149
Indeno[1 2 3-cd]pyrene	1.00E-01	6.60E-01	5.40E-02	2.30E-01	2.00E-01	6.36E-02	2.00E-01	1.00E-04	Modified BaP			6.70E+00	2.76E+02	1.25E-10	2680000
Lead	1.00E+01		4.50E+01	1.24E+02	1.00E+00	1.00E+00	1.00E+00	1.00E-02	ODWQS				2.07E+02	7.28E-11	0
Mercury	1.00E-01	2.00E-01	1.32E-01	2.65E-01	1.00E-01	2.00E-01	1.00E-01	1.00E-03	ODWQS			6.20E-01	2.01E+02	1.96E-03	660000
Methoxychlor	5.00E-02	1.20E+01	5.00E-03	5.00E-03	5.00E-02	1.59E-01	5.00E-02	9.00E-01	ODWQS			5.08E+00	3.46E+02	4.17E-05	42600
Methyl Ethyl Ketone	5.00E-01	3.20E-01			2.00E+01	1.00E+01	2.00E+01			47.00	AIHA	2.90E-01	7.21E+01	9.06E+01	3.827
Methyl Isobutyl Ketone	5.00E-01	1.60E-01			2.00E+01	5.00E+01	2.00E+01			3.60	AIHA	1.31E+00	1.00E+02	1.99E+01	10.91
Methyl Mercury **												8.00E-02	2.16E+02	7.70E+01	4000
Methyl tert-Butyl Ether (MTBE)	5.00E-02	1.60E-02			2.00E+00	1.00E+00	2.00E+00	1.50E-02	CDWQS			9.40E-01	8.82E+01	2.50E+02	5.258
Methylene Chloride	5.00E-02	5.00E-03	7.30E-04	1.00E-03	5.00E+00		5.00E+00	5.00E-02	ODWQS	550.00	AIHA	1.25E+00	8.49E+01	4.35E+02	23.74
Methlynaphthalene, 2-(1-) ***	5.00E-02		6.00E-03	2.00E-01	2.00E+00	1.00E+01	2.00E+00			0.07	MDEP	3.86E+00	1.42E+02	5.50E-02	2976
Molybdenum	2.00E+00		9.84E-01	1.31E+00	5.00E-01		5.00E-01	7.00E-02	WHO				9.59E+01	0.00E+00	0

CHEMICAL NAME	Soil MOE-LSB Reporting Limit (RL) (mg/kg)	Soil MASS. PQL (mg/kg)	OTR98 Value Rural mg/kg	OTR98 Value Urban mg/kg	Water MOE-LSB Reporting Limit (RL) (ug/L)	Water MASS PDL (ug/L)	Water MOE Reg 153/04 RL (ug/L)	Ontario Drinking Water Standard or Substitute (mg/L)	Ref.	Odour Threshold in Air (mg/m^3)	Basis	Log of Octanol-Water Partition Coef.	Molecular Weight (g/mol)	Vapour Pressure (mm Hg)	Organic carbon partition coefficient, K_{oc} (cm^3/g)
Naphthalene	5.00E-02	2.10E+00	6.00E-03	7.50E-02	2.00E+00	1.27E-01	2.00E+00			0.20	AIHA	3.30E+00	1.28E+02	8.50E-02	1837
Nickel	5.00E+00		3.40E+01	5.02E+01	1.00E+00	1.00E+00	1.00E+00	1.00E-01	Cal EPA				5.87E+01	4.24E-09	0
Pentachlorophenol	1.00E-01	1.00E-01	1.40E-02	1.40E-02	5.00E-01	2.42E-01	5.00E-01	3.00E-02	ODWQAO			5.12E+00	2.66E+02	1.10E-04	3380
Petroleum Hydrocarbons F1****	1.00E+01		1.72E+01	2.50E+01	2.50E+01		2.50E+01						1.11E+02		
Aliphatic C6-C8												3.60E+00	1.00E+02	4.80E+01	3981
Aliphatic C>8-C10												4.50E+00	1.30E+02	4.80E+00	31623
Aromatic C>8-C10												3.20E+00	1.20E+02	4.80E+00	1585
Petroleum Hydrocarbons F2	1.00E+01		1.00E+01	1.00E+01	1.00E+02		1.00E+02						1.70E+02		
Aliphatic C>10-C12												5.40E+00	1.60E+02	4.80E-01	251189
Aliphatic C>12-C16												6.70E+00	2.00E+02	3.64E-02	5011872
Aromatic C>10-C12												3.40E+00	1.30E+02	4.80E-01	2512
Aromatic C>12-C16												3.70E+00	1.50E+02	3.64E-02	5012
Petroleum Hydrocarbons F3	5.00E+01		2.40E+02	1.45E+02	5.00E+02		5.00E+02						2.71E+02		
Aliphatic C>16-C21												8.80E+00	2.70E+02	8.73E-04	630957344
Aliphatic C>21-C34													4.00E+02	5.02E-07	1E+13
Aromatic C>16-C21												4.20E+00	1.80E+02	8.73E-04	15849
Aromatic C>21-C34												5.10E+00	2.50E+02	5.02E-07	125893
Petroleum Hydrocarbons F4	5.00E+01		1.19E+02	6.10E+01	5.00E+02		5.00E+02						4.76E+02		
Aliphatic C>34													*5.00E+02*	*2.30E-09*	1E+18
Aromatic C>34													*4.00E+02*	*2.30E-09*	*1778279*
Phenanthrene	5.00E-02	2.10E+00	9.20E-02	3.10E-01	1.00E-01	6.36E-01	1.00E-01	1.00E-03	Modified BaP			4.46E+00	1.78E+02	1.12E-04	20800
Phenol	5.00E-01	2.10E+00	1.40E-02	2.70E-02	1.00E+00	1.00E+01	1.00E+00			0.23	AIHA	1.46E+00	9.41E+01	3.50E-01	268
Polychlorinated Biphenyls	3.00E-01	2.20E-01	1.50E-02	3.20E-02	2.00E-01	3.18E-01	2.00E-01	3.00E-03	ODWQS			6.29E+00	2.92E+02	8.63E-05	309000
Pyrene	5.00E-02	2.10E+00	1.10E-01	4.90E-01	2.00E-01	3.18E-01	2.00E-01					4.88E+00	2.02E+02	4.50E-06	69400
Selenium	1.00E+00		9.11E-01	1.15E+00	5.00E+00	2.00E+00	5.00E+00	1.00E-02	ODWQS				8.10E+01	9.12E+03	0
Silver	5.00E-01		2.68E-01	3.30E-01	3.00E-01	7.00E+00	3.00E-01	1.00E-01	USEPA				1.08E+02	0.00E+00	0
Styrene	5.00E-02	1.60E-02	6.20E-06	3.00E-06	5.00E-01	1.27E-01	5.00E-01	1.00E-01	USEPA	0.60	AIHA	2.95E+00	1.04E+02	6.40E+00	517.8
Tetrachloroethane, 1,1,1,2-	5.00E-02	1.60E-02			5.00E-01	1.59E-03	5.00E-01					2.93E+00	1.68E+02	1.20E+01	96.63

CHEMICAL NAME	Soil MOE-LSB Reporting Limit (RL) (mg/kg)	Soil MASS. PQL (mg/kg)	OTR98 Value Rural mg/kg	OTR98 Value Urban mg/kg	Water MOE-LSB Reporting Limit (RL) (ug/L)	Water MASS PDL (ug/L)	Water MOE Reg 153/04 RL (ug/L)	Ontario Drinking Water Standard or Substitute (mg/L)	Ref.	Odour Threshold in Air (mg/m^3)	Basis	Log of Octanol-Water Partition Coef.	Molecular Weight (g/mol)	Vapour Pressure (mm Hg)	Organic carbon partition coefficient, K_{oc} (cm^3/g)
Tetrachloroethane, 1,1,2,2-	5.00E-02		5.00E-06	5.00E-06	5.00E-01		5.00E-01	1.00E-03	Cal EPA	50.00	AIHA	2.39E+00	1.68E+02	1.33E+01	106.8
Tetrachloroethylene	5.00E-02	1.60E-02	1.10E-03	8.70E-04	5.00E-01	1.59E-03	5.00E-01	3.00E-02	ODWQS	320.00	AIHA	3.40E+00	1.66E+02	1.85E+01	106.8
Thallium	1.00E+00		8.10E-01	7.70E-01	5.00E-01		5.00E-01	2.00E-03	USEPA				2.04E+02	1.81E-36	0
Toluene	2.00E-01	1.60E-02	2.50E-02	2.00E-02	5.00E-01	1.59E-02	5.00E-01	2.40E-02	CDWQS	6.00	AIHA	2.73E+00	9.21E+01	2.84E+01	268
Trichlorobenzene, 1,2,4-	5.00E-02	1.60E-02			5.00E-01	1.59E-02	5.00E-01	7.00E-02	USEPA	11.00	Amoore - Hautala	4.02E+00	1.81E+02	4.60E-01	717.6
Trichloroethane, 1,1,1-	5.00E-02	1.60E-02	5.00E-03	4.70E-03	5.00E-01	1.59E-02	5.00E-01	2.00E-01	USEPA	2100.00	AIHA	2.49E+00	1.33E+02	1.24E+02	48.64
Trichloroethane, 1,1,2-	5.00E-02	1.60E-02	3.70E-05	2.20E-05	5.00E-01	.	5.00E-01	5.00E-03	USEPA			1.89E+00	1.33E+02	2.30E+01	67.7
Trichloroethylene	5.00E-02	1.60E-02	3.20E-03	6.30E-04	5.00E-01	1.59E+02	5.00E-01	5.00E-03	ODWQS	440.00	AIHA	2.42E+00	1.31E+02	6.90E+01	67.7
Trichlorofluoromethane	5.00E-02		1.20E-02	1.30E-01	5.00E+00		5.00E+00	1.50E-01	Cal EPA			2.53E+00	1.37E+02	8.03E+02	48.64
Trichlorophenol, 2,4,5-	1.00E-01	2.10E+00	6.00E-03	6.00E-03	2.00E-01	2..0988	2.00E-01					3.72E+00	1.97E+02	7.50E-03	1186
Trichlorophenol, 2,4,6-	1.00E-01	2.10E+00	6.00E-03	6.00E-03	2.00E-01	2.10E+00	2.00E-01	2.00E-03	ODWQAO			3.69E+00	1.97E+02	8.00E-03	1186
Uranium	1.00E+00		1.35E+00	1.92E+00	2.00E+00		2.00E+00	2.00E-02	ODWQS						0
Vanadium	1.00E+01		8.60E+01	7.15E+01	5.00E-01		5.00E-01						5.09E+01	4.24E-09	0
Vinyl Chloride	2.00E-02	1.60E-02	3.00E-05	3.00E-05	5.00E-01	1.59E-02	5.00E-01	2.00E-03	ODWQS	6000.00	Amoore - Hautala	1.62E+00	6.25E+01	2.98E+03	23.74
Xylene Mixture	5.00E-02	1.60E-02	7.00E-03	9.00E-03	5.00E-01	1.59E-02	5.00E-01	3.00E-01	CDWQS	100.00	AIHA	3.12E+00	1.06E+02	7.99E+00	443.1
Zinc	3.00E+01		1.57E+02	1.80E+02	5.00E+00	2.00E+00	5.00E+00	5.00E+00	CDWQS				6.74E+01	7.99E-23	0
Electrical Conductivity (mS/cm)			3.60E-01	5.70E-01	5.00E-03		5.00E-03		not for human						0
Chloride	5.00E+00		3.50E+01	1.34E+02	1.00E+03		1.00E+03	2.50E+02	CDWQS			5.40E-01	3.55E+01	4.16E-08	0
Sodium Adsorption Ratio			7.10E-01	1.50E+00					not for human						0
Sodium	5.00E+01		3.85E+02	1.00E+03	5.00E+03		5.00E+03	2.00E+02	CDWQS			-7.70E-01	2.30E+01	3.64E-19	0

CHEMICAL NAME	Adjusted Koc (Koc*2) K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Chemical half-life Vertical Transport, unsaturated, (days)	Chemical half-life Lateral Transport, saturated (days)	Empirical Correction Factor for Soil Vapour Degradation aka Bioattenuation Factor (BAF)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol)
Acenaphthene	12246	4.21E-02	7.69E-06	3.90E+00	1.00E+90	1.00E+10	1	7.44E-03	1.82E-04	5.51E+02	8.03E+02	1.22E+04
Acenaphthylene	12246	4.39E-02	7.53E-06	1.61E+01	1.00E+90	1.00E+10	1	5.11E-03	1.25E-04			
Acetone	3.962	1.24E-01	1.14E-05	1.00E+06	1.00E+90	1.00E+10	1	1.62E-03	3.96E-05	3.29E+02	5.08E+02	6.96E+03
Aldrin	212000	1.32E-02	4.86E-06	1.70E-02	1.00E+90	1.00E+10	1	1.80E-03	4.40E-05	6.03E+02	8.39E+02	1.50E+04
Anthracene	40800	3.24E-02	7.74E-06	4.34E-02	1.00E+90	1.00E+10	1	2.27E-03	5.55E-05	6.15E+02	8.73E+02	1.31E+04
Antimony	0			2.30E+04	1.00E+90	1.00E+10	1					
Arsenic	0			3.47E+04	1.00E+90	1.00E+10	1					
Barium	0			5.48E+04	1.00E+90	1.00E+10	1					
Benzene	331	8.80E-02	9.80E-06	1.79E+03	1.00E+90	1.00E+10	10	2.27E-01	5.55E-03	3.53E+02	5.62E+02	7.34E+03
Benz[a]anthracene	462000	5.10E-02	9.00E-06	9.40E-03	1.00E+90	1.00E+10	1	4.91E-04	1.20E-05	7.08E+02	1.00E+03	1.60E+04
Benzo[a]pyrene	1574000	4.30E-02	9.00E-06	1.62E-03	1.00E+90	1.00E+10	1	1.87E-05	4.58E-07	7.16E+02	9.69E+02	1.90E+04
Benzo[b]fluoranthene	1606000	2.26E-02	5.56E-06	1.50E-03	1.00E+90	1.00E+10	1	2.69E-05	6.58E-07	7.16E+02	9.69E+02	1.70E+04
Benzo[ghi]perylene	5360000			2.60E-04	1.00E+90	1.00E+10	1	1.35E-05	3.30E-07			
Benzo[k]fluoranthene	1574000	2.26E-02	5.56E-06	8.00E-04	1.00E+90	1.00E+10	1	2.39E-05	5.85E-07	7.53E+02	1.02E+03	1.80E+04
Beryllium	0			1.49E+05	1.00E+90	1.00E+10	1					
Biphenyl 1,1'-	12500	4.04E-02	8.15E-06	6.94E+00	1.00E+90	1.00E+10	1	1.26E-02	3.08E-04			
Bis(2-chloroethyl)ether	29.9	6.92E-02	7.53E-06	1.72E+04	1.00E+90	1.00E+10	1	6.95E-04	1.70E-05	4.51E+02	6.60E+02	1.08E+04
Bis(2-chloroisopropyl)ether	42.8	3.50E-02	7.36E-06	3.99E+01	1.00E+90	1.00E+10	1	1.36E-02	3.33E-04			
Bis(2-ethylhexyl)phthalate	330000	3.51E-02	3.66E-06	2.70E-01	1.00E+90	1.00E+10	1	1.10E-05	2.69E-07	6.57E+02	8.06E+02	1.60E+04
Boron (Hot Water Soluble)*	0				1.00E+90	1.00E+10						
Boron (total)	28.6			4.37E+04	1.00E+90	1.00E+10	1					
Bromodichloromethane	70.08	2.98E-02	1.06E-05	3.03E+03	1.00E+90	1.00E+10	1	8.67E-02	2.12E-03	3.63E+02	5.86E+02	7.80E+03
Bromoform	70.08	1.49E-02	1.03E-05	3.10E+03	1.00E+90	1.00E+10	1	2.19E-02	5.36E-04	4.22E+02	6.96E+02	9.48E+03
Bromomethane	28.6	7.28E-02	1.21E-05	1.52E+04	1.00E+90	1.00E+10	1	2.55E-01	6.24E-03			
Cadmium	0			1.23E+05	1.00E+90	1.00E+10	1					
Carbon Tetrachloride	97.28	7.80E-02	8.80E-06	7.93E+02	1.00E+90	1.00E+10	1	1.13E+00	2.77E-02	3.50E+02	5.57E+02	7.13E+03
Chlordane	173400	1.18E-02	4.37E-06	5.60E-02	1.00E+90	1.00E+10	1	1.99E-03	4.87E-05	6.24E+02	8.86E+02	1.40E+04
Chloroaniline p-	145.06	4.83E-02	1.01E-05	3.90E+03	1.00E+90	1.00E+10	1	4.74E-05	1.16E-06			
Chlorobenzene	536	7.30E-02	8.70E-06	4.98E+02	1.00E+90	1.00E+10	1	1.27E-01	3.11E-03	4.05E+02	6.32E+02	8.41E+03
Chloroform	70.08	1.04E-01	1.00E-05	7.95E+03	1.00E+90	1.00E+10	1	1.50E-01	3.67E-03	3.34E+02	5.36E+02	6.99E+03
Chlorophenol, 2-	886.2	5.01E-02	9.46E-06	2.85E+04	1.00E+90	1.00E+10	1	4.58E-04	1.12E-05	4.48E+02	6.75E+02	9.57E+03

CHEMICAL NAME	Adjusted Koc (Koc*2) K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Chemical half-life Vertical Transport, unsaturated, (days)	Chemical half-life Lateral Transport, saturated (days)	Empirical Correction Factor for Soil Vapour Degradation aka Bioattenuation Factor (BAF)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol)
Chromium Total	0			1.20E+04	1.00E+90	1.00E+10	1					
Chromium VI	0			1.20E+04	1.00E+90	1.00E+10	1					
Chrysene	472000	2.48E-02	6.21E-06	2.00E-03	1.00E+90	1.00E+10	1	2.14E-04	5.24E-06	7.14E+02	9.79E+02	1.65E+04
Cobalt	0			8.75E+04	1.00E+90	1.00E+10	1					
Copper	0			4.21E+05	1.00E+90	1.00E+10	1					
Cyanide (CN`)	34			1.00E+06	1.00E+90	1.00E+10	1	5.44E-03	1.33E-04			
Dibenz[a h]anthracene	5240000	2.02E-02	5.18E-06	1.03E-03	1.00E+90	1.00E+10	1	5.03E-06	1.23E-07	7.43E+02	9.90E+02	3.00E+04
Dibromochloromethane	70.08	1.96E-02	1.05E-05	2.70E+03	1.00E+90	1.00E+10	1	3.20E-02	7.83E-04			
Dichlorobenzene, 1,2-	886.2	6.90E-02	7.90E-06	8.00E+01	1.00E+90	1.00E+10	1	7.85E-02	1.92E-03	4.54E+02	7.05E+02	9.70E+03
Dichlorobenzene, 1,3-	868			1.25E+02	1.00E+90	1.00E+10	1	1.08E-01	2.64E-03			
Dichlorobenzene, 1,4-	868	6.90E-02	7.90E-06	8.13E+01	1.00E+90	1.00E+10	1	9.85E-02	2.41E-03	4.47E+02	6.85E+02	9.27E+03
Dichlorobenzidine, 3,3'-	14978	1.94E-02	6.74E-06	3.10E+00	1.00E+90	1.00E+10	1	2.09E-09	5.11E-11	5.60E+02	7.54E+02	2.00E+04
Dichlorodifluoromethane	97.28	5.20E-02	1.05E-05	2.80E+02	1.00E+90	1.00E+10	1	1.40E+01	3.43E-01	2.44E+02		
DDD	306000	1.69E-02	4.76E-06	9.00E-02	1.00E+90	1.00E+10	1	2.70E-04	6.61E-06	6.40E+02	8.64E+02	1.70E+04
DDE	306000	1.44E-02	5.87E-06	4.00E-02	1.00E+90	1.00E+10	1	1.70E-03	4.16E-05	6.36E+02	8.60E+02	1.50E+04
DDT	440000	1.37E-02	4.95E-06	5.50E-03	1.00E+90	1.00E+10	1	3.40E-04	8.32E-06	5.33E+02	7.21E+02	2.20E+04
Dichloroethane, 1,1-	70.08	7.42E-02	1.05E-05	5.04E+03	1.00E+90	1.00E+10	1	2.30E-01	5.63E-03	3.31E+02	5.23E+02	6.90E+03
Dichloroethane, 1,2-	87.58	1.04E-01	9.90E-06	5.10E+03	1.00E+90	1.00E+10	1	4.82E-02	1.18E-03	3.57E+02	5.61E+02	7.64E+03
Dichloroethylene, 1,1-	70.08	9.00E-02	1.04E-05	2.42E+03	1.00E+90	1.00E+10	1	1.07E+00	2.62E-02	3.05E+02	5.76E+02	6.25E+03
Dichloroethylene, 1,2-cis-	87.58	7.36E-02	1.13E-05	3.50E+03	1.00E+90	1.00E+10	1	1.67E-01	4.09E-03			
Dichloroethylene, 1,2-trans-	87.58	7.07E-02	1.19E-05	3.50E+03	1.00E+90	1.00E+10	1	3.83E-01	9.37E-03			
Dichlorophenol, 2,4-	1435.2	3.46E-02	8.77E-06	4.50E+03	1.00E+90	1.00E+10	1	8.95E-05	2.19E-06	4.82E+02	7.08E+02	1.50E+04
Dichloropropane, 1,2-	135.4	7.82E-02	8.73E-06	2.80E+03	1.00E+90	1.00E+10	1	1.15E-01	2.81E-03	3.70E+02	5.72E+02	7.59E+03
Dichloropropene,1,3-	161.54	6.26E-02	1.00E-05	2.80E+03	1.00E+90	1.00E+10	1	1.45E-01	3.55E-03	3.81E+02	5.87E+02	7.90E+03
Dieldrin	21200	1.25E-02	4.74E-06	2.50E-01	1.00E+90	1.00E+10	1	4.09E-04	1.00E-05	6.13E+02	8.42E+02	1.70E+04
Diethyl Phthalate	252.4	2.56E-02	6.35E-06	1.08E+03	1.00E+90	1.00E+10	1	2.49E-05	6.09E-07	5.67E+02	7.57E+02	1.37E+04
Dimethylphthalate	74.18	5.68E-02	6.29E-06	4.00E+03	1.00E+90	1.00E+10	1	4.29E-06	1.05E-07			
Dimethylphenol, 2,4-	1435.2	5.84E-02	8.69E-06	7.87E+03	1.00E+90	1.00E+10	1	3.89E-05	9.52E-07	4.84E+02	7.08E+02	1.13E+04
Dinitrophenol, 2,4-	727.6	2.73E-02	9.06E-06	2.79E+03	1.00E+90	1.00E+10	1	3.52E-06	8.61E-08	6.05E+02	8.28E+02	2.50E+04
Dinitrotoluene, 2,4 & 2,6-	727.6	2.03E-01	7.06E-06	2.70E+02	1.00E+90	1.00E+10	1	2.21E-06	5.41E-08	5.90E+02	8.14E+02	1.35E+04
Dioxane, 1,4	2	2.29E-01	1.02E-05	1.00E+06	1.00E+90	1.00E+10	1	1.96E-04	4.80E-06	1.02E+02		
Dioxin/Furan (TEQ)	292000	1.43E-02	5.83E-06	2.00E-04	1.00E+90	1.00E+10	1	2.04E-03	4.99E-05			
Endosulfan	44000	1.15E-02	4.55E-06	4.50E-01	1.00E+90	1.00E+10	1	2.66E-03	6.51E-05	6.74E+02	9.43E+02	1.40E+04
Endrin	21200	1.25E-02	4.74E-06	2.50E-01	1.00E+90	1.00E+10	1	2.60E-04	6.36E-06	7.18E+02	9.86E+02	1.50E+04

CHEMICAL NAME	Adjusted Koc (Koc*2) K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Chemical half-life Vertical Transport, unsaturated, (days)	Chemical half-life Lateral Transport, saturated (days)	Empirical Correction Factor for Soil Vapour Degradation aka Bioattenuation Factor (BAF)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol)
Ethylbenzene	1035.6	7.50E-02	7.80E-06	1.69E+02	1.00E+90	1.00E+10	10	3.22E-01	7.88E-03	4.09E+02	6.17E+02	8.50E+03
Ethylene dibromide	87.58	2.17E-02	1.19E-05	3.91E+03	1.00E+90	1.00E+10	1	2.73E-02	6.68E-04			
Fluoranthene	141800	3.02E-02	6.35E-06	2.60E-01	1.00E+90	1.00E+10	1	3.62E-04	8.86E-06	6.56E+02	9.05E+02	1.38E+04
Fluorene	22600	3.63E-02	7.88E-06	1.89E+00	1.00E+90	1.00E+10	1	3.93E-03	9.62E-05	5.70E+02	8.70E+02	1.27E+04
Heptachlor	104800	1.12E-02	5.69E-06	1.80E-01	1.00E+90	1.00E+10	1	1.20E-02	2.94E-04	6.04E+02	8.46E+02	1.30E+04
Heptachlor Epoxide	10520	1.32E-02	4.23E-06	2.00E-01	1.00E+90	1.00E+10	1	8.59E-04	2.10E-05			
Hexachlorobenzene	6760	5.42E-02	5.91E-06	6.20E-03	1.00E+90	1.00E+10	1	6.95E-02	1.70E-03	5.83E+02	8.25E+02	1.44E+04
Hexachlorobutadiene	1987	5.61E-02	6.16E-06	3.20E+00	1.00E+90	1.00E+10	1	4.21E-01	1.03E-02	4.86E+02	7.38E+02	1.02E+04
Hexachlorocyclohexane Gamma-	6760	1.42E-02	7.34E-06	8.00E+00	1.00E+90	1.00E+10	1	2.10E-04	5.14E-06	5.97E+02	8.39E+02	1.50E+04
Hexachloroethane	449.4	2.50E-03	6.80E-06	5.00E+01	1.00E+90	1.00E+10	1	1.59E-01	3.89E-03	4.58E+02	6.95E+02	9.51E+03
Hexane (n)	298	2.00E-01	7.77E-06	9.50E+00	1.00E+90	1.00E+10	10	7.36E+01	1.80E+00	3.41E+02		
Indeno[1 2 3-cd]pyrene	5360000	1.90E-02	5.66E-06	1.90E-04	1.00E+90	1.00E+10	1	1.42E-05	3.47E-07	8.09E+02	1.08E+03	1.90E+04
Lead	0			9.58E+03	1.00E+90	1.00E+10	1					
Mercury	1320000	3.07E-02	6.30E-06	6.00E-02	1.00E+90	1.00E+10	1	4.70E-01	1.15E-02	6.30E+02	1.75E+03	1.41E+04
Methoxychlor	85200	1.56E-02	4.46E-06	1.00E-01	1.00E+90	1.00E+10	1	8.30E-06	2.03E-07	6.51E+02	8.48E+02	1.60E+04
Methyl Ethyl Ketone	7.654	8.08E-02	9.80E-06	2.23E+05	1.00E+90	1.00E+10	1	2.33E-03	5.70E-05			
Methyl Isobutyl Ketone	21.82	7.50E-02	7.80E-06	1.90E+04	1.00E+90	1.00E+10	1	5.64E-03	1.38E-04			
Methyl Mercury **	8000			3.13E+04	1.00E+90	1.00E+10	1	2.95E-01	7.22E-03			
Methyl tert-Butyl Ether (MTBE)	10.516	1.02E-01	1.05E-05	5.10E+04	1.00E+90	1.00E+10	1	2.40E-02	5.87E-04			
Methylene Chloride	47.48	1.01E-01	1.17E-05	1.30E+04	1.00E+90	1.00E+10	1	1.33E-01	3.25E-03	3.13E+02	5.10E+02	6.71E+03
Methlynaphthalene, 2-(1-) ***	5952	4.80E-02	7.84E-06	2.46E+01	1.00E+90	1.00E+10	1	2.12E-02	5.19E-04			
Molybdenum	0			7.66E+04	1.00E+90	1.00E+10	1					

CHEMICAL NAME	Adjusted Koc (Koc*2) K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Chemical half-life Vertical Transport, unsaturated, (days)	Chemical half-life Lateral Transport, saturated (days)	Empirical Correction Factor for Soil Vapour Degradation aka Bioattenuation Factor (BAF)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol)
Naphthalene	3674	5.90E-02	7.50E-06	3.10E+01	1.00E+90	1.00E+10	10	1.80E-02	4.40E-04	4.91E+02	7.48E+02	1.04E+04
Nickel	0			4.22E+05	1.00E+90	1.00E+10	1					
Pentachlorophenol	6760	5.60E-02	6.10E-06	1.40E+01	1.00E+90	1.00E+10	1	1.00E-06	2.45E-08	5.82E+02	8.13E+02	1.61E+04
Petroleum Hydrocarbons F1****					1.00E+90	1.00E+10	1					
Aliphatic C6-C8	7962	5.00E-02	6.00E-06	5.40E+00	1.00E+90	1.00E+10	10	5.00E+01	1.2225			
Aliphatic C>8-C10	63246	5.00E-02	6.00E-06	4.30E-01	1.00E+90	1.00E+10	10	8.00E+01	1.96E+00			
Aromatic C>8-C10	3170	5.00E-02	6.00E-06	6.50E+01	1.00E+90	1.00E+10	10	4.80E-01	1.17E-02			
Petroleum Hydrocarbons F2					1.00E+90	1.00E+10	1					
Aliphatic C>10-C12	502377	5.00E-02	6.00E-06	3.40E-02	1.00E+90	1.00E+10	10	1.20E+02	2.94E+00			
Aliphatic C>12-C16	10023745	5.00E-02	6.00E-06	7.60E-04	1.00E+90	1.00E+10	10	5.20E+02	1.27E+01			
Aromatic C>10-C12	5024	5.00E-02	6.00E-06	2.50E+01	1.00E+90	1.00E+10	10	1.40E-01	3.43E-03			
Aromatic C>12-C16	10024	5.00E-02	6.00E-06	5.80E+00	1.00E+90	1.00E+10	10	5.30E-02	1.30E-03			
Petroleum Hydrocarbons F3					1.00E+90	1.00E+10	1					
Aliphatic C>16-C21	1261914689	5.00E-02	6.00E-06	2.50E-06	1.00E+90	1.00E+10	1	4.90E+03	1.20E+02			
Aliphatic C>21-C34	2E+13	5.00E-02	6.00E-06	2.37E-11	1.00E+90	1.00E+10	1	5.47E+05	1.34E+04			
Aromatic C>16-C21	31698	5.00E-02	6.00E-06	6.50E-01	1.00E+90	1.00E+10	1	1.30E-02	3.18E-04			
Aromatic C>21-C34	251785	5.00E-02	6.00E-06	6.60E-03	1.00E+90	1.00E+10	1	6.70E-04	1.64E-05			
Petroleum Hydrocarbons F4					1.00E+90	1.00E+10	1					
Aliphatic C>34	2E+18	5.00E-02	6.00E-06	6.31E-15	1.00E+90	1.00E+10	1	1.17E+08	2.87E+06			
Aromatic C>34	*3556559*	5.00E-02	6.00E-06	3.63E-04	1.00E+90	1.00E+10	1	1.78E-06	4.36E-08			
Phenanthrene	41600			1.15E+00	1.00E+90	1.00E+10	1	1.73E-03	4.23E-05			
Phenol	536	8.20E-02	9.10E-06	8.28E+04	1.00E+90	1.00E+10	1	1.36E-05	3.33E-07	4.55E+02	6.94E+02	1.09E+04
Polychlorinated Biphenyls	618000	1.75E-02	8.00E-06	2.77E-01	1.00E+90	1.00E+10	1	4.93E-03	1.21E-04			
Pyrene	138800	2.72E-02	7.24E-06	1.35E-01	1.00E+90	1.00E+10	1	4.87E-04	1.19E-05	6.68E+02	9.36E+02	1.44E+04
Selenium	0			8.14E+04	1.00E+90	1.00E+10	1					
Silver	0			7.05E+04	1.00E+90	1.00E+10	1					
Styrene	1035.6	7.10E-02	8.00E-06	3.10E+02	1.00E+90	1.00E+10	1	1.12E-01	2.74E-03	4.18E+02	6.36E+02	8.74E+03
Tetrachloroethane, 1,1,1,2-	193.26	4.23E-02	9.14E-06	1.07E+03	1.00E+90	1.00E+10	1	9.89E-02	2.42E-03	1.31E+02		

CHEMICAL NAME	Adjusted Koc (Koc*2) K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Chemical half-life Vertical Transport, unsaturated, (days)	Chemical half-life Lateral Transport, saturated (days)	Empirical Correction Factor for Soil Vapour Degradation aka Bioattenuation Factor (BAF)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol)
Tetrachloroethane, 1,1,2,2-	213.6	7.10E-02	7.90E-06	2.87E+03	1.00E+90	1.00E+10	1	1.50E-02	3.67E-04	4.20E+02	6.61E+02	9.00E+03
Tetrachloroethylene	213.6	7.20E-02	8.20E-06	2.06E+02	1.00E+90	1.00E+10	1	7.24E-01	1.77E-02	3.94E+02	6.20E+02	8.29E+03
Thallium	0			2.65E+04	1.00E+90	1.00E+10	1					
Toluene	536	8.70E-02	8.60E-06	5.26E+02	1.00E+90	1.00E+10	10	2.71E-01	6.63E-03	3.84E+02	5.92E+02	7.93E+03
Trichlorobenzene, 1,2,4-	1435.2	3.00E-02	8.23E-06	4.90E+01	1.00E+90	1.00E+10	1	5.81E-02	1.42E-03	4.86E+02	7.25E+02	1.05E+04
Trichloroethane, 1,1,1-	97.28	7.80E-02	8.80E-06	1.29E+03	1.00E+90	1.00E+10	1	7.03E-01	1.72E-02	3.47E+02	5.45E+02	7.14E+03
Trichloroethane, 1,1,2-	135.4	7.80E-02	8.80E-06	1.10E+03	1.00E+90	1.00E+10	1	3.37E-02	8.25E-04	3.86E+02	6.02E+02	8.32E+03
Trichloroethylene	135.4	7.90E-02	9.10E-06	1.28E+03	1.00E+90	1.00E+10	1	4.03E-01	9.86E-03	3.60E+02	5.44E+02	7.51E+03
Trichlorofluoromethane	97.28	8.70E-02	9.70E-06	1.10E+03	1.00E+90	1.00E+10	1	3.97E+00	9.71E-02	2.97E+02		
Trichlorophenol, 2,4,5-	2372	2.91E-02	7.03E-06	1.20E+03	1.00E+90	1.00E+10	1	6.62E-05	1.62E-06	5.26E+02	7.59E+02	1.10E+04
Trichlorophenol, 2,4,6-	2372	3.18E-02	6.25E-06	8.00E+02	1.00E+90	1.00E+10	1	1.06E-04	2.59E-06	5.19E+02	7.49E+02	1.20E+04
Uranium	0				1.00E+90	1.00E+10	1					
Vanadium	0			8.64E+04	1.00E+90	1.00E+10	1					
Vinyl Chloride	47.48	1.06E-01	1.23E-06	8.80E+03	1.00E+90	1.00E+10	1	1.14E+00	2.79E-02	2.59E+02	4.32E+02	5.25E+03
Xylene Mixture	886.2	7.14E-02	9.34E-06	1.06E+02	1.00E+90	1.00E+10	10	2.71E-01	6.63E-03			
Zinc	0			3.44E+05	1.00E+90	1.00E+10	1					
Electrical Conductivity (mS/cm)	0				1.00E+90	1.00E+10	1					
Chloride	0			4.24E+04	1.00E+90	1.00E+10	1	0.00E+00	0.00E+00			
Sodium Adsorption Ratio	0				1.00E+90	1.00E+10	1					
Sodium	0			4.45E+05	1.00E+90	1.00E+10	1					

CHEMICAL NAME	CASRN	Plant and Soil Invertebrates		Plant and Soil Invertebrates		American Woodcock	Garter Snake	Meadow Vole	Sheep	Red Winged Black Bird
		Agricultural/Residential		Commercial/Industrial						
		coarse	med./fine	coarse	med./fine	ug/g	ug/g	ug/g	ug/g	ug/g
Acenaphthene	83329							46000	24400	
Acenaphthylene	208968									
Acetone	67641							56	32	
Aldrin	309002	0.044	0.055	0.088	0.11			1200	501	
Anthracene	120127	2.5	3.125	32	40			473000	237000	
Antimony	7440360	20	25	40	50			2140	804	
Arsenic	7440382	20	25	40	50	333		2690	890	384
Barium	7440393	750	1000	1500	2000	689		4950	2640	672
Benzene	71432	25	60	180	310			6800	3870	
Benz[a]anthracene	56553	0.5	0.625	1	1.25					
Benzo[a]pyrene	50328	20	25	72	90			69000	25800	
Benzo[b]fluoranthene	205992									
Benzo[ghi]perylene	191242	6.6	8.25	13.2	16.5					
Benzo[k]fluoranthene	207089	7.6	9.5	15.2	19					
Beryllium	7440417	4	5	8	10			1140	426	
Biphenyl 1,1'-	92524									
Bis(2-chloroethyl)ether	111444									
Bis(2-chloroisopropyl)ether	108601									
Bis(2-ethylhexyl)phthalate	117817	13.8	17.25	27.6	34.5			136000	63400	
Boron (Hot Water Soluble)*	7440428-HWS	1.5	1.5	2	2					
Boron (total)	7440428					4240		1370	781	115
Bromodichloromethane	75274									
Bromoform	75252									
Bromomethane	74839									
Cadmium	7440439	12	12	24	30	1.9		4520	2600	87
Carbon Tetrachloride	56235	5.8	7.25	11.6	14.5			882	497	
Chlordane	57749	1.08	1.35	2.16	2.7	0.0085		15900	5940	573
Chloroaniline p-	106478	20	25	40	50					
Chlorobenzene	108907	6	7.5	12	15					
Chloroform	67663	34	42.5	68	85			825	470	
Chlorophenol, 2-	95578	1.56	1.95	3.12	3.9					
Chromium Total	16065831	312	390	500	630	338		1000000	3000	161
Chromium VI	18540299	8	10	8	10			8540	4070	
Chrysene	218019	7	8.75	14	17.5					
Cobalt	7440484	40	50	80	100	180		14543	5526	400
Copper	7440508	140	180	225	300	4080		31900	283	3060
Cyanide (CN-)	57125	0.9	1.125	8	10	0.81		464	3.7	0.11
Dibenz[a h]anthracene	53703									
Dibromochloromethane	124481									
Dichlorobenzene, 1,2-	95501	3.4	4.25	6.8	8.5					
Dichlorobenzene, 1,3-	541731	4.8	6	9.6	12					

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		coarse	med./fine	coarse	med./fine	ug/g	ug/g	ug/g	ug/g	ug/g
Dichlorobenzene, 1,4-	106467	3.6	4.5	7.2	9					
Dichlorobenzidine, 3,3'-	91941									
Dichlorodifluoromethane	75718	40	50	80	100					
DDD	72548	6.8	8.5	13.6	17					
DDE	72559	0.26	0.325	0.52	0.65					
DDT	50293	1	1.3	6.3	7.8	0.0012		933	379	47
Dichloroethane, 1,1-	75343	8.4	10.5	16.8	21					
Dichloroethane, 1,2-	107062	48	60	96	120	134		531	303	29
Dichloroethylene, 1,1-	75354	50	63	100	125			757	430	
Dichloroethylene, 1,2-cis-	156592							935	532	
Dichloroethylene, 1,2-trans-	156605							935	532	
Dichlorophenol, 2,4-	120832	1.68	2.1	3.36	4.2					
Dichloropropane, 1,2-	78875	25	31.25	50	62.5					
Dichloropropene,1,3-	542756	25	31.25	50	62.5					
Dieldrin	60571	0.044	0.055	0.088	0.11			312	82	
Diethyl Phthalate	84662	10.6	13.25	21.2	26.5			1000000	1000000	
Dimethylphthalate	131113	16.8	21	33.6	42					
Dimethylphenol, 2,4-	105679									
Dinitrophenol, 2,4-	51285									
Dinitrotoluene, 2,4 & 2,6-	121142									
Dioxane, 1,4	123911							1.82	0.174	
Dioxin/Furan (TEQ)	1746016					0.000099		0.017	0.0065	0.0073
Endosulfan	115297	0.15	0.19	0.3	0.38	1.2		22	12	102
Endrin	72208	0.019	0.02375	0.038	0.0475	0.0011		843	377	12
Ethylbenzene	100414	55	120	300	430			38400	21400	
Ethylene dibromide	106934									
Fluoranthene	206440	50	62.5	180	225			115000	51200	
Fluorene	86737									
Heptachlor	76448	0.2	0.25	0.4	0.5			1090	467	
Heptachlor Epoxide	1024573									
Hexachlorobenzene	118741	100	125	200	250					
Hexachlorobutadiene	87683									
Hexachlorocyclohexane Gamma	58899	5.9	7.4	12	15					
Hexachloroethane	67721									
Hexane (n)	11053									
Indeno[1 2 3-cd]pyrene	193395	0.38	0.475	0.76	0.95					
Lead	7439921	250	310	1100	1400	32		185000	5380	140
Mercury	7439976	10	15	50	62.5	20		1590	532	26
Methoxychlor	72435							4120	2040	
Methyl Ethyl Ketone	78933	35	43.75	70	87.5			9920	5680	
Methyl Isobutyl Ketone	108101									

CHEMICAL NAME	CASRN	Plant and Soil Invertebrates		Plant and Soil Invertebrates		American Woodcock	Garter Snake	Meadow Vole	Sheep	Red Winged Black Bird
		Agricultural/Residential		Commercial/Industrial						
		coarse	med./fine	coarse	med./fine	ug/g	ug/g	ug/g	ug/g	ug/g
Methyl Mercury **	22967926	0.8	1	1.6	2	0.034		174	75	2.7
Methyl tert-Butyl Ether (MTBE)	1634044	25	31.25	50	62.5					
Methylene Chloride	75092	0.78	0.975	1.56	1.95			401	229	
Methlynaphthalene, 2-(1-) ***	91576									
Molybdenum	7439987	40	40	40	40	74		557	299	497
Naphthalene	91203	0.6	0.75	22	27.5			1260	697	
Nickel	7440020	100	130	270	340	6300		160000	55000	5430
Pentachlorophenol	87865	17	21	31	39			2040	927	
Petroleum Hydrocarbons F1****	PHCF1	210	210	320	320					
Aliphatic C6-C8	PHCAL0608									
Aliphatic C>8-C10	PHCAL0810									
Aromatic C>8-C10	PHCAR0810									
Petroleum Hydrocarbons F2	PHCF2	150	150	260	260					
Aliphatic C>10-C12	PHCAL1012									
Aliphatic C>12-C16	PHCAL1216									
Aromatic C>10-C12	PHCAR1012									
Aromatic C>12-C16	PHCAR1216									
Petroleum Hydrocarbons F3	PHCF3	300	1300	1700	2500					
Aliphatic C>16-C21	PHCAL1621									
Aliphatic C>21-C34	PHCAL2134									
Aromatic C>16-C21	PHCAR1621									
Aromatic C>21-C34	PHCAR2134									
Petroleum Hydrocarbons F4	PHCF4	2800	5600	3300	6600					
Aliphatic C>34	PHCAL3499									
Aromatic C>34	PHCAR3499									
Phenanthrene	85018	6.2	7.75	12.4	15.5			36000	17800	
Phenol	108952	17	22	40	40	41		324	185	9.4
Polychlorinated Biphenyls	1336363	33	41.25	33	41.25	1.1		1700	617	19
Pyrene	129000							99100	45700	
Selenium	7782492	10	12.5	10	12.5	5.7		26	4.3	5.5
Silver	7440224	20	25	40	50					
Styrene	100425	17.2	21.5	34.4	43					
Tetrachloroethane, 1,1,1,2-	630206									
Tetrachloroethane, 1,1,2,2-	79345									
Tetrachloroethylene	127184	3.8	4.75	34	42.5			310	175	
Thallium	7440280	1.4	1.75	3.6	4.5			419	146	
Toluene	108883	150	220	500	660			13600	7650	
Trichlorobenzene, 1,2,4-	120821	13	16	30	30					
Trichloroethane, 1,1,1-	71556	17.6	22	35.2	44			38500	21800	
Trichloroethane, 1,1,2-	79005	80	100	160	200					
Trichloroethylene	79016	100	125	200	250			385	218	

CHEMICAL NAME	CASRN	Plant and Soil Invertebrates		Plant and Soil Invertebrates		American Woodcock	Garter Snake	Meadow Vole	Sheep	Red Winged Black Bird
		Agricultural/Residential		Commercial/Industrial						
		coarse	med./fine	coarse	med./fine	ug/g	ug/g	ug/g	ug/g	ug/g
Trichlorofluoromethane	75694	16	20	32	40					
Trichlorophenol, 2,4,5-	95954	4.4	5.5	10	10					
Trichlorophenol, 2,4,6-	88062	4.4	5.5	10	10					
Uranium	7440611	500	500	2000	2000			33		
Vanadium	7440622	200	250	200	250	18		4180	1490	21
Vinyl Chloride	75014	3.4	4.25	6.8	8.5			12	6.8	
Xylene Mixture	1330207	95	55	350	210			47000	261000	
Zinc	7440666	400	500	600	800	337		492000	4200	2770
Electrical Conductivity (mS/cm)	EC	0.7	0.7	1.4	1.4					
Chloride	16887006									
Sodium Adsorption Ratio	SAR	5	5	12	12					
Sodium	7440235									

CHEMICAL NAME	Red Fox	Red Tailed Hawk	Short-tailed Shrew	Spring Peeper	Terrestrial Protection Value for Animal Life			Aquatic Receptor Protection Value (ug/L)	Basis	Sediment Quality Guidelines
					Agricultural	Residential/ Parkland	Commercial/ Industrial			
	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g			µg/g
Acenaphthene	206000		6630		6630	6630	46000	520	EPA FCC (1986)	NV
Acenaphthylene								0.14	MADEP (2008)	NV
Acetone	58900		2360		32	56	56	10000	ECOTOX LOEL	NV
Aldrin	1170		0.0024		0.0024	0.0024	1170	0.3	CMC/10 (2008)	0.002
Anthracene	1000000		37900		37900	37900	473000	0.1	ECOTOX LOEL/10	0.22
Antimony	1470		24.6		24.6	24.6	1470	1600	EPA FCC (1986)	NV
Arsenic	1420	4530	51		51	51	333	150	EPA CCC (2008)	6
Barium	6750	11900	394		394	394	672	2300	ECOTOX LOEL	NV
Benzene	311000		373		373	373	6800	460	MADEP (2008)	NV
Benz[a]anthracene								0.18	ECOTOX LOEL/10	0.32
Benzo[a]pyrene	46300		1620		1620	1620	46300	0.21	ECOTOX LOEL	0.37
Benzo[b]fluoranthene								0.42	ECOTOX LOEL/10	NV
Benzo[ghi]perylene								0.02	ECOTOX LOEL/10	0.17
Benzo[k]fluoranthene								0.14	ECOTOX LOEL/10	0.24
Beryllium	776		13		13	13	776	5.3	EPA FCC (1986)	NV
Biphenyl 1,1'-								170	ECOTOX LOEL	NV
Bis(2-chloroethyl)ether								24000	MADEP (2008)	NV
Bis(2-chloroisopropyl)ether								24000	MADEP (2008)	NV
Bis(2-ethylhexyl)phthalate	215000		0.8		0.8	0.8	136000	3	EPA FCC (1986)	NV
Boron (Hot Water Soluble)*										NV
Boron (total)	111000	63000	4440		115	115	115	3550	Cantox (2007a)	NV
Bromodichloromethane								6700	ECOTOX LOEL/10	NV
Bromoform								2900	ECOTOX LOEL/10	NV
Bromomethane								320	ECOTOX LOEL	NV
Cadmium	2390	1490	2.4		1.9	1.9	1.9	0.21	EPA CCC (2008) (Hardness @ 70 mg/L)	0.6
Carbon Tetrachloride	18800		7.6		7.6	7.6	882	200	MADEP (2008)	NV
Chlordane	10700	6900	0.009		0.0085	0.0085	0.0085	0.0043	EPA CCC (2008)	0.007
Chloroaniline p-								32	ECOTOX LOEL	NV
Chlorobenzene								50	EPA FCC (1986)	NV
Chloroform	48300		81		81	81	825	1240	EPA FCC (1986)	NV
Chlorophenol, 2-								260	MADEP (2008)	NV
Chromium Total	3300	2050	193000		161	161	161	64	EPA CCC (2008) (Hardness @ 70 mg/L)	26
Chromium VI	8800		914		914	914	8540	11	EPA CCC (2008)	NV
Chrysene								0.07	ECOTOX LOEL/10	0.34
Cobalt	10288	4896	239		180	180	180	5.2	ECOTOX LOEL	50
Copper	16600	38400	772		283	772	3060	6.9	EPA CCC (2008) (Hardness @ 70 mg/L)	16
Cyanide (CN-)	81200	132	333		0.11	0.11	0.11	5.2	EPA CCC (2008)	0.1
Dibenz[a h]anthracene								0.04	ECOTOX- LOEL/10	0.06
Dibromochloromethane								6500	ECOTOX LOEL/10	NV
Dichlorobenzene, 1,2-								763	EPA FCC (1986)	NV
Dichlorobenzene, 1,3-								763	EPA FCC (1986)	NV

CHEMICAL NAME	Red Fox	Red Tailed Hawk	Short-tailed Shrew	Spring Peeper	Terrestrial Protection Value for Animal Life			Aquatic Receptor Protection Value (ug/L)	Basis	Sediment Quality Guidelines
					Agricultural	Residential/ Parkland	Commercial/ Industrial			
	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g			µg/g
Dichlorobenzene, 1,4-								763	EPA FCC (1986)	NV
Dichlorobenzidine, 3,3'-								50	MOE LOEL/10	NV
Dichlorodifluoromethane								350	MOE - QSAR (2000)	NV
DDD								0.18	ECOTOX LOEL	0.008
DDE								1.66	ECOTOX LOEL	0.005
DDT	820	628	0.0011		0.0011	0.0011	0.0012	0.001	EPA CCC (2008)	0.007
Dichloroethane, 1,1-								202000	ECOTOX LOEL	NV
Dichloroethane, 1,2-	58900	21400	245		29	29	29	20000	EPA FCC (1986)	NV
Dichloroethylene, 1,1-	35300		43		43	43	757	1200	MADEP (2008)	NV
Dichloroethylene, 1,2-cis-	53000		84		84	84	935	14000	MADEP (2008)	NV
Dichloroethylene, 1,2-trans-	53000		84		84	84	935	22000	MADEP (2008)	NV
Dichlorophenol, 2,4-								365	EPA FCC (1986)	NV
Dichloropropane, 1,2-								5700	EPA FCC (1986)	NV
Dichloropropene,1,3-								244	EPA FCC (1986)	NV
Dieldrin	235		0.00096		0.00096	0.00096	235	0.056	EPA CCC (2008)	0.002
Diethyl Phthalate	1000000		85		85	85	1000000	3	EPA FCC (1986)	NV
Dimethylphthalate								3	EPA FCC (1986)	NV
Dimethylphenol, 2,4-								3100	MADEP (2008)	NV
Dinitrophenol, 2,4-								900	MADEP (2008)	NV
Dinitrotoluene, 2,4 & 2,6-								230	EPA FCC (1986)	NV
Dioxane, 1,4	625		176		0.174	1.82	1.82	575000	Cantox (2007c))	NV
Dioxin/Furan (TEQ)	0.00032	0.0037	0.000013		0.000013	0.000013	0.000099	0.00001	EPA FCC (1986)	NV
Endosulfan	177	6300	0.023		0.023	0.023	1.2	0.056	EPA CCC (2008)	NV
Endrin	1080	63	0.0044		0.0011	0.0011	0.0011	0.036	EPA CCC (2008)	0.003
Ethylbenzene	480000		90		90	90	38400	181	MADEP (2008)	NV
Ethylene dibromide								9600	MADEP (2008)	NV
Fluoranthene	147000		0.69		0.69	0.69	115000	7.3	ECOTOX LOEL	0.75
Fluorene								29	ECOTOX LOEL	0.19
Heptachlor	1180		3.9		3.9	3.9	1090	0.0038	EPA CCC (2008)	NV
Heptachlor Epoxide								0.0038	EPA CCC (2008)	0.005
Hexachlorobenzene								23	MADEP (2008)	0.02
Hexachlorobutadiene								9.3	EPA FCC (1986)	NV
Hexachlorocyclohexane Gamma								0.095	EPA CMC/10 (2008)	NV
Hexachloroethane								540	EPA FCC (1986)	NV
Hexane (n)								250	ECOTOX LOEL/10	NV
Indeno[1 2 3-cd]pyrene								0.14	MADEP (2008)	0.2
Lead	88200	163000	1760		32	32	32	2	EPA CCC (2008) (Hardness @ 70 mg/L)	31
Mercury	216	178	32		20	20	20	0.77	EPA CCC (2008)	0.2
Methoxychlor	9410		0.13		0.13	0.13	4120	0.03	EPA FCC (1986)	NV
Methyl Ethyl Ketone	1000000		137000		5680	9920	9920	120000	ECOTOX LOEL	NV
Methyl Isobutyl Ketone								46000	ECOTOX LOEL/10	NV

CHEMICAL NAME	Red Fox	Red Tailed Hawk	Short-tailed Shrew	Spring Peeper	Terrestrial Protection Value for Animal Life			Aquatic Receptor Protection Value (ug/L)	Basis	Sediment Quality Guidelines
					Agricultural	Residential/ Parkland	Commercial/ Industrial			
	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g			µg/g
Methyl Mercury **	188	40	0.11		0.034	0.034	0.034	0.012	EPA FCC (1986)	NV
Methyl tert-Butyl Ether (MTBE)								100000	ECOTOX LOEL	NV
Methylene Chloride	58900		350		229	350	401	1320	ECOTOX LOEL/10	NV
Methlynaphthalene, 2-(1-) ***								146	ECOTOX LOEL/10	NV
Molybdenum	3050	22000	6.9		6.9	6.9	74	730	ECOTOX LOEL	NV
Naphthalene	11800		379		379	379	1260	620	EPA FCC (1986)	NV
Nickel	88500	65000	5010		5010	5010	5430	39	EPA CCC (2008) (Hardness @ 70 mg/L)	16
Pentachlorophenol	2820		0.013		0.013	0.013	2040	4.95	EPA CCC (2008) (at pH 6.7)	NV
Petroleum Hydrocarbons F1****										NV
Aliphatic C6-C8								46.5	CCME (2008)	NV
Aliphatic C>8-C10								7.6	CCME (2008)	NV
Aromatic C>8-C10								140	CCME (2008)	NV
Petroleum Hydrocarbons F2										NV
Aliphatic C>10-C12								1.18	CCME (2008)	NV
Aliphatic C>12-C16								0.074	CCME (2008)	NV
Aromatic C>10-C12								96	CCME (2008)	NV
Aromatic C>12-C16								55.4	CCME (2008)	NV
Petroleum Hydrocarbons F3										NV
Aliphatic C>16-C21									CCME (2008)	NV
Aliphatic C>21-C34									CCME (2008)	NV
Aromatic C>16-C21									CCME (2008)	NV
Aromatic C>21-C34									CCME (2008)	NV
Petroleum Hydrocarbons F4										NV
Aliphatic C>34									CCME (2008)	NV
Aromatic C>34									CCME (2008)	NV
Phenanthrene	82400		2650		2650	2650	36000	38	MADEP (2008)	0.56
Phenol	35300	6930	139		9.4	9.4	9.4	961	ECOTOX LOEL	NV
Polychlorinated Biphenyls	1040	218	1.2		1.1	1.1	1.1	0.014	EPA CCC (2008)	0.07
Pyrene	147000		4740		4740	4740	99100	0.57	ECOTOX LOEL/10	0.49
Selenium	212	2190	2.4		2.4	2.4	5.5	5	EPA CCC (2008)	NV
Silver								0.12	EPA FCC (1986)	0.5
Styrene								720	ECOTOX LOEL	NV
Tetrachloroethane, 1,1,1,2-								2000	MADEP (2008)	NV
Tetrachloroethane, 1,1,2,2-								2400	EPA FCC (1986)	NV
Tetrachloroethylene	8240		4.54		4.54	4.54	310	840	EPA FCC (1986)	NV
Thallium	47		3.9		3.9	3.9	47	40	EPA FCC (1986)	NV
Toluene	306000		135		135	135	13600	1400	MADEP (2008)	NV
Trichlorobenzene, 1,2,4-								340	MADEP (2008)	NV
Trichloroethane, 1,1,1-	1000000		824		824	824	38500	900	MADEP (2008)	NV
Trichloroethane, 1,1,2-								9400	EPA FCC (1986)	NV
Trichloroethylene	11800		8.1		8.1	8.1	385	21900	EPA FCC (1986)	NV

CHEMICAL NAME	Red Fox	Red Tailed Hawk	Short-tailed Shrew	Spring Peeper	Terrestrial Protection Value for Animal Life			Aquatic Receptor Protection Value (ug/L)	Basis	Sediment Quality Guidelines
					Agricultural	Residential/ Parkland	Commercial/ Industrial			
	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g	ug/g			µg/g
Trichlorofluoromethane								200	MOE(2000) -QSAR	NV
Trichlorophenol, 2,4,5-								130	MADEP (2008)	NV
Trichlorophenol, 2,4,6-								18	MADEP (2008)	NV
Uranium					33	33	33	33	Vizon SciTec (2004)	NV
Vanadium	2470	239	108		18	18	18	20	ECOTOX LOEL	NV
Vinyl Chloride	2000		14		6.8	12	12	35600	ECOTOX LOEL/10	NV
Xylene Mixture	589000		96		96	96	47000	330	ECOTOX LOEL/10	NV
Zinc	36900	79000	5520		337	337	337	89	EPA CCC (2008) (Hardness @ 70 mg/L)	120
Electrical Conductivity (mS/cm)										NA
Chloride								180000	Cantox (2007b)	NV
Sodium Adsorption Ratio										NA
Sodium								180000	substitute chloride value for Na	NV

Information Used in Determination of Final Direct Contact Ecological Soil Criteria

Ontario MOE Developed (2008) Soil Remediation Criteria

CHEMICAL NAME	Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/Commercial Coarse	Industrial/Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg
Acenaphthene				
Acenaphthylene				
Acetone				
Aldrin				
Anthracene				
Antimony	20	25	40	50
Arsenic	22	28	34	43
Barium	750	1000	1500	2000
Benzene				
Benz[a]anthracene				
Benzo[a]pyrene				
Benzo[b]fluoranthene				
Benzo[ghi]perylene				
Benzo[k]fluoranthene				
Beryllium	4	5	8	10
Biphenyl 1,1'-				
Bis(2-chloroethyl)ether				
Bis(2-chloroisopropyl)ether				
Bis(2-ethylhexyl)phthalate				
Boron (Hot Water Soluble)*	1.5	1.5	2	2
Boron (total)				
Bromodichloromethane				
Bromoform				
Bromomethane				
Cadmium	10	13	24	30
Carbon Tetrachloride				
Chlordane				
Chloroaniline p-	20	25	40	50
Chlorobenzene				
Chloroform				
Chlorophenol, 2-				
Chromium Total	312	390	500	630
Chromium VI	8	10	8	10
Chrysene				
Cobalt	33	41	72	90
Copper	140	180	230	290
Cyanide (CN-)				
Dibenz[a h]anthracene				
Dibromochloromethane				
Dichlorobenzene, 1,2-				
Dichlorobenzene, 1,3-				

Information Used in Determination of Final Direct Contact Ecological Soil Criteria

Ontario MOE Developed (2008) Soil Remediation Criteria

CHEMICAL NAME	Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/Commercial Coarse	Industrial/Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg
Dichlorobenzene, 1,4-				
Dichlorobenzidine, 3,3'-				
Dichlorodifluoromethane	40	50	80	100
DDD				
DDE				
DDT	1	1.3	6.3	7.8
Dichloroethane, 1,1-				
Dichloroethane, 1,2-				
Dichloroethylene, 1,1-	50	63	100	125
Dichloroethylene, 1,2-cis-				
Dichloroethylene, 1,2-trans-				
Dichlorophenol, 2,4-				
Dichloropropane, 1,2-				
Dichloropropene,1,3-				
Dieldrin				
Diethyl Phthalate				
Dimethylphthalate				
Dimethylphenol, 2,4-				
Dinitrophenol, 2,4-				
Dinitrotoluene, 2,4 & 2,6-				
Dioxane, 1,4				
Dioxin/Furan (TEQ)				
Endosulfan	0.15	0.19	0.3	0.38
Endrin				
Ethylbenzene				
Ethylene dibromide				
Fluoranthene				
Fluorene				
Heptachlor				
Heptachlor Epoxide				
Hexachlorobenzene	100	125	200	250
Hexachlorobutadiene				
Hexachlorocyclohexane Gamma	5.9	7.4	12	15
Hexachloroethane				
Hexane (n)				
Indeno[1 2 3-cd]pyrene				
Lead	250	310	1100	1400
Mercury				
Methoxychlor				
Methyl Ethyl Ketone				
Methyl Isobutyl Ketone				

Information Used in Determination of Final Direct Contact Ecological Soil Criteria

Ontario MOE Developed (2008) Soil Remediation Criteria

CHEMICAL NAME	Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/Commercial Coarse	Industrial/Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg
Methyl Mercury **				
Methyl tert-Butyl Ether (MTBE)				
Methylene Chloride				
Methlynaphthalene, 2-(1-) ***				
Molybdenum	40	40	40	40
Naphthalene				
Nickel	100	130	270	340
Pentachlorophenol	17	21	31	39
Petroleum Hydrocarbons F1****				
Aliphatic C6-C8				
Aliphatic C>8-C10				
Aromatic C>8-C10				
Petroleum Hydrocarbons F2				
Aliphatic C>10-C12				
Aliphatic C>12-C16				
Aromatic C>10-C12				
Aromatic C>12-C16				
Petroleum Hydrocarbons F3				
Aliphatic C>16-C21				
Aliphatic C>21-C34				
Aromatic C>16-C21				
Aromatic C>21-C34				
Petroleum Hydrocarbons F4				
Aliphatic C>34				
Aromatic C>34				
Phenanthrene				
Phenol	17	22	35	44
Polychlorinated Biphenyls				
Pyrene				
Selenium	10	12.5	10	12.5
Silver	20	25	40	50
Styrene				
Tetrachloroethane, 1,1,1,2-				
Tetrachloroethane, 1,1,2,2-				
Tetrachloroethylene				
Thallium				
Toluene				
Trichlorobenzene, 1,2,4-	13	16	26	32
Trichloroethane, 1,1,1-				
Trichloroethane, 1,1,2-				
Trichloroethylene	100	125	200	250

Information Used in Determination of Final Direct Contact Ecological Soil Criteria

CHEMICAL NAME	Ontario MOE Developed (2008) Soil Remediation Criteria			
	Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/Commercial Coarse	Industrial/Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg
Trichlorofluoromethane	16	20	32	40
Trichlorophenol, 2,4,5-				
Trichlorophenol, 2,4,6-	4.4	5.5	8.8	11
Uranium				
Vanadium	200	250	200	250
Vinyl Chloride				
Xylene Mixture				
Zinc	400	500	600	800
Electrical Conductivity (mS/cm)	0.7	0.7	1.4	1.4
Chloride				
Sodium Adsorption Ratio	5	5	12	12
Sodium				

CHEMICAL NAME	CCME Soil Quality Guidelines					
	Toxicity to soil invertebrates and plants					
	Agricultural		Residential		Industrial/Commercial	
	Coarse	Medium/fine	Coarse	Medium/fine	Coarse	Medium/fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Acenaphthene						
Acenaphthylene						
Acetone						
Aldrin						
Anthracene	2.5		2.5		32	
Antimony						
Arsenic	17		17		26	
Barium						
Benzene	31	60	31	60	180	310
Benz[a]anthracene						
Benzo[a]pyrene	20		20		72	
Benzo[b]fluoranthene						
Benzo[ghi]perylene						
Benzo[k]fluoranthene						
Beryllium						
Biphenyl 1,1'-						
Bis(2-chloroethyl)ether						
Bis(2-chloroisopropyl)ether						
Bis(2-ethylhexyl)phthalate						
Boron (Hot Water Soluble)*						
Boron (total)						
Bromodichloromethane						
Bromoform						
Bromomethane						
Cadmium	10		10		22	
Carbon Tetrachloride						
Chlordane						
Chloroaniline p-						
Chlorobenzene						
Chloroform						
Chlorophenol, 2-						
Chromium Total	64		64		87	
Chromium VI	0.4		0.4		1.4	
Chrysene						
Cobalt						
Copper	63		63		91	
Cyanide (CN-)	0.9		0.9		8	
Dibenz[a h]anthracene						
Dibromochloromethane						
Dichlorobenzene, 1,2-						
Dichlorobenzene, 1,3-						

CHEMICAL NAME	CCME Soil Quality Guidelines					
	Toxicity to soil invertebrates and plants					
	Agricultural		Residential		Industrial/Commercial	
	Coarse	Medium/fine	Coarse	Medium/fine	Coarse	Medium/fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Dichlorobenzene, 1,4-						
Dichlorobenzidine, 3,3'-						
Dichlorodifluoromethane						
DDD						
DDE						
DDT	12		12		12	
Dichloroethane, 1,1-						
Dichloroethane, 1,2-						
Dichloroethylene, 1,1-						
Dichloroethylene, 1,2-cis-						
Dichloroethylene, 1,2-trans-						
Dichlorophenol, 2,4-						
Dichloropropane, 1,2-						
Dichloropropene,1,3-						
Dieldrin						
Diethyl Phthalate						
Dimethylphthalate						
Dimethylphenol, 2,4-						
Dinitrophenol, 2,4-						
Dinitrotoluene, 2,4 & 2,6-						
Dioxane, 1,4						
Dioxin/Furan (TEQ)						
Endosulfan						
Endrin						
Ethylbenzene	55	120	55	120	300	430
Ethylene dibromide						
Fluoranthene	50		50		180	
Fluorene						
Heptachlor						
Heptachlor Epoxide						
Hexachlorobenzene						
Hexachlorobutadiene						
Hexachlorocyclohexane Gamma						
Hexachloroethane						
Hexane (n)						
Indeno[1 2 3-cd]pyrene						
Lead	300		300		600	
Mercury	12		12		50	
Methoxychlor						
Methyl Ethyl Ketone						
Methyl Isobutyl Ketone						

CHEMICAL NAME	CCME Soil Quality Guidelines					
	Toxicity to soil invertebrates and plants					
	Agricultural		Residential		Industrial/Commercial	
	Coarse	Medium/fine	Coarse	Medium/fine	Coarse	Medium/fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Methyl Mercury **						
Methyl tert-Butyl Ether (MTBE)						
Methylene Chloride						
Methlynaphthalene, 2-(1-) ***						
Molybdenum						
Naphthalene	0.6		0.6		22	
Nickel	50		50		50	
Pentachlorophenol	11		11		28	
Petroleum Hydrocarbons F1****	210	210	210	210	320	320
Aliphatic C6-C8						
Aliphatic C>8-C10						
Aromatic C>8-C10						
Petroleum Hydrocarbons F2	150	150	150	150	260	260
Aliphatic C>10-C12						
Aliphatic C>12-C16						
Aromatic C>10-C12						
Aromatic C>12-C16						
Petroleum Hydrocarbons F3	300	1300	300	1300	1700	2500
Aliphatic C>16-C21						
Aliphatic C>21-C34						
Aromatic C>16-C21						
Aromatic C>21-C34						
Petroleum Hydrocarbons F4	2800	5600	2800	5600	3300	6600
Aliphatic C>34						
Aromatic C>34						
Phenanthrene						
Phenol	20		20		128	
Polychlorinated Biphenyls	33		33		33	
Pyrene						
Selenium	1		1		3.9	
Silver						
Styrene						
Tetrachloroethane, 1,1,1,2-						
Tetrachloroethane, 1,1,2,2-						
Tetrachloroethylene	3.8		3.8		34	
Thallium	1.4		1.4		3.6	
Toluene	150	220	150	220	500	660
Trichlorobenzene, 1,2,4-						
Trichloroethane, 1,1,1-						
Trichloroethane, 1,1,2-						
Trichloroethylene	3		3		31	

CHEMICAL NAME	CCME Soil Quality Guidelines					
	Toxicity to soil invertebrates and plants					
	Agricultural		Residential		Industrial/Commercial	
	Coarse	Medium/fine	Coarse	Medium/fine	Coarse	Medium/fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Trichlorofluoromethane						
Trichlorophenol, 2,4,5-						
Trichlorophenol, 2,4,6-						
Uranium	500	500	500	500	2000	2000
Vanadium	130		130		130	
Vinyl Chloride						
Xylene Mixture	95	55	95	55	350	210
Zinc	200		200		360	
Electrical Conductivity (mS/cm)						
Chloride						
Sodium Adsorption Ratio						
Sodium						

CHEMICAL NAME	Dutch ecotoxicological soil values (mg/kg in a standard soil 10% organic matter and 25% clay)					SRCeco recalculated to 2% OM
	Target Soil Screening Benchmark	Maximum Permissible Concentration	SRC_{ECO} Soil Screening Benchmark	Revised SRC_{ECO} Soil Screening Benchmark	Current SRC_{ECO} Soil Screening Benchmark	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Swartjes, 1999; VROM, 1999;	Crommentuijn *et al*., 1997a;	Swartjes, 1999	Lizjen *et al*., 2001		Q*0.2 for organics
Acenaphthene						
Acenaphthylene						
Acetone						
Aldrin	0.06		0.35	0.22	0.22	0.044
Anthracene	0.0012	0.12		1.6	1.6	0.32
Antimony	3	3.5	2900		2900	
Arsenic	29	34	40	85	85	
Barium	160	165	650	890	890	
Benzene	0.01		25	130	130	26
Benz[a]anthracene	0.0025	0.25		2.5	2.5	0.5
Benzo[a]pyrene	0.0026	0.26		7	7	1.4
Benzo[b]fluoranthene						
Benzo[ghi]perylene	0.075	7.5		33	33	6.6
Benzo[k]fluoranthene	0.024	2.4		38	38	7.6
Beryllium	1.1	1.1	29		29	
Biphenyl 1,1'-						
Bis(2-chloroethyl)ether						
Bis(2-chloroisopropyl)ether						
Bis(2-ethylhexyl)phthalate				69	69	13.8
Boron (Hot Water Soluble)*						
Boron (total)						
Bromodichloromethane						
Bromoform						
Bromomethane						
Cadmium	0.8	1.6	12	13	13	
Carbon Tetrachloride				29	29	5.8
Chlordane	0.00003		5.4		5.4	1.08
Chloroaniline p-						
Chlorobenzene			30		30	6
Chloroform	0.02			170	170	34
Chlorophenol, 2-				7.8	7.8	1.56
Chromium Total	100	100	230	220	220	
Chromium VI						
Chrysene	0.107	10.7		35	35	7
Cobalt	9	33	240	180	180	
Copper	36	40	190	96	96	
Cyanide (CN-)						
Dibenz[a h]anthracene						
Dibromochloromethane						
Dichlorobenzene, 1,2-				17	17	3.4
Dichlorobenzene, 1,3-				24	24	4.8

CHEMICAL NAME	Dutch ecotoxicological soil values (mg/kg in a standard soil 10% organic matter and 25% clay)					SRCeco recalculated to 2% OM
	Target Soil Screening Benchmark	Maximum Permissible Concentration	SRC_{ECO} Soil Screening Benchmark	Revised SRC_{ECO} Soil Screening Benchmark	Current SRC_{ECO} Soil Screening Benchmark	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Swartjes, 1999; VROM, 1999;	Crommentuijn *et al*., 1997a;	Swartjes, 1999	Lizjen *et al*., 2001		Q*0.2 for organics
Dichlorobenzene, 1,4-				18	18	3.6
Dichlorobenzidine, 3,3'-						
Dichlorodifluoromethane						
DDD				34	34	6.8
DDE	0.01			1.3	1.3	0.26
DDT	0.09			1	1	0.2
Dichloroethane, 1,1-	0.02		42		42	8.4
Dichloroethane, 1,2-	0.02		60	240	240	48
Dichloroethylene, 1,1-						
Dichloroethylene, 1,2-cis-						
Dichloroethylene, 1,2-trans-						
Dichlorophenol, 2,4-				8.4	8.4	1.68
Dichloropropane, 1,2-	0.002		125		125	25
Dichloropropene,1,3-	0.002		125		125	25
Dieldrin	0.0005		4	0.22	0.22	0.044
Diethyl Phthalate				53	53	10.6
Dimethylphthalate				84	84	16.8
Dimethylphenol, 2,4-						
Dinitrophenol, 2,4-						
Dinitrotoluene, 2,4 & 2,6-						
Dioxane, 1,4						
Dioxin/Furan (TEQ)						
Endosulfan	0.00001		7.1		7.1	1.42
Endrin	0.00004		0.06	0.095	0.095	0.019
Ethylbenzene	0.03			110	110	22
Ethylene dibromide						
Fluoranthene	0.026	2.6		260	260	52
Fluorene						
Heptachlor	0.0007		1		1	0.2
Heptachlor Epoxide	0.0000002					
Hexachlorobenzene				2	2	0.4
Hexachlorobutadiene						
Hexachlorocyclohexane Gamma	0.00005		2	1.2	1.2	0.24
Hexachloroethane	0.17					
Hexane (n)						
Indeno[1 2 3-cd]pyrene	0.059	5.9		1.9	1.9	0.38
Lead	85	140	290	580	580	
Mercury	0.3	2.2	10	36	36	
Methoxychlor						
Methyl Ethyl Ketone			175		175	35
Methyl Isobutyl Ketone						

CHEMICAL NAME	Dutch ecotoxicological soil values (mg/kg in a standard soil 10% organic matter and 25% clay)					SRCeco recalculated to 2% OM
	Target Soil Screening Benchmark	Maximum Permissible Concentration	SRC_{ECO} Soil Screening Benchmark	Revised SRC_{ECO} Soil Screening Benchmark	Current SRC_{ECO} Soil Screening Benchmark	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Swartjes, 1999; VROM, 1999;	Crommentuijn *et al*., 1997a;	Swartjes, 1999	Lizjen *et al*., 2001		Q*0.2 for organics
Methyl Mercury **	0.3	0.67		4	4	0.8
Methyl tert-Butyl Ether (MTBE)			125		125	25
Methylene Chloride				3.9	3.9	0.78
Methlynaphthalene, 2-(1-) ***						
Molybdenum	3	254	480	190	190	
Naphthalene	0.0014	0.14		17	17	3.4
Nickel	35	38	210	100	100	
Pentachlorophenol	0.002		5	12	12	2.4
Petroleum Hydrocarbons F1****						
Aliphatic C6-C8						
Aliphatic C>8-C10						
Aromatic C>8-C10						
Petroleum Hydrocarbons F2						
Aliphatic C>10-C12						
Aliphatic C>12-C16						
Aromatic C>10-C12						
Aromatic C>12-C16						
Petroleum Hydrocarbons F3						
Aliphatic C>16-C21						
Aliphatic C>21-C34						
Aromatic C>16-C21						
Aromatic C>21-C34						
Petroleum Hydrocarbons F4						
Aliphatic C>34						
Aromatic C>34						
Phenanthrene	0.0051	0.51		31	31	6.2
Phenol			40	14	14	2.8
Polychlorinated Biphenyls			1	3.4	3.4	0.68
Pyrene						
Selenium	0.7	0.81	5		5	
Silver			15		15	
Styrene	0.3			86	86	17.2
Tetrachloroethane, 1,1,1,2-						
Tetrachloroethane, 1,1,2,2-						
Tetrachloroethylene						
Thallium	1	1.3	14		14	2.8
Toluene	0.01		130	47	47	9.4
Trichlorobenzene, 1,2,4-				5.1	5.1	1.02
Trichloroethane, 1,1,1-	0.07		88		88	17.6
Trichloroethane, 1,1,2-	0.4		400		400	80
Trichloroethylene						

CHEMICAL NAME	Dutch ecotoxicological soil values (mg/kg in a standard soil 10% organic matter and 25% clay)					SRCeco recalculated to 2% OM
	Target Soil Screening Benchmark	Maximum Permissible Concentration	SRC_{ECO} Soil Screening Benchmark	Revised SRC_{ECO} Soil Screening Benchmark	Current SRC_{ECO} Soil Screening Benchmark	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Swartjes, 1999; VROM, 1999;	Crommentuijn *et al*., 1997a;	Swartjes, 1999	Lizjen *et al*., 2001		Q*0.2 for organics
Trichlorofluoromethane						
Trichlorophenol, 2,4,5-				22	22	4.4
Trichlorophenol, 2,4,6-				8.1	8.1	1.62
Uranium						
Vanadium	42	43	250		250	
Vinyl Chloride	0.01		60	17	17	3.4
Xylene Mixture				17	17	3.4
Zinc	140	160	720	350	350	
Electrical Conductivity (mS/cm)						
Chloride						
Sodium Adsorption Ratio						
Sodium						

CHEMICAL NAME	2008 Terrestrial Ecological Protection values - before comparison to 1996 values				1996 Terrestrial Ecological Protection values			
	Toxicity to soil invertebrates and plants				Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Acenaphthene								
Acenaphthylene								
Acetone								
Aldrin	0.044	0.055	0.088	0.11	0.35	0.35	0.35	0.35
Anthracene	2.5	3.125	32	40	40	40	40	40
Antimony	20	25	40	50	20	25	40	50
Arsenic	22	28	34	43	20	25	40	50
Barium	750	1000	1500	2000	750	1000	1500	2000
Benzene	31	60	180	310	25	25	25	25
Benz[a]anthracene	0.5	0.625	1	1.25	40	40	40	40
Benzo[a]pyrene	20	25	72	90	40	40	40	40
Benzo[b]fluoranthene								
Benzo[ghi]perylene	6.6	8.25	13.2	16.5	40	40	40	40
Benzo[k]fluoranthene	7.6	9.5	15.2	19	40	40	40	40
Beryllium	4	5	8	10	4	5	8	10
Biphenyl 1,1'-								
Bis(2-chloroethyl)ether								
Bis(2-chloroisopropyl)ether								
Bis(2-ethylhexyl)phthalate	13.8	17.25	27.6	34.5				
Boron (Hot Water Soluble)*	1.5	1.5	2	2	1.5	1.5	2	2
Boron (total)								
Bromodichloromethane								
Bromoform								
Bromomethane								
Cadmium	10	13	24	30	12	12	12	12
Carbon Tetrachloride	5.8	7.25	11.6	14.5				
Chlordane	1.08	1.35	2.16	2.7				
Chloroaniline p-	20	25	40	50				
Chlorobenzene	6	7.5	12	15	30	30	30	30
Chloroform	34	42.5	68	85				
Chlorophenol, 2-	1.56	1.95	3.12	3.9	10	10	10	10
Chromium Total	312	390	500	630	750	1000	750	1000
Chromium VI	8	10	8	10	8	10	8	10
Chrysene	7	8.75	14	17.5	40	40	40	40
Cobalt	33	41	72	90	40	50	80	100
Copper	140	180	230	290	225	300	225	300
Cyanide (CN-)	0.9	1.125	8	10				
Dibenz[a h]anthracene								
Dibromochloromethane								
Dichlorobenzene, 1,2-	3.4	4.25	6.8	8.5	30	30	30	30
Dichlorobenzene, 1,3-	4.8	6	9.6	12	30	30	30	30

CHEMICAL NAME	2008 Terrestrial Ecological Protection values - before comparison to 1996 values				1996 Terrestrial Ecological Protection values			
	Toxicity to soil invertebrates and plants				Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Dichlorobenzene, 1,4-	3.6	4.5	7.2	9	30	30	30	30
Dichlorobenzidine, 3,3'-								
Dichlorodifluoromethane	40	50	80	100				
DDD	6.8	8.5	13.6	17				
DDE	0.26	0.325	0.52	0.65	4	4	4	4
DDT	1	1.3	6.3	7.8	4	4	4	4
Dichloroethane, 1,1-	8.4	10.5	16.8	21				
Dichloroethane, 1,2-	48	60	96	120	60	60	60	60
Dichloroethylene, 1,1-	50	63	100	125				
Dichloroethylene, 1,2-cis-								
Dichloroethylene, 1,2-trans-								
Dichlorophenol, 2,4-	1.68	2.1	3.36	4.2	10	10	10	10
Dichloropropane, 1,2-	25	31.25	50	62.5				
Dichloropropene,1,3-	25	31.25	50	62.5				
Dieldrin	0.044	0.055	0.088	0.11	4	4	4	4
Diethyl Phthalate	10.6	13.25	21.2	26.5				
Dimethylphthalate	16.8	21	33.6	42				
Dimethylphenol, 2,4-								
Dinitrophenol, 2,4-								
Dinitrotoluene, 2,4 & 2,6-								
Dioxane, 1,4								
Dioxin/Furan (TEQ)								
Endosulfan	0.15	0.19	0.3	0.38				
Endrin	0.019	0.02375	0.038	0.0475	0.06	0.06	0.06	0.06
Ethylbenzene	55	120	300	430				
Ethylene dibromide								
Fluoranthene	50	62.5	180	225	40	40	40	40
Fluorene								
Heptachlor	0.2	0.25	0.4	0.5				
Heptachlor Epoxide								
Hexachlorobenzene	100	125	200	250	30	30	30	30
Hexachlorobutadiene								
Hexachlorocyclohexane Gamma	5.9	7.4	12	15	2	2	2	2
Hexachloroethane								
Hexane (n)								
Indeno[1 2 3-cd]pyrene	0.38	0.475	0.76	0.95	40	40	40	40
Lead	250	310	1100	1400	200	200		
Mercury	12	15	50	62.5	10	10	10	10
Methoxychlor								
Methyl Ethyl Ketone	35	43.75	70	87.5				
Methyl Isobutyl Ketone								

CHEMICAL NAME	2008 Terrestrial Ecological Protection values - before comparison to 1996 values				1996 Terrestrial Ecological Protection values			
	Toxicity to soil invertebrates and plants				Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Methyl Mercury **	0.8	1	1.6	2	10	10	10	10
Methyl tert-Butyl Ether (MTBE)	25	31.25	50	62.5				
Methylene Chloride	0.78	0.975	1.56	1.95				
Methlynaphthalene, 2-(1-) ***								
Molybdenum	40	40	40	40	40	40	40	40
Naphthalene	0.6	0.75	22	27.5	40	40	40	40
Nickel	100	130	270	340	150	200	150	200
Pentachlorophenol	17	21	31	39	5	5	5	5
Petroleum Hydrocarbons F1****	210	210	320	320				
Aliphatic C6-C8								
Aliphatic C>8-C10								
Aromatic C>8-C10								
Petroleum Hydrocarbons F2	150	150	260	260				
Aliphatic C>10-C12								
Aliphatic C>12-C16								
Aromatic C>10-C12								
Aromatic C>12-C16								
Petroleum Hydrocarbons F3	300	1300	1700	2500				
Aliphatic C>16-C21								
Aliphatic C>21-C34								
Aromatic C>16-C21								
Aromatic C>21-C34								
Petroleum Hydrocarbons F4	2800	5600	3300	6600				
Aliphatic C>34								
Aromatic C>34								
Phenanthrene	6.2	7.75	12.4	15.5	40	40	40	40
Phenol	17	22	35	44	40	40	40	40
Polychlorinated Biphenyls	33	41.25	33	41.25				
Pyrene								
Selenium	10	12.5	10	12.5	10	10	10	10
Silver	20	25	40	50	20	25	40	50
Styrene	17.2	21.5	34.4	43				
Tetrachloroethane, 1,1,1,2-								
Tetrachloroethane, 1,1,2,2-								
Tetrachloroethylene	3.8	4.75	34	42.5	60	60	60	60
Thallium	1.4	1.75	3.6	4.5				
Toluene	150	220	500	660	150	150	150	150
Trichlorobenzene, 1,2,4-	13	16	26	32	30	30	30	30
Trichloroethane, 1,1,1-	17.6	22	35.2	44				
Trichloroethane, 1,1,2-	80	100	160	200				
Trichloroethylene	100	125	200	250	60	60	60	60

CHEMICAL NAME	2008 Terrestrial Ecological Protection values - before comparison to 1996 values				1996 Terrestrial Ecological Protection values			
	Toxicity to soil invertebrates and plants				Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Trichlorofluoromethane	16	20	32	40				
Trichlorophenol, 2,4,5-	4.4	5.5	8.8	11	10	10	10	10
Trichlorophenol, 2,4,6-	4.4	5.5	8.8	11	10	10	10	10
Uranium	500	500	2000	2000				
Vanadium	200	250	200	250	200	250	200	250
Vinyl Chloride	3.4	4.25	6.8	8.5	60	60	60	60
Xylene Mixture	95	55	350	210				
Zinc	400	500	600	800	600	800	600	800
Electrical Conductivity (mS/cm)	0.7	0.7	1.4	1.4	0.7	0.7	1.4	1.4
Chloride								
Sodium Adsorption Ratio	5	5	12	12	5	5	12	12
Sodium								

CHEMICAL NAME	2008 Terrestrial Ecological Protection values - final - after comparison to 1996			
	Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg
Acenaphthene				
Acenaphthylene				
Acetone				
Aldrin	0.044	0.055	0.088	0.11
Anthracene	2.5	3.125	32	40
Antimony	20	25	40	50
Arsenic	20	25	40	50
Barium	750	1000	1500	2000
Benzene	25	60	180	310
Benz[a]anthracene	0.5	0.625	1	1.25
Benzo[a]pyrene	20	25	72	90
Benzo[b]fluoranthene				
Benzo[ghi]perylene	6.6	8.25	13.2	16.5
Benzo[k]fluoranthene	7.6	9.5	15.2	19
Beryllium	4	5	8	10
Biphenyl 1,1'-				
Bis(2-chloroethyl)ether				
Bis(2-chloroisopropyl)ether				
Bis(2-ethylhexyl)phthalate	13.8	17.25	27.6	34.5
Boron (Hot Water Soluble)*	1.5	1.5	2	2
Boron (total)				
Bromodichloromethane				
Bromoform				
Bromomethane				
Cadmium	12	12	24	30
Carbon Tetrachloride	5.8	7.25	11.6	14.5
Chlordane	1.08	1.35	2.16	2.7
Chloroaniline p-	20	25	40	50
Chlorobenzene	6	7.5	12	15
Chloroform	34	42.5	68	85
Chlorophenol, 2-	1.56	1.95	3.12	3.9
Chromium Total	312	390	500	630
Chromium VI	8	10	8	10
Chrysene	7	8.75	14	17.5
Cobalt	40	50	80	100
Copper	140	180	225	300
Cyanide (CN-)	0.9	1.125	8	10
Dibenz[a h]anthracene				
Dibromochloromethane				
Dichlorobenzene, 1,2-	3.4	4.25	6.8	8.5
Dichlorobenzene, 1,3-	4.8	6	9.6	12

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	Toxicity to soil invertebrates and plants			
	Residential Coarse	Residential Medium/fine	Industrial/ Commercial Coarse	Industrial/ Commercial Medium/Fine
	mg/kg	mg/kg	mg/kg	mg/kg
Dichlorobenzene, 1,4-	3.6	4.5	7.2	9
Dichlorobenzidine, 3,3'-				
Dichlorodifluoromethane	40	50	80	100
DDD	6.8	8.5	13.6	17
DDE	0.26	0.325	0.52	0.65
DDT	1	1.3	6.3	7.8
Dichloroethane, 1,1-	8.4	10.5	16.8	21
Dichloroethane, 1,2-	48	60	96	120
Dichloroethylene, 1,1-	50	63	100	125
Dichloroethylene, 1,2-cis-				
Dichloroethylene, 1,2-trans-				
Dichlorophenol, 2,4-	1.68	2.1	3.36	4.2
Dichloropropane, 1,2-	25	31.25	50	62.5
Dichloropropene,1,3-	25	31.25	50	62.5
Dieldrin	0.044	0.055	0.088	0.11
Diethyl Phthalate	10.6	13.25	21.2	26.5
Dimethylphthalate	16.8	21	33.6	42
Dimethylphenol, 2,4-				
Dinitrophenol, 2,4-				
Dinitrotoluene, 2,4 & 2,6-				
Dioxane, 1,4				
Dioxin/Furan (TEQ)				
Endosulfan	0.15	0.19	0.3	0.38
Endrin	0.019	0.02375	0.038	0.0475
Ethylbenzene	55	120	300	430
Ethylene dibromide				
Fluoranthene	50	62.5	180	225
Fluorene				
Heptachlor	0.2	0.25	0.4	0.5
Heptachlor Epoxide				
Hexachlorobenzene	100	125	200	250
Hexachlorobutadiene				
Hexachlorocyclohexane Gamma	5.9	7.4	12	15
Hexachloroethane				
Hexane (n)				
Indeno[1 2 3-cd]pyrene	0.38	0.475	0.76	0.95
Lead	250	310	1100	1400
Mercury	10	15	50	62.5
Methoxychlor				
Methyl Ethyl Ketone	35	43.75	70	87.5
Methyl Isobutyl Ketone				

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	mg/kg	mg/kg	mg/kg	mg/kg
Methyl Mercury **	0.8	1	1.6	2
Methyl tert-Butyl Ether (MTBE)	25	31.25	50	62.5
Methylene Chloride	0.78	0.975	1.56	1.95
Methlynaphthalene, 2-(1-) ***				
Molybdenum	40	40	40	40
Naphthalene	0.6	0.75	22	27.5
Nickel	100	130	270	340
Pentachlorophenol	17	21	31	39
Petroleum Hydrocarbons F1****	210	210	320	320
Aliphatic C6-C8				
Aliphatic C>8-C10				
Aromatic C>8-C10				
Petroleum Hydrocarbons F2	150	150	260	260
Aliphatic C>10-C12				
Aliphatic C>12-C16				
Aromatic C>10-C12				
Aromatic C>12-C16				
Petroleum Hydrocarbons F3	300	1300	1700	2500
Aliphatic C>16-C21				
Aliphatic C>21-C34				
Aromatic C>16-C21				
Aromatic C>21-C34				
Petroleum Hydrocarbons F4	2800	5600	3300	6600
Aliphatic C>34				
Aromatic C>34				
Phenanthrene	6.2	7.75	12.4	15.5
Phenol	17	22	40	40
Polychlorinated Biphenyls	33	41.25	33	41.25
Pyrene				
Selenium	10	12.5	10	12.5
Silver	20	25	40	50
Styrene	17.2	21.5	34.4	43
Tetrachloroethane, 1,1,1,2-				
Tetrachloroethane, 1,1,2,2-				
Tetrachloroethylene	3.8	4.75	34	42.5
Thallium	1.4	1.75	3.6	4.5
Toluene	150	220	500	660
Trichlorobenzene, 1,2,4-	13	16	30	30
Trichloroethane, 1,1,1-	17.6	22	35.2	44
Trichloroethane, 1,1,2-	80	100	160	200
Trichloroethylene	100	125	200	250

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	mg/kg	mg/kg	mg/kg	mg/kg
Trichlorofluoromethane	16	20	32	40
Trichlorophenol, 2,4,5-	4.4	5.5	10	10
Trichlorophenol, 2,4,6-	4.4	5.5	10	10
Uranium	500	500	2000	2000
Vanadium	200	250	200	250
Vinyl Chloride	3.4	4.25	6.8	8.5
Xylene Mixture	95	55	350	210
Zinc	400	500	600	800
Electrical Conductivity (mS/cm)	0.7	0.7	1.4	1.4
Chloride				
Sodium Adsorption Ratio	5	5	12	12
Sodium				