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de l'environnement

CANADIAN GROUNDWATER QUALITY GUIDELINES FOR THE PROTECTION OF ENVIRONMENTAL AND HUMAN HEALTH

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LIST OF ABBREVIATIONS

Adj.F	adjustment factor
AF	allocation factor
AO	aesthetic objective
BGC	background groundwater concentration
BTEX	benzene, toluene, ethylbenzene, and xylenes
CCME	Canadian Council of Ministers of the Environment
CGWQG	Canadian groundwater quality guideline. Its value is based on the GWQG _F (groundwater quality guideline final).
DNAPL	dense non-aqueous phase liquid
GWQG	groundwater quality guideline
GWQG _F	groundwater quality guideline final. This final guideline, selected based on the lowest of available environmental and human health pathway-specific guidelines for a chemical, becomes the CGWQG (Canadian groundwater quality guideline).
GWQG _{FL}	groundwater quality guideline for the protection of freshwater aquatic life
GWQG _{GC}	groundwater quality guideline for groundwater contact by soil-dependant organisms
GWQG _{IAQ}	groundwater quality guideline for the protection of indoor air quality
GWQG _{IR}	groundwater quality guideline for the protection of irrigation water
GWQG _{LW}	groundwater quality guideline for the protection of livestock watering
GWQG _M	groundwater quality guideline for management considerations
GWQG _{ML}	groundwater quality guideline for the protection of marine aquatic life
GWQG _{PW}	groundwater quality guideline for the protection of potable water
HC	Health Canada
IUR	inhalation unit risk
K _{OC}	organic carbon-water partition coefficient
LNAPL	light non-aqueous phase liquid
MAC	maximum acceptable concentration
NAPL	non-aqueous phase liquid
OSF	oral slope factor
PAH	polycyclic aromatic hydrocarbon
PHC	petroleum hydrocarbon
PQL	practical quantitation limit
RSC	risk-specific concentration
RSD	risk-specific dose
SoQG _{Sc}	soil quality guideline for soil contact
TC	tolerable concentration
TDI	tolerable daily intake
TRV	toxicological reference value

DOCUMENT OVERVIEW

This document is divided into three sections: (1) a summary of the protocol used to derive the Canadian Groundwater Quality Guidelines (CGWQGs), (2) separate tables with guidelines for ninety-nine organic compounds and (3) references. In addition, two appendices (Appendix A describing a revision to the Canadian Council of Ministers of the Environment (CCME) groundwater protocol (CCME 2015) and Appendix B describing limitations and assumptions of the models used to derive the groundwater guidelines) are included. Additional appendices (Appendices C to F) containing substance-specific chemical property information used to derive the guidelines are provided in a separate spreadsheet file. Detailed guiding principles and guideline development processes are available in the CCME soil and groundwater protocols (CCME 2006a; 2015).

1.0 SUMMARY OF THE GROUNDWATER QUALITY GUIDELINE PROTOCOL

CCME has established a framework for assessing and remediating contaminated sites in Canada and has developed scientific tools to provide guidance and promote consistency across the country. The CGWQGs are a part of the existing suite of Canadian Environmental Quality Guidelines (available at <https://ccme.ca>). These groundwater quality guidelines (GWQGs) may be used at contaminated sites in conjunction with the Canadian Soil Quality Guidelines and other relevant Canadian Environmental Quality Guidelines.

GWQGs are intended to protect both environmental and human health. Procedures for deriving GWQGs are documented in *A Protocol for the Derivation of Groundwater Quality Guidelines for Use at Contaminated Sites* (CCME 2015), referred to herein as the groundwater protocol. The groundwater protocol is based on *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* (CCME 2006a) referred to herein as the soil protocol. The groundwater protocol represents a separate and abbreviated version of the soil protocol, presenting key policy and technical elements needed to derive groundwater-specific guidelines.

GWQGs are developed to maintain specific uses of groundwater (e.g., irrigation or drinking water) and to protect receptors in environments that may directly or indirectly come into contact with contaminated groundwater due to contaminant migration (e.g., surface water bodies or vapour intrusion into basements). The GWQGs are not intended to protect organisms living in aquifers, but rather to protect the uses of groundwater or receptors in other media which may be exposed to groundwater contamination (Table 1).

GWQGs are primarily derived by using existing benchmarks (e.g., Canadian Water Quality Guidelines) and back-calculating a groundwater concentration, using fate and transport models, that will not result in an exceedance of the benchmark once the contaminant reaches the environmental medium of concern (e.g., surface water body). In cases where exposure to groundwater may be through untreated well water, the benchmark (e.g., Guidelines for Canadian Drinking Water Quality) is adopted directly as the groundwater quality guideline.

Table 1: Key receptors and exposure pathways addressed by the groundwater quality guidelines

Exposure pathway	Receptor(s)
saturated zone transport to surface water	aquatic life
rising water table into shallow soils	terrestrial plants and invertebrates
migration of vapours into indoor air	human
use of well water	human, livestock, crops

The lowest of the guidelines established for human health and environmental health becomes the final GWQG (GWQG_F) — also called CGWQG — for a given substance. These guidelines are considered generic or Tier 1 guidelines as default or “generic” assumptions are used. The generic guidelines can be adjusted to account for a limited number of site-specific conditions to develop Tier 2 objectives. Finally, if required, a site-specific risk assessment may be conducted to develop Tier 3 site-specific objectives.

One method of modifying guidelines at Tier 2 based on site-specific conditions is the elimination of guidelines for exposure pathways that are not operative at or near a contaminated site. Individual jurisdictions may specify requirements for the elimination of specific pathways. Tier 2 guidelines may also be established by re-calculating guidelines with site-specific values substituted for certain default model parameters. Derivation of Tier 2 guidelines could result in equivalent protection provided by numerically higher guidelines. For more information on setting Tier 2 site-specific objectives, see Section 1.1 of the soil protocol (CCME 2006a), suggestions presented in the groundwater protocol (CCME 2015) and *Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada* (CCME 1996).

1.1 Chemicals of Concern

Chemicals will exhibit different fate and transport characteristics in the environment by virtue of different physical and chemical properties. Chemicals considered for GWQG derivation include soluble organic chemicals, which may be dissociating or non-dissociating, volatile or non-volatile, and for which an existing soil or water quality guideline or benchmark, or an existing toxicological reference value (TRV) for human health, is available from CCME, Health Canada (HC) or other reliable source. The groundwater protocol does not derive guidelines for inorganic substances (e.g., metals) due to the high level of uncertainty and variability in the fate and transport of inorganic substances in groundwater as well as the absence of biodegradation of these substances.

The evaluation of chemical aqueous solubility is based on a review of the available published water quality guidelines in Canada. Any chemical for which a published water quality guideline is available in Canada can be considered sufficiently soluble to warrant consideration for GWQG derivation. Guidelines published by CCME are preferred; however, if no Canadian Water Quality Guideline exists, then guidelines from other jurisdictions (e.g., Canadian or international) offering a similar level of protection may be used. When CCME develops human health guidelines, it consults HC for appropriate human health benchmarks.

Consistent with CCME’s *Protocol for the derivation of soil vapour quality guidelines for protection of human exposures via inhalation of vapours* (CCME 2014), the indoor vapour

inhalation pathway is always considered for any chemical for which vapour concentrations can exceed risk-based concentration limits after accounting for a *de minimis* amount of attenuation from the subsurface to the breathing zone (a factor of 30 is considered a conservative estimate from available data on sub-slab to indoor air attenuation rates). This definition accounts for the fact that some chemicals with low vapour pressures and Henry's law constants are nevertheless capable of posing a potential risk because of their high toxicity, while some highly volatile compounds are not capable of posing a risk via inhalation because of their insufficient toxicity.

1.2 Environmental Fate and Behaviour in Groundwater

Four primary processes control the fate and behaviour of a chemical in groundwater, including: (1) ability to form a dissolved phase into groundwater; (2) adsorption to soil and sediment affecting chemical mobility; (3) volatilization into the gas phase, coupled with diffusive and advective transport; and (4) biodegradation and chemical persistence.

Among the soluble organic chemicals considered for guideline development, there are approximately five to eight orders of magnitude difference in terms of aqueous solubility. There is a potential for a non-aqueous phase liquid (NAPL) to be present as the concentration of a chemical approaches its solubility limit. If present, a NAPL can act as an ongoing contaminant source.

The tendency to partition between water and air (represented by Henry's law constant) is approximated as the ratio of a chemical's abundance in the gas phase (i.e., vapour pressure) to that in the aqueous phase (i.e., solubility) at equilibrium. Henry's law constants provide an indicator of a chemical's tendency to volatilize from water to air. Chemicals with a relatively higher Henry's law constant are usually more volatile, such as benzene, toluene, ethylbenzene, and xylenes (BTEX) and n-hexane compared to polycyclic aromatic hydrocarbons (PAHs). As stated by Environment Canada (EC) (2005), temperature significantly influences the partitioning of a chemical between the air and water phases. As the Henry's law constant increases with increasing temperature, the loss of dissolved phase chemicals in groundwater to the soil (in vapour phase) through volatilization also increases.

Chemicals with a high organic carbon partition coefficient (K_{OC}) tend to sorb strongly to soil organic matter and therefore can be less mobile in the environment relative to those with a lower K_{OC} . The reported K_{OC} values across soluble organic chemicals of concern can range a few orders of magnitude. PAHs with greater than two rings are an example of high K_{OC} , low-mobility compounds while trihalomethanes and BTEX are examples of relatively high-mobility, low K_{OC} compounds.

Certain contaminants may potentially degrade into chemicals which are more toxic or mobile than the parent compound. The rate and extent of degradation of the parent compound may be affected by a number of site-specific factors, such as electron acceptor availability and redox conditions. With the exception of certain parent products (1,1,2,2-tetrachloroethene [also known as perchloroethylene or PCE] and 1,1,2-trichloroethene [also known as trichloroethylene or TCE]) associated with the anaerobic degradation pathway resulting in monochloroethene (vinyl chloride) formation, no formal Tier 1 method for adjusting GWQGs to reflect degradation into more toxic

compounds is specified. If concerns are identified, jurisdictions could recommend additional assessment of the degradation products.

1.3 Guideline Derivation

The development of GWQGs is based on both scientific and management considerations and takes into account risks to both the environment and human receptors. Where appropriate, separate guidelines are developed for coarse- and fine-textured soils¹. Detailed guideline development processes are discussed in the groundwater protocol.

1.3.1 Groundwater Quality Guidelines for Human Health

GWQGs for the protection of human health are developed to ensure that contaminants present at the guideline concentration will result in no appreciable human health risk. For the purpose of guideline development, CCME assumes a chronic exposure scenario at the guideline value (i.e., lifetime exposure). Human health GWQGs are derived for the protection of potable groundwater and indirect exposure via indoor vapour inhalation. Human health guidelines for non-threshold carcinogenic chemicals are derived based on a specified incremental risk above background exposure for groundwater ingestion and indoor vapour inhalation. Canadian jurisdictions generally employ a 10^{-5} or 10^{-6} incremental lifetime cancer risk as a *de minimis* risk level. For convenience, CCME provides guidelines for the protection of human health at both the 10^{-5} and 10^{-6} incremental risk levels. Individual jurisdictions may apply guidelines based on either one of these risk levels.

The volatilization of a chemical in groundwater and its subsequent migration through soil and into indoor air is considered for any chemical for which vapour concentrations can exceed risk-based concentration limits after accounting for a *de minimis* amount of attenuation from the subsurface to the breathing zone (as described in Appendix D of CCME 2014). Groundwater quality guidelines for the protection of indoor air quality (GWQG_{SLAQ}) are calculated using a model developed by Johnson and Ettinger (1991) (J&E model) which is based on a number of assumptions that, if not met, can invalidate the use of the model and, thus, the GWQG_{SLAQ}. A list of limitations (or precluding conditions) that may invalidate model assumptions is presented in Appendix B and CCME (2014). Guideline users should ensure that these limitations are not present at a site prior to using the GWQG_{SLAQ}. When limitations are present, it is recommended that the indoor air pathway be evaluated using a Tier 2 or site-specific approach (see CCME 2014; 2015 for details). HC has published a vapour intrusion assessment guidance (HC 2023) to support site-specific evaluation of the vapour intrusion pathway.

GWQG_{SLAQ} are derived separately for buildings with a basement and for buildings with a foundation built as a concrete slab directly on the ground surface with no basement (slab-on-grade). For commercial land uses, only slab-on-grade construction is considered (CCME 2015).

¹ Coarse-grained soil contains greater than 50% by mass particles greater than 75 µm mean diameter ($D_{50} > 75 \mu\text{m}$). Fine-grained soil contains greater than 50% by mass particles equal to or less than 75 µm mean diameter ($D_{50} \leq 75 \mu\text{m}$).

GWQGs protective of indoor air inhalation are derived based on chemical-specific TRVs. For threshold substances a tolerable concentration (TC) is used to evaluate chemical toxicity to humans; for non-threshold substances, such as many carcinogens, a risk-specific concentration (RSC) is used. If a TC or RSC is not available, they can be extrapolated from a tolerable daily intake (TDI) or a risk-specific dose (RSD), respectively, if the mode of toxicity supports extrapolation of an inhalation TRV from an oral TRV (CCME 2006a; 2015). Human health TRVs developed or endorsed by HC or CCME are preferred for guideline derivation purposes, if available; however, when not available, TRVs from other reliable sources such as the United States Environmental Protection Agency (USEPA) are used. The GWQGs_{SIAQ} are calculated separately for two land use scenarios: an agricultural/residential scenario reflecting an individual residing at the site full-time, and a commercial/industrial scenario reflecting a typical occupational exposure scenario (as described in CCME 2014, with modifications as noted in Appendix A). If toxicity is evaluated using a TC or RSC, receptor characteristics are unnecessary. If a TC or RSC is extrapolated from a TDI or RSD, characteristics for a toddler are used for all land uses. Some jurisdictions may allow the indoor air exposure pathway to be eliminated if there are no potential existing or future receptors within the vicinity of the contamination (CCME 2015).

GWQGs for the protection of potable water (GWQGs_{SPW}) are based directly on the *Guidelines for Canadian Drinking Water Quality* (generally HC 2024, see Appendix E), if available. While these guidelines primarily address the ingestion of water, recent drinking water guidelines published by HC have also included dermal and inhalation contact with water while bathing and showering. Since the values developed by HC are applied directly, there is no need to consider additional receptor characteristics. As noted, the 10^{-5} to 10^{-6} incremental cancer risk range corresponds to the range considered essentially negligible in the derivation of the maximum acceptable concentrations (MACs) for non-threshold carcinogenic chemicals in drinking water. The use of groundwater as a source of domestic water (water used by humans for household purposes) is not considered to be dependent on land use. When no Guidelines for Canadian Drinking Water Quality are available, HC drinking water screening values are used. If neither are available, source guidance values for groundwater are developed (CCME 2006a). For pesticides where a Guideline for Canadian Drinking Water Quality is not available, the GWQGs_{SPW} are based directly on the long-term Human Health Reference Values for pesticides in drinking water sources from the Pest Management Regulatory Agency of HC (PMRA 2024), where available.

1.3.2 Groundwater Quality Guidelines for Environmental Health

Ecological receptors may, in rare cases, come into direct contact with contaminated groundwater but more commonly may be exposed to contaminants in groundwater after groundwater discharges into a surface water body, enters a dugout or well, or moves up into the vadose zone. GWQG derivation is thus not oriented toward the protection of receptors residing in groundwater (e.g., stygobitic organisms), but rather receptors in other media which may be exposed to groundwater contamination.

Groundwater quality guidelines for groundwater contact by soil-dependant organisms (GWQGs_{GC}) are intended to protect terrestrial plants and soil invertebrates immersed temporarily in contaminated groundwater and are derived based on the conservative assumption that roots of

phreatophyte species may be permanently immersed in, and drawing from, contaminated groundwater. The GWQ_{SGC} are calculated from partitioning of the soil quality guidelines for soil contact ($SoQG_{SSC}$) (CCME 1999) for agricultural land to porewater using equations described in the groundwater protocol. The groundwater protocol provides site-specific options for when phreatophytes are not present.

The protection of the aquatic life exposure pathway addresses contaminants moving laterally in groundwater and being discharged into a downgradient surface water body. As the distance to the nearest downgradient surface water body increases, the likelihood of adverse impacts on the aquatic life at the receiving water body decreases due to the attenuation of the chemical. GWQGs for the protection of aquatic life (GWQ_{GSL} for freshwater life and GWQ_{GSM} for marine life) are developed to be sufficiently low as to maintain the water quality of a surface water body (freshwater or marine) located 10 metres (m) away from the contaminated groundwater. The calculation is intended to result in a groundwater concentration at 10 m from the surface water body that, upon discharge to the receiving water body, meets the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 1999). There is no adjustment for receiving water body dilution (i.e., the dilution factor is 1). For contaminated groundwater within 10 m of a surface water body, the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* should be applied directly for the protection of aquatic life (CCME 2015). The groundwater transport model used to calculate the GWQGs for the protection of aquatic life is based on a number of assumptions that, if not met, may invalidate the use of the model. The assumptions and limitations of this model are presented in Appendix B. If any of these limitations are present, the guideline value for this pathway should not be used without further evaluation. Please refer to the groundwater protocol (CCME 2015) for details on what to do when limitations are present.

If the surface water body is a potential drinking water source, the Guidelines for Canadian Drinking Water Quality may also apply (CCME 2015).

In addition, water wells and dugouts are potential exposure pathways to groundwater used for livestock watering or crop irrigation. A water well or dugout can potentially be installed or constructed at any location, including within, or immediately adjacent to, a groundwater contaminant source. As a result, the GWQGs for the protection of livestock watering (GWQ_{GSLW}) and irrigation water (GWQ_{GSI}) are adopted directly from the *Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses* (Livestock Water and Irrigation Water, respectively) (CCME 1999). Jurisdictions may allow the elimination of the exposure pathway to livestock and irrigation watering at land uses other than agricultural. Furthermore, it may be possible to exclude these pathways on a Tier 2, site-specific level where a site is sufficiently far from agricultural land and future agricultural land is not likely (CCME 2015).

Chemicals in groundwater tend to be more mobile than those in soil, and therefore the potential for contaminants to move from a less sensitive to a more sensitive land use (i.e., industrial land use is considered the least sensitive and agricultural land use is considered the most sensitive land use) is greater for groundwater than for soil. Accordingly, GWQGs for environmental health are not developed to be land use-specific, but rather to reflect a level of ecological protection appropriate to the most sensitive land use or to support any ecological groundwater use which can reasonably be anticipated.

1.3.3 *Non-Toxicity Considerations, Management Limits*

A GWQG for management considerations (GWQG_M) is developed to reflect any additional concerns associated with the chemical of concern beyond toxicity to human and ecological receptors. These may include considerations for aesthetics, explosive hazards, free-phase liquid formation, or damage to utilities and infrastructure. At this time, standard methods for the calculation of management limits have not been established and each chemical should be evaluated on a case-by-case basis.

However, as discussed in the groundwater protocol (CCME 2015), as a minimum the solubility limit of the chemical should be considered due to the potential for chemical concentrations approaching solubility to result in the formation of a separate NAPL that may act as an ongoing contaminant source. In addition, certain models used in the development of GWQGs for some pathways (groundwater contact, protection of freshwater and marine life, and protection of indoor air quality) are based on a three-phase system (soil, air, and water) that does not account for the presence of a free-phase liquid as a fourth phase. Therefore, guideline values determined for these pathways are invalid if a NAPL is present.

In general, the GWQG_M should not exceed 50% of the chemical's aqueous solubility limit. Additionally, a chemical that forms a dense NAPL (DNAPL; i.e., the NAPL has a density greater than that of water) should not exceed 10% of its aqueous solubility limit.

These management limits based on aqueous solubility are intended as an alert to the potential presence of upstream sources of a free-phase liquid that will require further investigation to confirm. It is not intended to prevent free-phase liquid formation, and a free-phase liquid might be present at concentrations lower than the management limit depending on the specifics of the site and the substances present. Risk managers must use their professional knowledge to determine if the management limit is adequate. For example, the solubility of a chemical in a mixture is approximately proportionate to its mole fraction within the mixture (see CCME 2016a); thus, its solubility when in a mixture is less than the solubility of the pure chemical alone and the chemical may form a free-phase liquid at a lower concentration than when present alone. The solubility of a chemical that makes up a small proportion of a mixture might be less than half of its pure chemical aqueous solubility.

In addition, risk managers must use their professional judgement and knowledge of the contamination to determine the best management limit to use (10 or 50% of its aqueous solubility limit). For instance, certain chemicals might be associated with either a light NAPL (LNAPL; i.e., the NAPL has a density less than that of water) or DNAPL, depending on the contamination. Some examples include certain polyaromatic hydrocarbons which can be associated with petroleum products forming LNAPLs or with coal tar products forming DNAPLs, or monochloroethene which forms an LNAPL in the pure phase but which is often found as a degradation product of chemicals associated with a DNAPL such as PCE and TCE. Certain chemical products that are associated with densities near one, such as bunker C fuel, may form both LNAPL and DNAPL when released. Additionally, chemicals that may not form NAPLs by themselves (e.g., chemicals that are highly miscible with water) might be associated with a NAPL consisting of other chemicals.

For chemicals with extremely low solubility, they may sorb to even small amounts of suspended solids present in a groundwater sample such that the measured concentration in the groundwater will be overestimated, which in turn might suggest a free-phase liquid when none is present. For example, dissolved concentrations for PAH compounds with four or more aromatic rings could easily be overestimated at sites if there are even trace amounts of suspended solids in the groundwater sample.

Risk managers can consult CCME (2016a) for further information on NAPLs and methods to determine their presence at a contaminated site.

For those cases where a management limit based on aqueous solubility is used as the final guideline value, if it is confirmed that no NAPL is present, the management limit pathway may be excluded at Tier 2.

In addition to a chemical's solubility, risk managers may also need to consider other contaminant characteristics on a site-specific basis and develop more applicable management limits should there be concerns regarding aesthetics (e.g., odour), explosion hazards, or damage to utilities or infrastructure from certain contaminants. The impact of contaminants on groundwater quality due to changes in physical, chemical or biological properties (e.g., pH, redox potential, biological oxygen demand) that might affect recharge zones may also need to be considered.

1.4 Use of Canadian Groundwater Quality Guidelines

The CGWQGs are intended to be used for assessing in-place contaminants in groundwater. They represent “clean down to” levels at contaminated sites and should not be interpreted as “pollute up to” levels for less contaminated sites. They are not intended to be used either to manage pristine sites or to evaluate the quality of wastes or other substances being discharged to groundwater. The guidelines are also not intended for application at the point of exposure (e.g., water distribution systems or surface water).

The guidelines should be used in combination with acceptable sampling and analytical methods. Guidance documents on sampling methods, site characterization, and analytical guidance have been published by CCME (CCME 2016a; 2016b; 2016c; 2016d).

GWQGs are developed using a specific set of assumptions and models. In some cases, the assumptions used to derive these guidelines may not be protective for particularly sensitive sites. A list of site conditions that may invalidate the assumptions used to develop groundwater quality guidelines are presented in Appendix B and described in the groundwater protocol (CCME 2015, Part A, Section 3.3).

Multiple lines of evidence are recommended to assess the indoor air quality pathway for vapour intrusion. Due to the high temporal and spatial variability of soil vapour, results for various environmental media (e.g., groundwater, soil vapour, sub-slab vapour, indoor air) should be considered and analysed in conjunction with information regarding subsurface and building conditions. Guidance for completing soil vapour intrusion assessments using multiple lines of

evidence is provided in CCME (2016a) and HC (2023). Note that in cases where there are contaminant sources in the vadose zone, consideration of additional guidelines (i.e., soil vapour and/or soil guidelines) in addition to groundwater guidelines is necessary.

Below are some specific deviations from the soil protocol (CCME 2006) associated with the development of GWQGs:

- GWQGs are not developed separately for the four land uses defined in the soil protocol with the exception of vapour inhalation guidelines which are calculated based on combined agricultural/residential and combined commercial/industrial exposure scenarios. However, jurisdictions may allow for the exclusion of certain exposure pathways based on land use (e.g., the exclusion of agricultural pathways at commercial or industrial sites) although there may be requirements for offset distances from more sensitive land uses.
- GWQGs for the protection of plants and soil organisms are calculated based on a single level of protection, equivalent to the $SoQG_{SC}$ for agricultural land use.
- Certain input parameters for the fate and transport models have been updated to reflect recent improvements in the science and research as noted in the 2008 update of the *Canada-wide Standards for Petroleum Hydrocarbons (PHC) in Soil* (CCME 2008) and in recent scientific literature.

1.5 Final Groundwater Quality Guidelines

The lowest of the guidelines established for human health and environmental health becomes the $GWQG_F$ (and thus the $CGWQG$) for a given substance. Professional judgement is used at the time of guideline development on whether to adjust the $GWQG_{SF}$ based on a management limit. The $GWQG_{SF}$ are also checked against background concentrations and practical quantitation limits (PQL) when available. Where the $GWQG_{SF}$ are less than typical Canadian background concentrations, CCME recommends that the accepted background concentration replace the $GWQG_{SF}$ generated using the groundwater protocol. More commonly, the $GWQG_{SF}$ may be higher than the typical Canadian background concentration, but specific locations may have unusually high background concentrations exceeding the $GWQG_{SF}$. In these cases, jurisdictions have the option to set site-specific (Tier 2) or regional guidelines that consider the background concentrations. If a $GWQG_F$ is lower than the available quantitation limit, a footnote is added, but the $GWQG_F$ should not be adjusted based on the PQL. Jurisdictions may incorporate PQLs in their implementation of the guideline. CCME provides a list of recommended maximum values for PQLs (CCME 2016d); however, achievable PQLs may improve with time.

Note that the $GWQG_{SPW}$, $GWQG_{SFL}$ and $GWQG_{SML}$ are considered required exposure pathways. If any of these guidelines (i.e., $GWQG_{PW}$, $GWQG_{FL}$ or $GWQG_{ML}$) cannot be established, the $GWQG_F$ is considered to be a provisional guideline. Some jurisdictions may allow the exclusion of the potable water exposure pathway at sites where groundwater is not likely to be used as a drinking water source (see CCME 2015 for details). Individual jurisdictions may exclude the aquatic life pathways on a Tier 2 site-specific basis if there are no surface water bodies in the vicinity of the site (CCME 2015).

2.0 CANADIAN GROUNDWATER QUALITY GUIDELINES

CGWQGs for 99 chemicals of concern are presented in the following tables. Each table presents the GWQGs for an individual substance or, in some cases, mixture, for two soil textures. Indoor air quality guidelines are calculated separately for two land use scenarios. In addition, human health guidelines for non-threshold carcinogenic chemicals are presented at both the 10^{-5} and 10^{-6} incremental risk levels.

GWQG_{SF} (which become CGWQGs) are presented in the top row of each table. Final guidelines are also referred to as Tier 1 or “generic” guidelines. The goal of the GWQG_F is to protect both ecological and human health. The final guideline is selected based on the lowest of available environmental and human health pathway-specific guidelines. It may be adjusted based on non-toxicity management considerations—for example, a management limit based on solubility intended as an alert to the potential presence of upstream sources of free-phase product.

Final guidelines may be labelled as provisional to reflect uncertainty in the guideline development process when there is a data gap (e.g., when a required pathway is missing, or when the drinking water pathway is based on a provisional Source Guidance Value for Groundwater).

At a site, all ecological and human health water uses (represented as pathway-specific guidelines in the table) are considered applicable at Tier 1.

It may be possible to exclude or modify certain water uses at Tier 2. Due to the mobility of both groundwater and soil vapour, particular care should be applied when excluding exposure pathways based on land use. Consult the jurisdiction for specific requirements for offset distances from more sensitive land uses.

The groundwater protocol provides an introduction to potential Tier 2 adjustments. More detailed Tier 2 guidance can be found in *Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada* (CCME 1996).

This suite of CGWQGs considered substances for which an existing soil or water quality guideline or benchmark, or an existing TRV for human health, is available from CCME, HC, or other reliable source.

CCME has not developed scientific criteria documents for this suite of CGWQGs. Background information for many substances in this document may be found in the scientific criteria documents for various Canadian soil or water quality guidelines. This section and Appendices C through F contain the input parameters needed to derive the CGWQGs. Readers may consult the equations in the groundwater protocol to understand how these physical and chemical parameters contribute to the guideline calculation, and/or replicate the individual guideline values presented here. Additionally, the footnote section of individual guideline tables contains information on any specific features or decisions related to the substance. By documenting the most essential elements of guideline derivation, CCME has been able to produce a large quantity of CGWQGs. For more detailed information on derivation of the guidelines, including models and assumptions, refer to the soil and groundwater protocols (CCME 2006a, 2015).

Additional information that is needed for guideline derivation but not found in Appendices C through F is summarized below:

- The lower of the MAC or aesthetic objective (AO) in the Guidelines for Canadian Drinking Water Quality was selected for the GWQG_{pw}. The potable water values in Appendix E attributed to HC are the MAC, unless indicated otherwise.
- Certain input parameters and methods unique to PHC fractions F1 and F2 can be found in the *Canada-wide Standards for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale Supporting Technical Document* (CCME 2008) and Table C-10 of the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (Alberta Environment and Parks 2019).
- Some substance-specific chemical information used to derive the GWQG_{sIAQ} is summarized here:
 - Adjustment factor (Adj.F) (unitless) = 10 for BTEX, F1, F2 (except when aviation fuel), naphthalene and n-hexane (see Appendix B for limitations which, if present, may invalidate the use of an Adj.F = 10). For all other substances, Adj.F = 1.
 - Allocation Factor (AF) (unitless) = 0.5 for F1 and F2, consistent with the soil allocation factors for F1 and F2 in the Canada-wide Standard for PHC in soil (CCME 2008). For all other substances AF = 0.2, consistent with the default value in the groundwater protocol.
 - Background groundwater concentration (BGC) (mg/L) = 0 for all substances.

Additionally, the guideline tables utilise a number of abbreviations for when a guideline value is not provided for a specific pathway:

- NA (not available; no CCME or HC benchmarks are available) is used for pathways that adopt a published guideline or benchmark value directly.
- NC (not calculated due to insufficient data) is used for all pathways for which a calculation is required in order to derive the GWQG for the pathway and there are insufficient data to calculate a guideline; this could be due to missing physical-chemical property data or if a required guideline/benchmark or TRV needed for the calculation is not available.
- ND (not determined) is used when a pathway is not applicable to a certain substance, i.e., it is used for the indoor air quality pathway when a substance is not sufficiently volatile for its vapour concentrations to exceed a health risk-based concentration limit for inhalation, as well as for the management limit when a substance is completely miscible with water and can not form a separate phase.

The GWQG tables are presented alphabetically, with some substances placed in groupings: chlorinated benzenes (11 chemicals), chlorinated ethanes (three chemicals), chlorinated ethenes (three chemicals), chlorinated phenols (five chemicals), halogenated methanes (six chemicals), organotins (two chemicals), PHC fraction F1 and F2, phthalate esters (two chemicals) and PAHs (nine chemicals plus carcinogenic PAHs).

Groundwater Quality Guidelines for Acridine (CAS RN 260-94-6) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0044	0.31	0.0044	0.31
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0044	0.31	0.0044	0.31
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ‡‡	3.8	3.8	3.8	3.8

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

‡‡ This substance has a density close to that of water and may potentially form a separate phase either less or more dense than water. The type of separate phase present should be determined.

**Canadian Groundwater Quality Guidelines
for the Protection of Environmental and Human Health**

Aldicarb

Groundwater Quality Guidelines for Aldicarb (CAS RN 116-06-3) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.00015 ^{ML}	0.00015 ^{ML}	0.00015 ^{ML}	0.00015 ^{ML}
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0010	0.0010	0.0010	0.0010
Protection of marine life	0.00015	0.00015	0.00015	0.00015
Protection of livestock watering	0.011	0.011	0.011	0.011
Protection of irrigation water	0.055	0.055	0.055	0.055
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	600	600	600	600

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

ML: Final guideline is based on the protection of marine life pathway. If no marine water bodies are present, users may wish to conduct a Tier 2 evaluation.

§ The Guideline for Canadian Drinking Water Quality for aldicarb has been withdrawn (HC 2024). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential degradation products include aldicarb sulfoxide and aldicarb sulfone. Consideration of these additional degradation products is potentially necessary when evaluating site groundwater quality impacted by aldicarb.

**Canadian Groundwater Quality Guidelines
for the Protection of Environmental and Human Health**

Aldrin + Dieldrin

Groundwater Quality Guidelines for Aldrin + Dieldrin (CAS RN 309-00-2 + 60-57-1) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0000040‡	0.000032	0.0000040‡	0.000032
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0000040	0.000032	0.0000040	0.000032
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.025	0.025	0.025	0.025

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

§ The Guideline for Canadian Drinking Water Quality for aldrin + dieldrin has been withdrawn (HC 2024). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Aldrin converts rapidly to dieldrin in the environment.

Groundwater Quality Guidelines for Aniline (CAS RN 62-53-3) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.0022	0.0022	0.0022	0.0022
Guideline – 10⁻⁶ incremental risk (provisional*)	0.0022	0.0022	0.0022	0.0022
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) #◇	3.6♦	26♦	--	--
Protection of indoor air quality (slab on grade) #◇	4.5♦	27♦	10♦●	77♦●
Protection of potable water	NA	NA	NA	NA
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) #◇	3.6♦	26♦	--	--
Protection of indoor air quality (slab on grade) #◇	4.5♦	27♦	10♦●	77♦●
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0022	0.0022	0.0022	0.0022
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ‡‡	3,600	3,600	3,600	3,600

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Risk-specific concentration (RsC) extrapolated from Risk-specific Dose (RsD).

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

♦ Presented value is based on the non-carcinogenic risk.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

‡‡ This substance has a density close to that of water and may potentially form a separate phase either less or more dense than water. The type of separate phase present should be determined.

Groundwater Quality Guidelines for Atrazine (CAS RN 1912-24-9) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0018	0.0018	0.0018	0.0018
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.005	0.005	0.005	0.005
Environmental health guidelines				
Protection of freshwater life	0.0018	0.0018	0.0018	0.0018
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.005	0.005	0.005	0.005
Protection of irrigation water	0.01	0.01	0.01	0.01
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	3.5	3.5	3.5	3.5

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential degradation products include possibly more toxic deethylatrazine, deisopropylatrazine and deethyldeisopropylatrazine. Consideration of these additional degradation products is potentially necessary when evaluating site groundwater quality impacted by atrazine, although it may not be possible to quantify these compounds separately from atrazine.

Groundwater Quality Guidelines for Benzene (CAS RN 71-43-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk	0.005	0.005	0.005	0.005
Guideline – 10⁻⁶ incremental risk	0.0029[‡]	0.005	0.005	0.005
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇	0.029	0.21	--	--
Protection of indoor air quality (slab on grade) ◇	0.036	0.23	0.084	0.63
Protection of potable water	0.005	0.005	0.005	0.005
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇	0.0029	0.021	--	--
Protection of indoor air quality (slab on grade) ◇	0.0036	0.023	0.0084	0.063
Protection of potable water	0.005	0.005	0.005	0.005
Environmental health guidelines				
Protection of freshwater life	0.69	33	0.69	33
Protection of marine life	0.20	9.8	0.20	9.8
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	62	110	62	110
Management considerations				
Water solubility (50%) † ¶¶	900	900	900	900

Notes: NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

Groundwater Quality Guidelines for Bromacil (CAS RN 314-40-9) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0002	0.0002	0.0002	0.0002
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.6	0.6	0.6	0.6
Environmental health guidelines				
Protection of freshwater life	0.0050	0.0050	0.0050	0.0050
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	1.1	1.1	1.1	1.1
Protection of irrigation water	0.0002	0.0002	0.0002	0.0002
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	82	82	82	82

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Bromoxynil (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00033	0.00033	0.00033	0.00033
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.03	0.03	0.03	0.03
Environmental health guidelines				
Protection of freshwater life	0.0050	0.0050	0.0050	0.0050
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.011	0.011	0.011	0.011
Protection of irrigation water	0.00033	0.00033	0.00033	0.00033
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) † ¶¶	65	65	65	65

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ No density information was available for this substance; there is uncertainty whether the value based on 50% solubility applies.

Groundwater Quality Guidelines for Monochlorobenzene (CAS RN 108-90-7) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0013	0.0013	0.0013	0.0013
Human health guidelines				
Protection of indoor air quality (basement) ◇	0.019	0.13	--	--
Protection of indoor air quality (slab on grade) ◇	0.024	0.14	0.20●	1.4●
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0013	0.0013	0.0013	0.0013
Protection of marine life	0.025	0.025	0.025	0.025
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	50	50	50	50

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening did not flag any concern with the air concentrations resulting from the dose-averaging for this substance (see Appendix A). However, there is some uncertainty associated with the use of dose-averaging as a full toxicological review was not conducted for each substance; thus, these values should be used with caution and other lines of evidence should be considered when assessing risks. Jurisdictional authorities should be consulted for further guidance.

§ The Guideline for Canadian Drinking Water Quality for monochlorobenzene has been withdrawn (HC 2022). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = benzene under anaerobic conditions. Consideration of this additional degradation product is necessary when evaluating site groundwater quality impacted by monochlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,2-Dichlorobenzene (CAS RN 95-50-1) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00070	0.00070	0.00070	0.00070
Human health guidelines				
Protection of indoor air quality (basement) #◇	3.2	21 ^{ES}	--	--
Protection of indoor air quality (slab on grade) #◇	4.2	23 ^{ES}	9.2 [●]	63 ^{●ES}
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.00070	0.00070	0.00070	0.00070
Protection of marine life	0.042	0.042	0.042	0.042
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	16	16	16	16

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

● Only an acute air quality benchmark was available for high-level screening; therefore, no dose averaging was used for a chronic scenario (see Appendix A).

§ The Guideline for Canadian Drinking Water Quality for 1,2-dichlorobenzene has been withdrawn (HC 2022). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = monochlorobenzene, D2 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,2-dichlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,3-Dichlorobenzene (CAS RN 541-73-1) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.15	0.15	0.15	0.15
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.15	0.15	0.15	0.15
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	12	12	12	12

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = monochlorobenzene, D2 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,3-dichlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,4-Dichlorobenzene (CAS RN 106-46-7) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.001	0.001	0.001	0.001
Human health guidelines ‡				
Protection of indoor air quality (basement) ◇	0.17	1.1	--	--
Protection of indoor air quality (slab on grade) ◇	0.23	1.2	1.8●	12●
Protection of potable water AO	0.001	0.001	0.001	0.001
Environmental health guidelines				
Protection of freshwater life	0.026	0.026	0.026	0.026
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	8.1	8.1	8.1	8.1

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

‡ There are no cancer toxicological reference values for this substance in HC (2021), therefore it is classified as a non-carcinogen for the purposes of the Canadian Groundwater Quality Guidelines. However, HC (2021) notes that this substance is a possible human carcinogen.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening did not flag any concern with the air concentrations resulting from the dose-averaging for this substance (see Appendix A). However, there is some uncertainty associated with the use of dose-averaging as a full toxicological review was not conducted for each substance; thus, these values should be used with caution and other lines of evidence should be considered when assessing risks. Jurisdictional authorities should be consulted for further guidance.

AO: Value is the aesthetic objective (AO). Consult HC 2024 for more information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = monochlorobenzene, D2 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,4-dichlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,2,3-Trichlorobenzene (CAS RN 87-61-6) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0080	0.0080	0.0080	0.0080
Human health guidelines				
Protection of indoor air quality (basement) #◇	0.021	0.13	--	--
Protection of indoor air quality (slab on grade) #◇	0.030	0.14	0.061 [●]	0.37 [●]
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0080	0.0080	0.0080	0.0080
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	1.8	1.8	1.8	1.8

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = dichlorobenzenes, D2 = monochlorobenzene, D3 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,2,3-trichlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,2,4-Trichlorobenzene (CAS RN 120-82-1) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0054 ^{ML}	0.0054 ^{ML}	0.0054 ^{ML}	0.0054 ^{ML}
Human health guidelines				
Protection of indoor air quality (basement) ◇	0.045	0.26	--	--
Protection of indoor air quality (slab on grade) ◇	0.063	0.30	0.13 [•]	0.78 [•]
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.024	0.024	0.024	0.024
Protection of marine life	0.0054	0.0054	0.0054	0.0054
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	4.9	4.9	4.9	4.9

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

ML: Final guideline is based on the protection of marine life pathway. If no marine water bodies are present, users may wish to conduct a Tier 2 evaluation.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

• Only an acute air quality benchmark was available for high-level screening; therefore, no dose averaging was used for a chronic scenario (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = dichlorobenzenes, D2 = monochlorobenzene, D3 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,2,4-trichlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,3,5-Trichlorobenzene (CAS RN 108-70-3) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.016	0.097	0.047	0.29
Human health guidelines				
Protection of indoor air quality (basement) ◇	0.016	0.097	--	--
Protection of indoor air quality (slab on grade) ◇	0.023	0.11	0.047 [●]	0.29 [●]
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	3.0	3.0	3.0	3.0

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = dichlorobenzenes, D2 = monochlorobenzene, D3 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,3,5-trichlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,2,3,4-Tetrachlorobenzene (CAS RN 634-66-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0018	0.0018	0.0018	0.0018
Human health guidelines				
Protection of indoor air quality (basement) #◇	0.096	0.52	--	--
Protection of indoor air quality (slab on grade) #◇	0.14	0.60 ^{ES}	0.27 [●]	1.5 ^{●ES}
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0018	0.0018	0.0018	0.0018
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.59	0.59	0.59	0.59

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = trichlorobenzenes, D2 = dichlorobenzenes, D3 = monochlorobenzene, D4 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,2,3,4-tetrachlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,2,3,5-Tetrachlorobenzene (CAS RN 634-90-2) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0056	0.030	0.016	0.087
Human health guidelines				
Protection of indoor air quality (basement) #◇	0.0056	0.030	--	--
Protection of indoor air quality (slab on grade) #◇	0.0081	0.034	0.016●	0.087●
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.51	0.51	0.51	0.51

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = trichlorobenzenes, D2 = dichlorobenzenes, D3 = monochlorobenzene, D4 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,2,3,5-tetrachlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,2,4,5-Tetrachlorobenzene (CAS RN 95-94-3) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0053	0.029	0.015	0.086**
Human health guidelines				
Protection of indoor air quality (basement) #◇	0.0053	0.029	--	--
Protection of indoor air quality (slab on grade) #◇	0.0077	0.034	0.015●	0.086● ^{ES}
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.060	0.060	0.060	0.060

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value exceeds the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = trichlorobenzenes, D2 = dichlorobenzenes, D3 = monochlorobenzene, D4 = benzene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,2,4,5-tetrachlorobenzene. (Note: D stands for the order of degradation products.)

**Canadian Groundwater Quality Guidelines
for the Protection of Environmental and Human Health**

Pentachlorobenzene

Groundwater Quality Guidelines for Pentachlorobenzene (CAS RN 608-93-5) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0060	0.0068	0.0060	0.0068
Human health guidelines				
Protection of indoor air quality (basement) #◇	0.039	0.21 ^{ES}	--	--
Protection of indoor air quality (slab on grade) #◇	0.056	0.24 ^{ES}	0.11 ^{●ES}	0.61 ^{●ES}
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0060	0.0068	0.0060	0.0068
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.083	0.083	0.083	0.083

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = tetrachlorobenzenes, D2 = trichlorobenzenes, D3 = dichlorobenzenes, D4 = monochlorobenzene, D5 = benzene. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by pentachlorobenzene. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,2-Dichloroethane (CAS RN 107-06-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.005	0.005	0.005	0.005
Guideline – 10⁻⁶ incremental risk (provisional*)	0.005	0.005	0.005	0.005
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) #◇	0.29	2.1	--	--
Protection of indoor air quality (slab on grade) #◇	0.36	2.3	0.83	6.3
Protection of potable water	0.005	0.005	0.005	0.005
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) #◇	0.029	0.21	--	--
Protection of indoor air quality (slab on grade) #◇	0.036	0.23	0.083	0.63
Protection of potable water	0.005	0.005	0.005	0.005
Environmental health guidelines				
Protection of freshwater life	0.10	0.10	0.10	0.10
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.005	0.005	0.005	0.005
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	860	860	860	860

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Risk-specific concentration (RsC) extrapolated from Risk-specific Dose (RsD).

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = chloroethane under anaerobic conditions. Alternatively, abiotic degradation may result in D1 = monochloroethene. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,2-dichloroethane. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,1,1-Trichloroethane (CAS RN 71-55-6) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	1.6	11	4.6	33
Human health guidelines				
Protection of indoor air quality (basement) ◇	1.6	11	--	--
Protection of indoor air quality (slab on grade) ◇	2.1	12	4.6 [•]	33 [•]
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	130	130	130	130

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

• Only an acute air quality benchmark was available for high-level screening; therefore, no dose averaging was used for a chronic scenario (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = 1,1-dichloroethane, D2 = chloroethane produced under anaerobic conditions. Alternatively, abiotic degradation may result in D1 = 1,1-dichloroethene and subsequent D2 = monochloroethene under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,1,1-trichloroethane. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,1,2,2-Tetrachloroethane (CAS RN 79-34-5) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.022	0.14	0.063	0.41
Guideline – 10⁻⁶ incremental risk (provisional*)	0.0022	0.014	0.0063	0.041
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) #◇	0.022	0.14	--	--
Protection of indoor air quality (slab on grade) #◇	0.03	0.15	0.063	0.41
Protection of potable water	NA	NA	NA	NA
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) #◇	0.0022	0.014	--	--
Protection of indoor air quality (slab on grade) #◇	0.0030	0.015	0.0063	0.041
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	280	280	280	280

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Risk-specific concentration (RsC) extrapolated from Risk-specific Dose (RsD).

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = 1,1,2-trichloroethane, D2 = 1,2-dichloroethane, D3 = chloroethane under anaerobic conditions. A variety of abiotic and anaerobic pathways can also result in numerous other degradation products, including 1,1,2-trichloroethene, dichloroethene, and monochloroethene. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,1,2,2-tetrachloroethane. (Note: D stands for the order of degradation products.)

**Canadian Groundwater Quality Guidelines
for the Protection of Environmental and Human Health**

Monochloroethene (Vinyl chloride)

**Groundwater Quality Guidelines for Monochloroethene (Vinyl chloride) (CAS RN 75-01-4)
(mg/L)**

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.00079	0.002	0.002	0.002
Guideline – 10⁻⁶ incremental risk (provisional*)	0.000079‡	0.00062	0.00023‡	0.0018
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇	0.00079	0.0062	--	--
Protection of indoor air quality (slab on grade) ◇	0.00097	0.0065	0.0023	0.018
Protection of potable water	0.002	0.002	0.002	0.002
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇	0.000079	0.00062	--	--
Protection of indoor air quality (slab on grade) ◇	0.000097	0.00065	0.00023	0.0018
Protection of potable water	0.002	0.002	0.002	0.002
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) †	4,400	4,400	4,400	4,400

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Vinyl chloride = a synonym for monochloroethene

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for 1,1,2-Trichloroethene (TCE) (CAS RN 79-01-6) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.00037‡	0.0027	0.0039	0.005
Guideline – 10⁻⁶ incremental risk (provisional*)	0.00037‡	0.0027	0.0022	0.005
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇	0.00037♦	0.0027♦	--	--
Protection of indoor air quality (slab on grade) ◇	0.00047♦	0.0029♦	0.0011♦ ●	0.0079♦ ●
Protection of potable water	0.005	0.005	0.005	0.005
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇	0.00037♦	0.0027♦	--	--
Protection of indoor air quality (slab on grade) ◇	0.00047♦	0.0029♦	0.0011♦ ●	0.0079♦ ●
Protection of potable water	0.005	0.005	0.005	0.005
Environmental health guidelines				
Protection of freshwater life	0.028	0.25	0.028	0.25
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.05	0.05	0.05	0.05
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	5.6	5	5.6	5
Management considerations				
Water solubility (10%) †	130	130	130	130

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

TCE = trichloroethene (or trichloroethylene)

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

♦ Presented value is based on the non-carcinogenic risk.

|| The 1,1,2-trichloroethene (TCE) guideline for indoor air quality (IAQ) and potable water is the lower of the calculated value for TCE or 10 times the corresponding guideline value derived for monochloroethene. For rationale, see Section 7.13 of OMOE (2011). The lowest values are the calculated IAQ and potable water values for TCE.

- The inhalation TRV for 1,1,2-trichloroethene (TCE) is based on adverse effects that suggest reproductive or developmental toxicity; therefore, dose-averaging was not used in the calculation of the indoor air quality guideline (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = dichloroethene, D2 = monochloroethene. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,1,2-trichloroethene (TCE). For human health pathways, the individual concentrations of D1 and the parent compound should not exceed 10 times the monochloroethene risk-based guideline. See OMOE (2011) for more details. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 1,1,2,2-Tetrachloroethene (PCE) (CAS RN 127-18-4) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.0079	0.01	0.01	0.01
Guideline – 10⁻⁶ incremental risk (provisional*)	0.00079	0.0062	0.0023	0.01
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇	0.0079	0.062	--	--
Protection of indoor air quality (slab on grade) ◇	0.0097	0.065	0.023 [•]	0.18 [•]
Protection of potable water	0.01	0.01	0.01	0.01
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇	0.00079	0.0062	--	--
Protection of indoor air quality (slab on grade) ◇	0.00097	0.0065	0.0023 [•]	0.018 [•]
Protection of potable water	0.01	0.01	0.01	0.01
Environmental health guidelines				
Protection of freshwater life	0.11	0.11	0.11	0.11
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	21	21	21	21

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

PCE= perchloroethylene, a synonym for 1,1,2,2-tetrachloroethene

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

|| The 1,1,2,2-tetrachloroethene (PCE) guideline for indoor air quality (IAQ) and potable water is the lower of the calculated IAQ or potable water value for PCE or 10 times the corresponding guideline value derived for monochloroethene. For rationale, see Section 7.13 of OMOE (2011). The lowest IAQ value is 10 times the corresponding guideline value derived for monochloroethene and the lowest potable water value is the calculated value for PCE.

• A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water

solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

D1 = 1,1,2-trichloroethene, D2 = dichloroethene, D3 = monochloroethene produced under anaerobic conditions. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by 1,1,2,2-tetrachloroethene. For human health pathways, the individual concentrations of D1 and D2 and the parent compound should not exceed 10 times the monochloroethene risk-based guideline. (Note: D stands for the order of degradation products.)

Groundwater Quality Guidelines for 2-Chlorophenol (CAS RN 95-57-8) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0070	0.0070	0.0070	0.0070
Human health guidelines				
Protection of indoor air quality (basement) #◇	6.5	45	--	--
Protection of indoor air quality (slab on grade) #◇	8.4	48	19●	130●
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0070	0.0070	0.0070	0.0070
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	1,100	1,100	1,100	1,100

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from Tolerable Daily Intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for 2,4-Dichlorophenol (CAS RN 120-83-2) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00020	0.00020	0.00020	0.00020
Human health guidelines				
Protection of indoor air quality (basement) #◇	420	2600 ^{ES}	--	--
Protection of indoor air quality (slab on grade) #◇	570 ^{ES}	2800 ^{ES}	1200 ^{●ES}	NRG [●]
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.00020	0.00020	0.00020	0.00020
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	450	450	450	450

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

§ The Guideline for Canadian Drinking Water Quality for 2,4-dichlorophenol has been withdrawn (HC 2022). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for 2,4,6-Trichlorophenol (CAS RN 88-06-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.002	0.002	0.002	0.002
Guideline – 10⁻⁶ incremental risk (provisional*)	0.002	0.002	0.002	0.002
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) #◇	90 ^{ES}	450 ^{ES}	--	--
Protection of indoor air quality (slab on grade) #◇	130 ^{ES}	490 ^{ES}	260 ^{ES}	NRG
Protection of potable water AO	0.002	0.002	0.002	0.002
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) #◇	9.0	45	--	--
Protection of indoor air quality (slab on grade) #◇	13	49	26	130 ^{ES}
Protection of potable water AO	0.002	0.002	0.002	0.002
Environmental health guidelines				
Protection of freshwater life	0.018	0.018	0.018	0.018
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	80	80	80	80

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Risk-specific concentration (RsC) extrapolated from Risk-specific Dose (RsD).

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

AO: Value is the aesthetic objective (AO). Consult HC 2024 for more information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for 2,3,4,6-Tetrachlorophenol (CAS RN 58-90-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0010	0.0010	0.0010	0.0010
Human health guidelines				
Protection of indoor air quality (basement) #◇	NRG	NRG	--	--
Protection of indoor air quality (slab on grade) #◇	NRG	NRG	NRG [•]	NRG [•]
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life ¶	0.0010	0.0010	0.0010	0.0010
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	2.3	2.3	2.3	2.3

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

• A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

§ The Guideline for Canadian Drinking Water Quality for 2,3,4,6-tetrachlorophenol has been withdrawn (HC 2022). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

¶ Guideline values are applicable to fine and coarse textured sites at all groundwater pHs. For sites with fine-textured soils and groundwater pH < 5.6, site-specific objectives using pH-specific K_{OC} values may result in slightly higher values than the generic guideline.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Pentachlorophenol (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00050	0.00050	0.00050	0.00050
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water AO	0.03	0.03	0.03	0.03
Environmental health guidelines				
Protection of freshwater life ¶	0.00050	0.00050	0.00050	0.00050
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NRG	NRG	NRG	NRG
Management considerations				
Water solubility (10%) †	1.4	1.4	1.4	1.4

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

AO: Value is the aesthetic objective (AO). Consult HC 2024 for more information.

¶ Guideline values are applicable to fine and coarse textured sites at all groundwater pHs. For sites with fine-textured soils and groundwater pH < 5.8, site-specific objectives using pH-specific K_{oc} values may result in slightly higher values than the generic guideline.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Captan (CAS RN 133-06-2) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0013	0.0013	0.0013	0.0013
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.4	0.4	0.4	0.4
Environmental health guidelines				
Protection of freshwater life	0.0013	0.0013	0.0013	0.0013
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.013	0.013	0.013	0.013
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.51	0.51	0.51	0.51

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Carbaryl (CAS RN 63-25-2) (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.00020	0.00020	0.00020	0.00020
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.07	0.07	0.07	0.07
Environmental health guidelines				
Protection of freshwater life	0.00020	0.00020	0.00020	0.00020
Protection of marine life	0.00029	0.00029	0.00029	0.00029
Protection of livestock watering	1.1	1.1	1.1	1.1
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	11	11	11	11

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potentially degraded to 1-naphthol and methylamine under anaerobic conditions. Consideration of these additional degradation products is potentially necessary when evaluating site groundwater quality impacted by carbaryl.

Groundwater Quality Guidelines for Carbofuran (CAS RN 1563-66-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0018	0.0018	0.0018	0.0018
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0018	0.0018	0.0018	0.0018
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.045	0.045	0.045	0.045
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	32	32	32	32

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The Guideline for Canadian Drinking Water Quality for carbofuran has been withdrawn (HC 2022). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potentially degraded to 3-hydroxy and 3-keto carbofuran. Consideration of these additional degradation products is potentially necessary when evaluating site groundwater quality impacted by carbofuran.

Groundwater Quality Guidelines for Chlorothalonil (CAS RN 1897-45-6) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline	0.00018	0.00018	0.00018	0.00018
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.096 ^{ES}	0.096 ^{ES}	0.096 ^{ES}	0.096 ^{ES}
Environmental health guidelines				
Protection of freshwater life	0.00018	0.00018	0.00018	0.00018
Protection of marine life	0.00036	0.00036	0.00036	0.00036
Protection of livestock watering	0.17 ^{ES}	0.17 ^{ES}	0.17 ^{ES}	0.17 ^{ES}
Protection of irrigation water	0.0058	0.0058	0.0058	0.0058
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.081	0.081	0.081	0.081

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Chlorpyrifos (CAS RN 2921-88-2) (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0000020‡	0.0000053	0.0000020‡	0.0000053
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.09	0.09	0.09	0.09
Environmental health guidelines				
Protection of freshwater life	0.0000020	0.0000053	0.0000020	0.0000053
Protection of marine life	0.0000020	0.0000053	0.0000020	0.0000053
Protection of livestock watering	0.024	0.024	0.024	0.024
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.11	0.11	0.11	0.11

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Cyanazine (CAS RN 21725-46-2) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0005	0.0005	0.0005	0.0005
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0020	0.0020	0.0020	0.0020
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.01	0.01	0.01	0.01
Protection of irrigation water	0.0005	0.0005	0.0005	0.0005
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	17	17	17	17

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The Guideline for Canadian Drinking Water Quality for cyanazine has been withdrawn (HC 2024). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Deltamethrin (CAS RN 52918-63-5) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0000023	0.0025**	0.0000023	0.0025**
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.02 ^{ES}	0.02 ^{ES}	0.02 ^{ES}	0.02 ^{ES}
Environmental health guidelines				
Protection of freshwater life	0.0000023	NRG	0.0000023	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.0025 ^{ES}	0.0025 ^{ES}	0.0025 ^{ES}	0.0025 ^{ES}
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) †	0.0010	0.0010	0.0010	0.0010

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value exceeds the management limit indicating the potential presence of a separate phase. Consult the jurisdictional authority for guidance.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

ES: Exceedance of 50% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Dicamba (CAS RN 1918-00-9) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000006	0.000006	0.000006	0.000006
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.11	0.11	0.11	0.11
Environmental health guidelines				
Protection of freshwater life	0.010	0.010	0.010	0.010
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.12	0.12	0.12	0.12
Protection of irrigation water	0.000006	0.000006	0.000006	0.000006
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	830	830	830	830

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for 2,4-Dichlorophenoxyacetic acid (2,4-D) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0040	0.0040	0.0040	0.0040
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.1	0.1	0.1	0.1
Environmental health guidelines				
Protection of freshwater life	0.0040	0.0040	0.0040	0.0040
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.1	0.1	0.1	0.1
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	68	68	68	68

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

The potential degradation product consists of 2,4-dichlorophenol. Consideration of this additional degradation product is potentially necessary when evaluating site groundwater quality impacted by 2,4-D.

**Canadian Groundwater Quality Guidelines
for the Protection of Environmental and Human Health**

DDT (total ^{II})

Groundwater Quality Guidelines for DDT (total ^{II}) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0030**	0.0030**	0.0030**	0.0030**
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NRG	NRG	NRG	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.03 ^{ES}	0.03 ^{ES}	0.03 ^{ES}	0.03 ^{ES}
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	0.0030 ^{ES}	0.0030 ^{ES}	0.0030 ^{ES}	0.0030 ^{ES}
Management considerations				
Water solubility (10%) †	0.00055	0.00055	0.00055	0.00055

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

II Total DDT = sum of the concentrations of *p,p'*-DDT, *o,p'*-DDT, *p,p'*-DDE, *o,p'*-DDE, *p,p'*-DDD and *o,p'*-DDD.

DDT= Dichlorodiphenyltrichloroethane; DDE= Dichlorodiphenyldichloroethylene; DDD= Dichlorodiphenyldichloroethane.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value exceeds the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid and is based on the solubility of DDT which is the chemical in this group with the lowest water solubility. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

DDT isomers are degraded or metabolized to DDE and DDD in the environment.

Groundwater Quality Guidelines for Diclofop-methyl (CAS RN 51338-27-3) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00018	0.00018	0.00018	0.00018
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0061	0.0062	0.0061	0.0062
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.009	0.009	0.009	0.009
Protection of irrigation water	0.00018	0.00018	0.00018	0.00018
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) † ¶¶	0.40	0.40	0.40	0.40

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The Guideline for Canadian Drinking Water Quality for diclofop-methyl has been withdrawn (HC 2022). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ No density information was available for this substance; there is uncertainty whether the value based on 50% solubility applies.

**Groundwater Quality Guidelines for Didecyl dimethyl ammonium chloride
(CAS RN 7173-51-5) (mg/L)**

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	350**	350**	350**	350**
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NRG	NRG	NRG	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) †	350	350	350	350

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value exceeds the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Diisopropanolamine (CAS RN 110-97-4) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	1.6	1.6	1.6	1.6
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	4	4	4	4
Environmental health guidelines				
Protection of freshwater life	1.6	1.6	1.6	1.6
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	2	2	2	2
Groundwater contact by soil-dependent organisms	160	160	160	160
Management considerations				
Water solubility (50%) †	ND	ND	ND	ND

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ This guideline is considered provisional because there was no Guideline for Canadian Drinking Water Quality. As a substitute, a Source Guidance Value for Groundwater was developed during the derivation of the Canadian Soil Quality Guideline for diisopropanolamine. The values are presented for users to consider applying at their own discretion.

† This substance is completely miscible in water (CCME 2006b) and will not form a separate phase. A management limit to prevent a separate phase does not apply.

Groundwater Quality Guidelines for Dimethoate (CAS RN 60-51-5) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.003	0.003	0.003	0.003
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.02	0.02	0.02	0.02
Environmental health guidelines				
Protection of freshwater life	0.0062	0.0062	0.0062	0.0062
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.003	0.003	0.003	0.003
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	2,300	2,300	2,300	2,300

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Dinoseb (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.000050	0.000062	0.000050	0.000062
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.000050	0.000062	0.000050	0.000062
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.15	0.15	0.15	0.15
Protection of irrigation water	0.016	0.016	0.016	0.016
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	5.2	5.2	5.2	5.2

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The Guideline for Canadian Drinking Water Quality for dinoseb has been withdrawn (HC 2024). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Endosulfan (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0000020 ^{ML}	0.0000045 ^{ML}	0.0000020 ^{ML}	0.0000045 ^{ML}
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0000030	0.0000068	0.0000030	0.0000068
Protection of marine life	0.0000020	0.0000045	0.0000020	0.0000045
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.032	0.032	0.032	0.032

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

ML: Final guideline is based on the protection of marine life pathway. If no marine water bodies are present, users may wish to conduct a Tier 2 evaluation.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential degradation products include endosulfan sulfate. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by endosulfan.

Groundwater Quality Guidelines for Ethylbenzene (CAS RN 100-41-4) (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0016‡	0.0016‡	0.0016‡	0.0016‡
Human health guidelines				
Protection of indoor air quality (basement) ◇	14	100 ^{ES}	--	--
Protection of indoor air quality (slab on grade) ◇	18	110 ^{ES}	41●	NRG●
Protection of potable water AO	0.0016	0.0016	0.0016	0.0016
Environmental health guidelines				
Protection of freshwater life	42	NRG	42	NRG
Protection of marine life	12	NRG	12	NRG
Protection of livestock watering	0.0024	0.0024	0.0024	0.0024
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	20	42	20	42
Management considerations				
Water solubility (50%) †	85	85	85	85

Notes: NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

ES: Exceedance of 50% aqueous solubility, a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

● A high-level screening flagged potential concern with dose-averaging; therefore, no dose-averaging was used (see Appendix A).

AO: Value is the aesthetic objective (AO). Consult HC 2024 for more information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Ethylene glycol (CAS RN 107-21-1) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	190	190	190	190
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	190	190	190	190
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	16,000	9,200	16,000	9,200
Management considerations				
Water solubility (50%) †	ND	ND	ND	ND

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This substance is completely miscible in water (PubChem 2021a) and will not form a separate phase. A management limit to prevent a separate phase does not apply.

Groundwater Quality Guidelines for Glyphosate (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.28	0.28	0.28	0.28
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.28	0.28	0.28	0.28
Environmental health guidelines				
Protection of freshwater life	0.80	0.81	0.80	0.81
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.28	0.28	0.28	0.28
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	1,200	1,200	1,200	1,200

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final Guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential degradation product includes aminomethylphosphonic acid. Consideration of this additional degradation product is potentially necessary when evaluating site groundwater quality impacted by glyphosate.

Groundwater Quality Guidelines for Dichloromethane (CAS RN 75-09-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.05	0.05	0.05	0.05
Guideline – 10⁻⁶ incremental risk (provisional*)	0.05	0.05	0.05	0.05
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇	0.82♦	6.3♦	--	--
Protection of indoor air quality (slab on grade) ◇	1.0♦	6.6♦	2.4♦●	18♦●
Protection of potable water	0.05	0.05	0.05	0.05
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇	0.69	5.3	--	--
Protection of indoor air quality (slab on grade) ◇	0.85	5.6	2.0	16
Protection of potable water	0.05	0.05	0.05	0.05
Environmental health guidelines				
Protection of freshwater life	0.098	0.098	0.098	0.098
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.05	0.05	0.05	0.05
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	1,300	1,300	1,300	1,300

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

♦ Presented value is based on the non-carcinogenic risk.

● A high-level screening flagged potential concern with dose-averaging; therefore, no dose-averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Trichloromethane (CAS RN 67-66-3) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.0018	0.0018	0.0018	0.0018
Guideline – 10⁻⁶ incremental risk (provisional*)	0.00031[‡]	0.0018	0.00089	0.0018
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇	0.0031	0.022	--	--
Protection of indoor air quality (slab on grade) ◇	0.0039	0.024	0.0089	0.065
Protection of potable water ‖	0.1	0.1	0.1	0.1
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇	0.00031	0.0022	--	--
Protection of indoor air quality (slab on grade) ◇	0.00039	0.0024	0.00089	0.0065
Protection of potable water ‖	0.1	0.1	0.1	0.1
Environmental health guidelines				
Protection of freshwater life	0.0018	0.0018	0.0018	0.0018
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering ‖	0.1	0.1	0.1	0.1
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	800	800	800	800

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

‖ This value is for trihalomethanes and refers to the total of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform) and trichloromethane (chloroform); the total sum of bromodichloromethane, dibromochloromethane, tribromomethane and trichloromethane concentrations should not exceed 0.1 mg/L. Due to insufficient data, the livestock watering value is based on the drinking water value (CCREM 1987).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Tetrachloromethane (CAS RN 56-23-5) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline- 10⁻⁵ incremental risk (provisional*)	0.00013‡	0.00087	0.0014	0.002
Guideline- 10⁻⁶ incremental risk (provisional*)	0.00013‡	0.00087	0.0005	0.002
Human health guidelines- 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇#	0.00013♦	0.00087♦	--	--
Protection of indoor air quality (slab on grade) ◇#	0.00017♦	0.00095♦	0.0014♦•	0.0094♦•
Protection of potable water	0.002	0.002	0.002	0.002
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇#	0.00013♦	0.00087♦	--	--
Protection of indoor air quality (slab on grade) ◇#	0.00017♦	0.00095♦	0.00050	0.0035
Protection of potable water	0.002	0.002	0.002	0.002
Environmental health guidelines				
Protection of freshwater life	0.013	0.013	0.013	0.013
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.005	0.005	0.005	0.005
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	79	79	79	79

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

For non-carcinogenic guidelines, the tolerable concentration (TC) was extrapolated from the tolerable daily intake (TDI).

♦ Presented value is based on the non-carcinogenic risk.

• A high-level screening did not flag any concern with the air concentrations resulting from the dose-averaging for this substance (see Appendix A). However, there is some uncertainty associated with the use of dose-averaging as a full toxicological review was not conducted for each substance; thus, these values should be used with caution and other lines of evidence should be considered when assessing risks. Jurisdictional authorities should be consulted for further guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Bromodichloromethane (CAS RN 75-27-4) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline – 10⁻⁵ incremental risk (provisional*)	0.0097	0.064	0.028	0.1
Guideline – 10⁻⁶ incremental risk (provisional*)	0.00097[‡]	0.0064	0.0028	0.019
Human health guidelines – 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) #◇	0.0097	0.064	--	--
Protection of indoor air quality (slab on grade) #◇	0.013	0.070	0.028	0.19
Protection of potable water ‖	0.1	0.1	0.1	0.1
Human health guidelines – 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) #◇	0.00097	0.0064	--	--
Protection of indoor air quality (slab on grade) #◇	0.0013	0.0070	0.0028	0.019
Protection of potable water ‖	0.1	0.1	0.1	0.1
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering ‖	0.1	0.1	0.1	0.1
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	300	300	300	300

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

Risk-specific Concentration (RsC) extrapolated from Risk-specific Dose (RsD).

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

‖ This value is for trihalomethanes and refers to the total of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform) and trichloromethane (chloroform); the total sum of bromodichloromethane, dibromochloromethane, tribromomethane and trichloromethane concentrations should not exceed 0.1 mg/L. Due to insufficient data, the livestock watering value is based on the drinking water value (CCREM 1987).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Dibromochloromethane (CAS RN 124-48-1) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.1	0.1	0.1	0.1
Human health guidelines				
Protection of indoor air quality (basement) #◇	0.33	1.9	--	--
Protection of indoor air quality (slab on grade) #◇	0.46	2.1	0.93●	5.5●
Protection of potable water ‖	0.1	0.1	0.1	0.1
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering ‖	0.1	0.1	0.1	0.1
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	270	270	270	270

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from Tolerable Daily Intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

‖ This value is for trihalomethanes and refers to the total of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform) and trichloromethane (chloroform); the total sum of bromodichloromethane, dibromochloromethane, tribromomethane and trichloromethane concentrations should not exceed 0.1 mg/L. Due to insufficient data, the livestock watering value is based on the drinking water value (CCREM 1987).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Tribromomethane (CAS RN 75-25-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.1	0.1	0.1	0.1
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water II	0.1	0.1	0.1	0.1
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering II	0.1	0.1	0.1	0.1
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	310	310	310	310

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

II This value is for trihalomethanes and refers to the total of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform) and trichloromethane (chloroform); the total sum of bromodichloromethane, dibromochloromethane, tribromomethane and trichloromethane concentrations should not exceed 0.1 mg/L. Due to insufficient data, the livestock watering value is based on the drinking water value (CCREM 1987).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for n-Hexane (CAS RN 110-54-3) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.016	0.14	0.13	0.14
Human health guidelines				
Protection of indoor air quality (basement) ◇	0.016	0.14	--	--
Protection of indoor air quality (slab on grade) ◇	0.018	0.14	0.17 [•]	1.3 [•]
Protection of potable water §	0.23	0.23	0.23	0.23
Environmental health guidelines				
Protection of freshwater life	0.13	0.14	0.13	0.14
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) †	4.8	4.8	4.8	4.8

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

• A high-level screening did not flag any concern with the air concentrations resulting from the dose-averaging for this substance (see Appendix A). However, there is some uncertainty associated with the use of dose-averaging as a full toxicological review was not conducted for each substance; thus, these values should be used with caution and other lines of evidence should be considered when assessing risks. Jurisdictional authorities should be consulted for further guidance.

§ This guideline is considered provisional because there was no Guideline for Canadian Drinking Water Quality. As a substitute, a Source Guidance Value for Groundwater was developed during the derivation of the Canadian Soil Quality Guideline for n-hexane. The values are presented for users to consider applying at their own discretion.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

**Groundwater Quality Guidelines for Heptachlor + heptachlor epoxide
(CAS RN 76-44-8 + 1024-57-3) (mg/L)**

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000014	0.003	0.000014	0.003
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.000014	NRG	0.000014	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.003	0.003	0.003	0.003
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.018	0.018	0.018	0.018

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid and is based on the solubility of heptachlor only; however, the solubility of heptachlor epoxide is very similar. It is based on single substance contamination and may not be applicable to mixtures containing substances other than heptachlor and heptachlor epoxide. As heptachlor and heptachlor epoxide have very similar water solubilities, the management limit is applicable to a mixture of these two substances. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Hexachlorobutadiene (CAS RN 87-68-3) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0013	0.0013	0.0013	0.0013
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0013	0.0013	0.0013	0.0013
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.32	0.32	0.32	0.32

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Hexachlorocyclohexane, gamma- (CAS RN 58-89-9) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000010	0.000010	0.000010	0.000010
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.000010	0.000010	0.000010	0.000010
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.004	0.004	0.004	0.004
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.73	0.73	0.73	0.73

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential degradation products include 1,2,3,5-tetrachlorobenzene and alpha-hexachlorocyclohexane. Consideration of these additional degradation products is necessary when evaluating site groundwater quality impacted by gamma-hexachlorocyclohexane.

Groundwater Quality Guidelines for Imidacloprid (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.00023	0.00023	0.00023	0.00023
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.4	0.4	0.4	0.4
Environmental health guidelines				
Protection of freshwater life	0.00023	0.00023	0.00023	0.00023
Protection of marine life	0.00065	0.00065	0.00065	0.00065
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	51	51	51	51

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

**Groundwater Quality Guidelines for 3-Iodo-2-propynyl butyl carbamate
(CAS RN 55406-53-6) (mg/L)**

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0019	0.0019	0.0019	0.0019
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0019	0.0019	0.0019	0.0019
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	44	44	44	44

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential aerobic degradation product is propargyl butyl carbamate (PBC). Consideration of this additional degradation product is potentially necessary when evaluating site groundwater quality impacted by 3-Iodo-2-propynyl butyl carbamate.

Groundwater Quality Guidelines for Linuron (CAS RN 330-55-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000071	0.000071	0.000071	0.000071
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.016	0.016	0.016	0.016
Environmental health guidelines				
Protection of freshwater life	0.0070	0.0070	0.0070	0.0070
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	0.000071	0.000071	0.000071	0.000071
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	7.5	7.5	7.5	7.5

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Methanol (CAS RN 67-56-1) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	19	19	19	19
Human health guidelines				
Protection of indoor air quality (basement) ◇	20,000	160,000	--	--
Protection of indoor air quality (slab on grade) ◇	23,000	170,000	59,000●	460,000●
Protection of potable water §	19	19	19	19
Environmental health guidelines				
Protection of freshwater life	32	630	32	630
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	17,000	9,900	17,000	9,900
Management considerations				
Water solubility (50%) †	ND	ND	ND	ND

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis. In addition, take note that the provisional guideline for the protection of potable water forms the basis of the final guidelines. See footnote § for more details.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● The inhalation TRV for methanol is based on adverse effects that suggest reproductive or developmental toxicity; therefore, dose-averaging was not used in the calculation of the indoor air quality guideline (see Appendix A).

§ This guideline is considered provisional because there was no Guideline for Canadian Drinking Water Quality. As a substitute, a Source Guidance Value for Groundwater was developed during the derivation of the Canadian Soil Quality Guideline for methanol. The values are presented for users to consider applying at their own discretion.

† This substance is completely miscible in water (PubChem 2021b) and will not form a separate phase. A management limit to prevent a separate phase does not apply.

Groundwater Quality Guidelines for Methoprene (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000090	0.000190	0.000090	0.000190
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.4	0.4	0.4	0.4
Environmental health guidelines				
Protection of freshwater life	0.000090	0.000190	0.000090	0.000190
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) †	0.70	0.70	0.70	0.70

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Methyl tertiary-butyl ether (MTBE) (CAS RN 1634-04-4) (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.015	0.015	0.015	0.015
Human health guidelines				
Protection of indoor air quality (basement) ◇	0.31	2.2	--	--
Protection of indoor air quality (slab on grade) ◇	0.40	2.4	3.3 [●]	24 [●]
Protection of potable water AO	0.015	0.015	0.015	0.015
Environmental health guidelines				
Protection of freshwater life	10	10	10	10
Protection of marine life	5.0	5.0	5.0	5.0
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) †	26,000	26,000	26,000	26,000

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening did not flag any concern with the air concentrations resulting from the dose-averaging for this substance (see Appendix A). However, there is some uncertainty associated with the use of dose-averaging as a full toxicological review was not conducted for each substance; thus, these values should be used with caution and other lines of evidence should be considered when assessing risks. Jurisdictional authorities should be consulted for further guidance.

AO: Value is the aesthetic objective (AO). Consult HC 2024 for more information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

**Groundwater Quality Guidelines for Methylchlorophenoxyacetic acid
(2-methyl-4-chlorophenoxyacetic acid) (MCPA) (CAS RN 94-74-6) (mg/L)**

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.000025	0.000025	0.000025	0.000025
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.35	0.35	0.35	0.35
Environmental health guidelines				
Protection of freshwater life	0.0026	0.0026	0.0026	0.0026
Protection of marine life	0.0042	0.0042	0.0042	0.0042
Protection of livestock watering	0.025	0.025	0.025	0.025
Protection of irrigation water	0.000025	0.000025	0.000025	0.000025
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	63	63	63	63

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Methylmercury (CAS RN 22967-92-6) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0000040	0.0000047	0.0000040	0.0000047
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0000040	0.0000047	0.0000040	0.0000047
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) † ¶¶	16,000	16,000	16,000	16,000

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ No density information was available for this substance; there is uncertainty whether the value based on 50% solubility applies.

Groundwater Quality Guidelines for Metolachlor (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0078	0.0078	0.0078	0.0078
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.96	0.96	0.96	0.96
Environmental health guidelines				
Protection of freshwater life	0.0078	0.0078	0.0078	0.0078
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.05	0.05	0.05	0.05
Protection of irrigation water	0.028	0.028	0.028	0.028
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	53	53	53	53

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential degradation products include sulfonic and oxanilic acids of metolachlor. Consideration of these additional degradation products is potentially necessary when evaluating site groundwater quality impacted by metolachlor.

Groundwater Quality Guidelines for Metribuzin (CAS RN 21087-64-9) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0005	0.0005	0.0005	0.0005
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.08	0.08	0.08	0.08
Environmental health guidelines				
Protection of freshwater life	0.0010	0.0010	0.0010	0.0010
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.08	0.08	0.08	0.08
Protection of irrigation water	0.0005	0.0005	0.0005	0.0005
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	100	100	100	100

Notes: NC = not calculated (due to insufficient data); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Nonylphenol and its ethoxylates (mg TEQ/L)

Guideline (provisional*) II	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0081	0.0081	0.0081	0.0081
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.092	NRG	0.092	NRG
Protection of marine life	0.065	NRG	0.065	NRG
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	0.0081	0.0081	0.0081	0.0081
Management considerations				
Water solubility (50%) †	2.7	2.7	2.7	2.7

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

II Expressed on a toxic equivalency (TEQ) basis using toxic equivalency factors (TEFs). See water or soil guideline factsheets (CCME 2002a,b), or Nonylphenol and its ethoxylates supporting document (EC 2002) for details.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid and is based on the water solubility of nonylphenol. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Additional note:

Nonylphenol is a term used to refer to a group of isomeric compounds each consisting of a nine-carbon alkyl chain attached to a phenol ring, with the chemical formula $C_{15}H_{24}O$. Nonylphenol ethoxylates consist of a phenol group attached to both a nine-carbon alkyl chain and an ethoxylate chain. Nonylphenol ethoxylates have the general formula $C_9H_{19}-C_6H_4O(CH_2CH_2O)_nH$, where n may range from 1 to 100, but with most commercially produced nonylphenol ethoxylates containing between 6 and 12 ethoxylate groups.

Groundwater Quality Guidelines for Tributyltin (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0000010 ^{ML}	0.000014 ^{ML}	0.0000010 ^{ML}	0.000014 ^{ML}
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0000080	0.00011	0.0000080	0.00011
Protection of marine life	0.0000010	0.000014	0.0000010	0.000014
Protection of livestock watering	0.25	0.25	0.25	0.25
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	1.7	1.7	1.7	1.7

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

ML: Final guideline is based on the protection of marine life pathway. If no marine water bodies are present, users may wish to conduct a Tier 2 evaluation.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Additional note:

The tributyltin guideline applies to the tributyltin cation.

Groundwater Quality Guidelines for Triphenyltin (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.069**	0.069**	0.069**	0.069**
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NRG	NRG	NRG	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.82 ^{ES}	0.82 ^{ES}	0.82 ^{ES}	0.82 ^{ES}
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) † ¶¶	0.069	0.069	0.069	0.069

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value exceeds the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

ES: Exceedance of 50% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ No density information was available for this substance; there is uncertainty whether the value based on 50% solubility applies.

Additional note:

The triphenyltin guideline applies to the triphenyltin cation.

Groundwater Quality Guidelines for Permethrin (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.00014^{ML}	0.00060^{**}	0.00014^{ML}	0.00060^{**}
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.1 ^{ES}	0.1 ^{ES}	0.1 ^{ES}	0.1 ^{ES}
Environmental health guidelines				
Protection of freshwater life	0.000055	NRG	0.000055	NRG
Protection of marine life	0.000014	NRG	0.000014	NRG
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.00060	0.00060	0.00060	0.00060

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

ML: Final guideline is based on the protection of marine life pathway. If no marine water bodies are present, users may wish to conduct a Tier 2 evaluation.

^{**} The final guideline value is based on the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Petroleum hydrocarbon fraction F1^{II} (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.5[‡]	2.2^{**}	1.4	2.2^{**}
Human health guidelines				
Protection of indoor air quality (basement) [◇]	0.50	3.1 ^{ES}	--	--
Protection of indoor air quality (slab on grade) [◇]	0.68	3.4 ^{ES}	1.4 [●]	9.2 ^{●ES}
Protection of potable water [§]	2.4 ^{ES}	2.2 ^{ES}	2.4 ^{ES}	2.2 ^{ES}
Environmental health guidelines				
Protection of aquatic life [#]	9.8 ^{ES}	NRG	9.8 ^{ES}	NRG
Protection of livestock watering	53 ^{ES}	53 ^{ES}	53 ^{ES}	53 ^{ES}
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	7.0 ^{ES}	6.5 ^{ES}	7.0 ^{ES}	6.5 ^{ES}
Management considerations				
Water solubility (50%) [†]	1.9	1.9	1.9	1.9

Notes: NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use. NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

^{II} Petroleum hydrocarbon fraction F1 does not include benzene, toluene, ethylbenzene or xylenes (BTEX) (see CCME 2008 for further information). These chemicals should be considered separately and compared to their individual groundwater guidelines.

[‡] This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

^{**} The final guideline value exceeds the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

[◇] Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

^{ES}: Exceedance of 50% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

[●] A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

[§] The potable water value is based on calculations for potable water quality provided in CCME (2008).

[#] The aquatic life value is based on calculations for aquatic life provided in CCME (2008). Separate freshwater and marine values were not given; however, the calculation is based on a body burden approach and therefore should be applicable to both freshwater and marine species.

[†] This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is calculated based on the solubility and assumed proportions of three subfractions (CCME 2008) and therefore this management limit is considered representative of the whole fraction (mixture). However, it may not be applicable to mixtures containing substances other than F1. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Petroleum hydrocarbon fraction F2^{II} (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.18^{**‡}	0.18 ^{**‡}	0.18 ^{**‡}	0.18^{**‡}
Human health guidelines				
Protection of indoor air quality (basement) ◇§§	0.9 ^{ES}	6.1 ^{ES}	--	--
Protection of indoor air quality (slab on grade) ◇§§	1.3 ^{ES}	6.7 ^{ES}	3 ^{●ES}	18 ^{●ES}
Protection of potable water §	1.1 ^{ES}	1.1 ^{ES}	1.1 ^{ES}	1.1 ^{ES}
Environmental health guidelines				
Protection of aquatic life #	1.3 ^{ES}	NRG	1.3 ^{ES}	NRG
Protection of livestock watering	49 ^{ES}	49 ^{ES}	49 ^{ES}	49 ^{ES}
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	1.8 ^{ES}	1.8 ^{ES}	1.8 ^{ES}	1.8 ^{ES}
Management considerations				
Water solubility (50%) †	0.18	0.18	0.18	0.18

Notes: NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use. NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

II Petroleum hydrocarbon fraction F2 does not include naphthalene (see CCME 2008 for further information). These chemicals should be considered separately and compared to their individual groundwater guidelines.

** The final guideline value is based on the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

§§ Use of an adjustment factor (Adj.F)=10 does not apply to this pathway when F2 is aviation fuel (see Section 2.0). If aviation fuel is present, divide the groundwater quality guideline for the indoor air quality pathway by 10 for a guideline value based on an Adj.F=1.

ES: Exceedance of 50% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

§ The potable water value is based on calculations for potable water quality provided in CCME (2008).

The aquatic life value is based on calculations for aquatic life provided in CCME (2008). Separate freshwater and marine values were not given; however, the calculation is based on a body burden approach and therefore should be applicable to both freshwater and marine species.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is calculated based on the solubility and assumed proportions of four subfractions (CCME 2008) and therefore this management limit is considered representative of the whole fraction (mixture). However, it may not be applicable to mixtures containing substances other than F2. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Phenol (CAS RN 108-95-2) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.002	0.002	0.002	0.002
Human health guidelines				
Protection of indoor air quality (basement) #◇	2,100	15,000 ^{ES}	--	--
Protection of indoor air quality (slab on grade) #◇	2,700	15,000 ^{ES}	6,200 [•]	45,000 ^{•ES}
Protection of potable water §	0.56	0.56	0.56	0.56
Environmental health guidelines				
Protection of freshwater life	0.0040	0.0040	0.0040	0.0040
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.002	0.002	0.002	0.002
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	150	110	150	110
Management considerations				
Water solubility (10%) † ‡‡	8,300	8,300	8,300	8,300

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

• A high-level screening flagged potential concern with dose-averaging; therefore, no dose-averaging was used (see Appendix A).

§ This guideline is considered provisional because there was no Guideline for Canadian Drinking Water Quality. As a substitute, a Source Guidance Value for Groundwater was developed during the derivation of the Canadian Soil Quality Guideline for phenol. The values are presented for users to consider applying at their own discretion.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

‡‡ This substance has a density close to that of water and may potentially form a separate phase either less or more dense than water. The type of separate phase present should be determined.

Groundwater Quality Guidelines for Di-*n*-butyl phthalate (CAS RN 84-74-2) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.019	0.019	0.019	0.019
Human health guidelines				
Protection of indoor air quality (basement)	ND	ND	--	--
Protection of indoor air quality (slab on grade)	ND	ND	ND	ND
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.019	0.019	0.019	0.019
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	1.1	1.1	1.1	1.1

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Di(2-ethylhexyl) phthalate (CAS RN 117-81-7) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.027**	0.027**	0.027**	0.027**
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NRG	NRG	NRG	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ‡‡	0.027	0.027	0.027	0.027

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value is based on the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

‡‡ This substance has a density close to that of water and may potentially form a separate phase either less or more dense than water. The type of separate phase present should be determined.

Groundwater Quality Guidelines for Acenaphthene (CAS RN 83-32-9) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0058	0.0060	0.0058	0.0060
Human health guidelines				
Protection of indoor air quality (basement) #◇	NRG	NRG	--	--
Protection of indoor air quality (slab on grade) #◇	NRG	NRG	NRG●	NRG●
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0058	0.0060	0.0058	0.0060
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ¶¶¶	0.39	0.39	0.39	0.39

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

Groundwater Quality Guidelines for Anthracene (CAS RN 120-12-7) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000012	0.0034	0.000012	0.0034
Human health guidelines				
Protection of indoor air quality (basement)	ND	ND	--	--
Protection of indoor air quality (slab on grade)	ND	ND	ND	ND
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.000012	0.0034	0.000012	0.0034
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	0.025 ^{ES}	0.025 ^{ES}	0.025 ^{ES}	0.025 ^{ES}
Management considerations				
Water solubility (10%) † ¶¶	0.0045	0.0045	0.0045	0.0045

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); -- = the pathway is not considered for the selected land use. Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

**Canadian Groundwater Quality Guidelines
for the Protection of Environmental and Human Health**

Benzo(a)pyrene

Groundwater Quality Guidelines for Benzo(a)pyrene (CAS RN 50-32-8) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline- 10⁻⁵ incremental risk (provisional*)	0.00004	0.00004	0.00004	0.00004
Guideline- 10⁻⁶ incremental risk (provisional*)	0.00004	0.00004	0.00004	0.00004
Human health guidelines- 10 ⁻⁵ incremental risk				
Protection of indoor air quality (basement) ◇	NRG [♦]	NRG [♦]	--	--
Protection of indoor air quality (slab on grade) ◇	NRG [♦]	NRG [♦]	NRG ^{♦•}	NRG ^{♦•}
Protection of potable water §	0.00004	0.00004	0.00004	0.00004
Human health guidelines- 10 ⁻⁶ incremental risk				
Protection of indoor air quality (basement) ◇	NRG [♦]	NRG [♦]	--	--
Protection of indoor air quality (slab on grade) ◇	NRG [♦]	NRG [♦]	NRG ^{♦•}	NRG ^{♦•}
Protection of potable water §	0.00004	0.00004	0.00004	0.00004
Environmental health guidelines				
Protection of freshwater life	NRG	NRG	NRG	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NRG	NRG	NRG	NRG
Management considerations				
Water solubility (10%) † ¶¶	0.00016	0.00016	0.00016	0.00016

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Value represents the lowest of either carcinogenic or non-carcinogenic guidelines. Multiple lines of evidence are recommended to assess the vapour intrusion pathway (see Section 1.4).

♦ Presented value is based on the non-carcinogenic risk.

• The inhalation TRV for benzo(a)pyrene is based on adverse effects that suggest reproductive or developmental toxicity; therefore, dose-averaging was not used in the calculation of the indoor air quality guideline (see Appendix A).

§ Other carcinogenic PAHs may also be present in the groundwater with benzo(a)pyrene. See also groundwater quality guidelines for protection of potable water for carcinogenic PAHs.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

Groundwater Quality Guidelines for Carcinogenic PAHs (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline*	0.00004	0.00004	0.00004	0.00004
	B[a]P TPE^{II}	B[a]P TPE^{II}	B[a]P TPE^{II}	B[a]P TPE^{II}
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	0.00004	0.00004	0.00004	0.00004
	B[a]P TPE ^{II}	B[a]P TPE ^{II}	B[a]P TPE ^{II}	B[a]P TPE ^{II}
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NC	NC	NC	NC
Protection of irrigation water	NC	NC	NC	NC
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%)	ND	ND	ND	ND

Notes: NC = not calculated (due to insufficient data); ND = not determined (not applicable to substance, see Section 2.0); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* This guideline is considered to be a full guideline despite lacking guideline values for the aquatic life pathways as carcinogenesis is only considered for human health.

^{II} B[a]P TPE = Benzo[a]pyrene Total Potency Equivalents (TPE), which is the sum of estimated cancer potency relative to B[a]P for all potentially carcinogenic unsubstituted polycyclic aromatic hydrocarbons (PAHs). The B[a]P TPE for a groundwater sample is calculated by multiplying the concentration of each PAH in the sample by its B[a]P Potency Equivalence Factor, given below, and summing the products. See CCME (2010) for more guidance.

B[a]P Potency Equivalence Factors:

Benz[a]anthracene	0.1
Benzo[a]pyrene	1
Benzo[b+j+k]fluoranthene	0.1
Benzo[g,h,i]perylene	0.01
Chrysene	0.01
Dibenz[a,h]anthracene	1
Indeno[1,2,3-c,d]pyrene	0.1

Groundwater Quality Guidelines for Fluoranthene (CAS RN 206-44-0) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000057	0.24**	0.000057	0.24**
Human health guidelines				
Protection of indoor air quality (basement)	ND	ND	--	--
Protection of indoor air quality (slab on grade)	ND	ND	ND	ND
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.000057	NRG	0.000057	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	0.24 ^{ES}	0.24 ^{ES}	0.24 ^{ES}	0.24 ^{ES}
Management considerations				
Water solubility (10%) † ¶¶	0.026	0.026	0.026	0.026

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value exceeds the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult jurisdictional authority for guidance.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

Groundwater Quality Guidelines for Fluorene (CAS RN 86-73-7) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0030	0.0042	0.0030	0.0042
Human health guidelines				
Protection of indoor air quality (basement) #◇	NRG	NRG	--	--
Protection of indoor air quality (slab on grade) #◇	NRG	NRG	NRG●	NRG●
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0030	0.0042	0.0030	0.0042
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ¶¶¶	0.19	0.19	0.19	0.19

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

Groundwater Quality Guidelines for 2-Methylnaphthalene (CAS RN 91-57-6) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.15	0.95	0.42	2.8^{ES}
Human health guidelines				
Protection of indoor air quality (basement) #◇	0.15	0.95	--	--
Protection of indoor air quality (slab on grade) #◇	0.20	1.0	0.42 [●]	2.8 ^{●ES}
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	NC	NC	NC	NC
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ¶¶ ‡‡	2.5	2.5	2.5	2.5

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

Tolerable concentration (TC) extrapolated from tolerable daily intake (TDI).

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening was not completed as no published air quality benchmark was available; therefore, no dose averaging was used (see Appendix A).

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

‡‡ This substance has a density close to that of water and may potentially form a separate phase either less or more dense than water. The type of separate phase present should be determined.

Groundwater Quality Guidelines for Naphthalene (CAS RN 91-20-3) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.0011	0.0011	0.0011	0.0011
Human health guidelines				
Protection of indoor air quality (basement) ◇	1.2	8.1 ^{ES}	--	--
Protection of indoor air quality (slab on grade) ◇	1.6	8.9 ^{ES}	13 ^{●ES}	NRG [●]
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0011	0.0011	0.0011	0.0011
Protection of marine life	0.0014	0.0014	0.0014	0.0014
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	0.17	0.16	0.17	0.16
Management considerations				
Water solubility (10%) † ¶¶ ‡‡	3.2	3.2	3.2	3.2

Notes: NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

ES: Exceedance of 10% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

● A high-level screening did not flag any concern with the air concentrations resulting from the dose-averaging for this substance (see Appendix A). However, there is some uncertainty associated with the use of dose-averaging as a full toxicological review was not conducted for each substance; thus, these values should be used with caution and other lines of evidence should be considered when assessing risks. Jurisdictional authorities should be consulted for further guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

‡‡ This substance has a density close to that of water and may potentially form a separate phase either less or more dense than water. The type of separate phase present should be determined.

Groundwater Quality Guidelines for Phenanthrene (CAS RN 85-01-8) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.00040	0.00087	0.00040	0.00087
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.00040	0.00087	0.00040	0.00087
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ¶¶ ‡‡	0.12	0.12	0.12	0.12

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

‡‡ This substance has a density close to that of water and may potentially form a separate phase either less or more dense than water. The type of separate phase present should be determined.

Groundwater Quality Guidelines for Pyrene (CAS RN 129-00-0) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000093	0.014**	0.000093	0.014**
Human health guidelines				
Protection of indoor air quality (basement)	ND	ND	--	--
Protection of indoor air quality (slab on grade)	ND	ND	ND	ND
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.000093	NRG	0.000093	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) † ¶¶	0.014	0.014	0.014	0.014

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

** The final guideline value is based on the management limit indicating the potential presence of a separate phase. The presence of a free-phase liquid may invalidate guideline values for some pathways (see Section 1.3.3). Consult the jurisdictional authority for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

Groundwater Quality Guidelines for Picloram (CAS RN 1918-02-1) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.029	0.029	0.029	0.029
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	1	1	1	1
Environmental health guidelines				
Protection of freshwater life	0.029	0.029	0.029	0.029
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.19	0.19	0.19	0.19
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) † ¶¶	220	220	220	220

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ No density information was available for this substance; there is uncertainty whether the value based on 50% solubility applies.

Groundwater Quality Guidelines for Quinoline (CAS RN 91-22-5) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.15	0.15	0.15	0.15
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life II	0.15	0.15	0.15	0.15
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	610	610	610	610

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

II The Federal Environmental Quality Guideline for the protection of freshwater life (ECCC 2020) is used in the determination of the groundwater quality guideline for the protection of freshwater life.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Simazine (CAS RN 122-34-9) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.0005	0.0005	0.0005	0.0005
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.010	0.010	0.010	0.010
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.01	0.01	0.01	0.01
Protection of irrigation water	0.0005	0.0005	0.0005	0.0005
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.62	0.62	0.62	0.62

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The Guideline for Canadian Drinking Water Quality for simazine has been withdrawn (HC 2022). If the substance is detected in groundwater which is used (or may be used) as a source of drinking water, the drinking water authority in the affected jurisdiction should be contacted for guidance.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Degradation note

Potential degradation product includes mono-deethylsimazine. Consideration of this additional degradation product is potentially necessary when evaluating site groundwater quality impacted by simazine.

Groundwater Quality Guidelines for Styrene (CAS RN 100-42-5) (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.072	0.072	0.072	0.072
Human health guidelines				
Protection of indoor air quality (basement) ◇	1.9	13	--	--
Protection of indoor air quality (slab on grade) ◇	2.4	14	5.4●	39●
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.072	0.072	0.072	0.072
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) †	160	160	160	160

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

● A high-level screening flagged potential concern with dose-averaging; therefore, no dose-averaging was used (see Appendix A).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Sulfolane (CAS RN 126-33-0) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.3	0.3	0.3	0.3
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.3	0.3	0.3	0.3
Environmental health guidelines				
Protection of freshwater life	50	50	50	50
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	0.5	0.5	0.5	0.5
Groundwater contact by soil-dependent organisms	2,800	1,700	2,800	1,700
Management considerations				
Water solubility (50%) †	ND	ND	ND	ND

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); ND = not determined (not applicable to substance, see Section 2.0); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based on the Health Canada screening value for sulfolane in drinking water sources (HC 2020).

† This substance is completely miscible in water (PubChem 2021c) and will not form a separate phase. A management limit to prevent a separate phase does not apply.

Groundwater Quality Guidelines for Tebuthiuron (CAS RN 34014-18-1) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00027	0.00027	0.00027	0.00027
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.0016	0.0016	0.0016	0.0016
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.13	0.13	0.13	0.13
Protection of irrigation water	0.00027	0.00027	0.00027	0.00027
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (50%) † ¶¶	1,300	1,300	1,300	1,300

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ No density information was available for this substance; there is uncertainty whether the value based on 50% solubility applies.

Groundwater Quality Guidelines for Toluene (CAS RN 108-88-3) (mg/L)

Guideline	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.024	0.024	0.024	0.024
Human health guidelines				
Protection of indoor air quality (basement) ◇	18	140	--	--
Protection of indoor air quality (slab on grade) ◇	23	150	54 [•]	410 ^{•ES}
Protection of potable water AO	0.024	0.024	0.024	0.024
Environmental health guidelines				
Protection of freshwater life	0.083	NRG	0.083	NRG
Protection of marine life	8.9	NRG	8.9	NRG
Protection of livestock watering	0.024	0.024	0.024	0.024
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	59	83	59	83
Management considerations				
Water solubility (50%) † ¶¶	260	260	260	260

Notes: NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

• A high-level screening flagged potential concern with dose-averaging; therefore, no dose-averaging was used (see Appendix A).

ES: Exceedance of 50% aqueous solubility; a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

AO: Value is the aesthetic objective (AO). Consult HC 2024 for more information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

Groundwater Quality Guidelines for Toxaphene (CAS RN 8001-35-2) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.000041‡	0.005	0.000041‡	0.005
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water	NA	NA	NA	NA
Environmental health guidelines				
Protection of freshwater life	0.000041	NRG	0.000041	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.005	0.005	0.005	0.005
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.074	0.074	0.074	0.074

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

‡ This value is below CCME 2016d laboratory reporting limits (LRLs); however, achievable LRLs may vary across jurisdictions and may improve with time.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Triallate (CAS RN 2303-17-5) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00024	0.00024	0.00024	0.00024
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.016	0.016	0.016	0.016
Environmental health guidelines				
Protection of freshwater life	0.00024	0.00024	0.00024	0.00024
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.23	0.23	0.23	0.23
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.40	0.40	0.40	0.40

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Trifluralin (CAS RN 1582-09-8) (mg/L)

	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
Guideline (provisional*)	0.00020	0.014	0.00020	0.014
Human health guidelines				
Protection of indoor air quality (basement)	NC	NC	--	--
Protection of indoor air quality (slab on grade)	NC	NC	NC	NC
Protection of potable water §	0.15 ^{ES}	0.15 ^{ES}	0.15 ^{ES}	0.15 ^{ES}
Environmental health guidelines				
Protection of freshwater life	0.00020	0.014	0.00020	0.014
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	0.045 ^{ES}	0.045 ^{ES}	0.045 ^{ES}	0.045 ^{ES}
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	NC	NC	NC	NC
Management considerations				
Water solubility (10%) †	0.018	0.018	0.018	0.018

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

§ The potable water pathway for this substance is based directly on the long-term Human Health Reference Value for pesticides in drinking water sources (PMRA 2024).

ES: Exceedance of 10% aqueous solubility, a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

Groundwater Quality Guidelines for Xylenes (mg/L)

Guideline (provisional*)	Land use and soil texture			
	Agricultural/Residential		Commercial/Industrial	
	Coarse	Fine	Coarse	Fine
	0.02	0.02	0.02	0.02
Human health guidelines				
Protection of indoor air quality (basement) ◇	0.82	6	--	--
Protection of indoor air quality (slab on grade) ◇	1.0	6.4	8.7 [•]	64 ^{•ES}
Protection of potable water AO	0.02	0.02	0.02	0.02
Environmental health guidelines				
Protection of freshwater life	18	NRG	18	NRG
Protection of marine life	NC	NC	NC	NC
Protection of livestock watering	NA	NA	NA	NA
Protection of irrigation water	NA	NA	NA	NA
Groundwater contact by soil-dependent organisms	31	21	31	21
Management considerations				
Water solubility (50%) † ¶¶¶	53	53	53	53

Notes: NC = not calculated (due to insufficient data); NA = not available (no CCME or Health Canada benchmarks are available); NRG = no recommended guideline (calculated guideline > substance solubility or > 1,000,000 mg/L); -- = the pathway is not considered for the selected land use.

Guidelines are based on soil and water quality guidelines/benchmarks current up to February 1, 2024.

* Provisional guideline. Protection of potable water and protection of aquatic life (freshwater and marine) are considered to be required exposure pathways; if any of these guidelines are missing, the final guideline is considered to be provisional. Missing pathways should be addressed on a site-specific basis.

◇ Multiple lines of evidence are recommended to assess the vapour intrusion pathway; see Section 1.4.

• A high-level screening did not flag any concern with the air concentrations resulting from the dose-averaging for this substance (see Appendix A). However, there is some uncertainty associated with the use of dose-averaging as a full toxicological review was not conducted for each substance; thus, these values should be used with caution and other lines of evidence should be considered when assessing risks. Jurisdictional authorities should be consulted for further guidance.

ES: Exceedance of 50% aqueous solubility, a separate phase may potentially be present. The presence of a free-phase liquid may invalidate guideline values for some pathways. Consult Section 1.3.3 for further information.

AO: Value is the aesthetic objective (AO). Consult HC 2024 for more information.

† This management limit is an alert to the potential presence of upstream sources of free-phase liquid. It is based on single substance contamination and may not be applicable to mixtures. Please consult Section 1.3.3 for further information. A value of 50% water solubility is used for a substance expected to form a separate phase less dense than water; a value of 10% water solubility is used for a substance expected to form a separate phase denser than water. Consult the jurisdictional authority for guidance if the management limit is exceeded.

¶¶¶ This substance is often found as part of a mixture; the management limit may not apply. Please consult Section 1.3.3 for further information.

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APPENDIX A: REVISION TO THE GROUNDWATER GUIDELINE PROTOCOL

Decision to use Time-Dependent Modelling of Contaminant Transport in Saturated Zone

CCME uses Domenico (1987) to model the movement of contaminants in groundwater to surface water bodies. At the time of publication in 2015, the groundwater protocol (CCME 2015) used the time-dependent version of the model, with values of time sufficiently long since contaminant release to ensure that the calculated $GWQGs_{FL}$ and $GWQGs_{ML}$ represent a steady state condition. CCME has revised guideline development from steady state conditions to a fixed time (“t”) of 500 years since release. The $GWQGs_{FL}$ and $GWQGs_{ML}$ presented in the tables of the GWQGs were calculated using a value of $t = 500$ years in equation A-3 of the groundwater protocol.

The rationale for this policy change is discussed below. Readers are encouraged to review the groundwater protocol description of the Domenico model (Part B, Section 4.3) and the time-dependent versus steady state considerations of the model (Part B, Section 4.3.1 and Appendix B page 49, Time at Which Groundwater Model is Evaluated).

Some contaminants adsorb strongly to surfaces of solids, resulting in very limited mobility and extremely long travel times in groundwater. Some highly retarded contaminants may take tens of thousands of years, in coarse textured soil, to hundreds of thousands of years, in fine textured soil, to travel the 10-m default CCME separation distance between contaminant source and surface water receptor. The time needed to reach steady state would take longer; steady state represents a worst-case scenario where contaminants in a groundwater plume reaching the receptor have reached maximum, and stable, concentrations.

The policy change to a time-dependent model is a recognition that driving site clean-up based on potential risks posed by contaminated groundwater to receptors which are only expected to occur in the far future is not necessary for two main reasons. First, technological advances will likely provide more effective contaminant management, reducing the potential of an exceedance more than 500 years from now. Second, more attenuation will likely occur than estimated from the generic model and assumptions, primarily due to an underestimation of diffusion and biodegradation over long time scales.

Section 4.3.2 of the groundwater protocol states that “generic groundwater quality guidelines [for the protection of aquatic life] are intended to protect water quality at all future times.” With the policy change to a time-dependent model, this is no longer true. Generic GWQGs can only assure the protection of surface water receptors over a defined time period, i.e., 500 years since contaminant release.

Clarification on the Management Limit

Section 1.2, Part D of the groundwater protocol (CCME 2015) states that for high molecular weight chemicals, dissolved concentrations should not exceed 10% of their theoretical solubility limit. While density of a fluid chemical is related to molecular weight, it is also influenced by molecular interaction and structure of the chemical (USEPA 1991). The concentration of DNAPL components in water is generally no more than 10% of their solubility (USEPA 1991), and thus concentrations of a chemical in water equivalent to a low percentage of its water solubility is commonly used as an indicator of the presence of a DNAPL (British Columbia Ministry of Environment and Climate Change Strategy 2021;

CCME 2016). The intent, therefore, of the statement in Section 1.2, Part D regarding the use of a management limit of 10% of the water solubility limit is to alert to the possible presence of a DNAPL. Therefore, during the development of the management limits, the density of the chemical and not its molecular weight was considered as the most appropriate property to determine if the chemical would form a DNAPL.

Revised Approach to the Use of Dose-Averaging for the Indoor Air Quality Pathway

The exposure assumptions presented in the groundwater protocol (CCME 2015) for the indoor air quality pathway follow those used by the soil protocol (CCME 2006). This is 24 hours/day, 365 days/year (i.e., an exposure term [ET] = 1) for threshold TRVs for agricultural and residential land uses, as well as for non-threshold (carcinogenic) TRVs for all land uses. For threshold TRVs, 10 hours/day, 5 days/week, 48 weeks/year (i.e., dose-averaging with an ET = 0.27) was used for commercial and industrial land uses. Dose-averaging results in a less conservative value for the calculated indoor air concentration of substances for the industrial and commercial land uses. However, since the publication of the groundwater protocol (CCME 2015), HC (2021) published guidance that recommends a precautionary approach with no dose-averaging (ET = 1) in human health risk assessments unless a scientific review of the TRVs supports the use of dose-averaging.

As a scientific review of TRVs for all chemicals addressed in this document would cause a significant delay in the publication of these groundwater guidelines, a high-level screening approach was taken to address the discrepancy in the recommended ET that balances uncertainty and the need for protective guidelines that are not overly conservative. This aligns with the soil protocol which states: “While acknowledging the need for toxicity and exposure data of the highest quality, it is considered to be better to establish a guideline based on incomplete data than to not establish a risk-based guideline”.

A targeted, high-level screening of the $GWQG_{IAQ}$ pathway was conducted to identify substances for which dose-averaging may result in values that exceed human health-based benchmarks from select jurisdictions. First, for chemicals that had guidelines driven by threshold TRVs, the basis for the TRV used in guideline derivation (Appendix D) was considered and an ET = 1 was used as a precautionary approach if the TRV was based on adverse effects that suggest reproductive or developmental toxicity. Next, for chemicals with TRVs that did not suggest reproductive or developmental toxicity, target indoor air concentrations² for the commercial/industrial indoor air quality pathway using an ET = 0.27 were compared to the lowest of available acute or chronic air quality benchmarks from California (Reference Exposure Levels [RELs] [California Office of Environmental Health Hazard Assessment (OEHHA) 2023]) or Ontario (Ambient Air Quality Criteria [AAQCs] [Ontario Ministry of the Environment, Conservation and Parks (OMECP) 2020])³. If the target indoor air concentration was above any of the available benchmarks, then as a precautionary measure an ET = 1 (i.e., no dose-averaging) was used. If the target indoor air concentration was below all available benchmarks, dose-averaging (i.e., ET = 0.27) was used. If no or only an acute air quality benchmark was available, a precautionary approach using an ET = 1 as recommended in HC (2021) was followed.

² The predicted concentration of the chemical in indoor air based on the TRV and an ET = 0.27; see Appendix D calculation for non-carcinogenic target air concentration, CCME 2014.

³ The California chronic RELs (California OEHHA 2023) and Ontario Ambient Air Quality Criteria (OMECP 2020) were chosen for this high-level screening due to the large number of chemicals for which values were available.

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APPENDIX B: LIMITATIONS AND ASSUMPTIONS USED IN THE DERIVATION OF GROUNDWATER GUIDELINES

In the development of the GWQGs, specific assumptions are made for the models used for various pathways that, if not met, may invalidate the use of a guideline for a particular pathway. Limitations that may invalidate the assumptions are listed below and are discussed further in CCME protocols (CCME 2006; 2014; 2015).

As noted in Section 1.3.3, the models used in the development of GWQGs_{GC}, GWQGs_{SFL}, GWQGs_{SML} and GWQGs_{IAQ} do not account for the presence of a NAPL; thus, guidelines for these pathways should not be used if a NAPL is present.

Table B1 lists a number of limitations (or precluding conditions) which, if present, may invalidate the assumptions used to develop the GWQGs for specific pathways. Please refer to the groundwater protocol (CCME 2015) for details on what to do when these limitations are present.

Table B1. Limitations of models used in the development of groundwater guidelines and the pathways that are impacted

Limitation	Pathway impacted		
	GWQG _{FL} GWQG _{ML}	GWQG _{IAQ}	Other
Presence of NAPL	X	X	GWQG _{GC}
Contaminated groundwater within 10 m of a surface water body	X		GWQG _{PW} ¹
Groundwater flow to stagnant water bodies	X		
Presence of fractured bedrock or fractured silt/clay	X	X	
Very coarse textured soils or other matrix with high gas permeability that enhance transport or high groundwater velocity	X	X	
Contaminated groundwater (including capillary fringe) within 1 m of a building foundation ²		X	
Earthen floors ³ or other unusual structural features		X	
The building is taller than 4 floors		X	
Highly permeable and atypical utility conduits in buildings		X	
The source-building separation is less than 1 m (there is <1 m of clean soil between the building and the source)		X	
Methanogenic or anaerobic conditions observed in close proximity to the foundation		X	

¹ The drinking water guideline value is used directly in cases where the surface water is a source of potable water.

² Seasonally high water tables should be taken into consideration to ensure that there is a minimum 1 m separation distance to the capillary fringe across seasons.

³ The presence of a building with an earthen floor within 10 m (laterally and vertically) of groundwater contamination invalidates the GWQG_{IAQ}.

When a limitation is present, further information can be found in Section 1.3.2 of this document, and Part A, Section 3.3 of the groundwater protocol (CCME 2015).

Information regarding assumptions and what to do if limitations specific to the Johnson and Ettinger (1991) model for the indoor air quality pathway are present is available in Part C, Section 3.2 of the groundwater protocol (CCME 2015), Part A, Section 3.3 and Appendix C of the soil vapour protocol (CCME 2014) and Appendix E of the soil protocol (CCME 2006).

Information specific to assumptions associated with the groundwater transport model used for the protection of freshwater and marine life is available in Appendix C of the soil protocol (CCME 2006); note that GWQG_{SFL} and GWQG_{SML} only use the saturated-zone transport of the contaminant to a downgradient receptor part of the model given in CCME (2006).

The GWQG_{IAQ} pathway has additional limitations to consider for PHC fractions F1 and F2 (excluding aviation fuel), BTEX, naphthalene and hexane which utilize an Adj.F = 10. The use of the Adj.F = 10 for these substances is only applicable if soils beneath the building are unsaturated and biologically active (i.e., oxygen levels are >5% by volume and soil moisture content is >4% dry weight) (CCME 2014; HC 2023). If site conditions suggest low oxygen levels, data to demonstrate oxygen distribution is recommended. For example, size of the contaminant source should be considered as large sources may have a greater oxygen demand (HC 2023), which could result in lower biodegradation. Presence of an impermeable surface cover or cap might impact both oxygen levels and moisture content (British Columbia Ministry of Environment and Climate Change Strategy 2023; HC 2023). Furthermore, for F2, naphthalene and hexane for which there is greater uncertainty in their biodegradation compared to F1 and BTEX, jurisdictions may require additional supporting evidence. This could include soil vapour data from nested wells demonstrating attenuation along with indoor air data showing that indoor air concentrations are below what is predicted without consideration of biodegradation (HC 2023). Part C, Section 3.1.1 and Appendix E of the soil vapour protocol (CCME 2014) and Section 7.6 and 7.7 of HC (2023) provide further information on factors affecting biodegradation and the use of an Adj.F. = 10 (termed bioattenuation or bioattenuation adjustment factor [BAF] in CCME 2014 and HC 2023) for these chemicals.

References:

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APPENDIX C: PHYSICAL AND CHEMICAL PARAMETERS

(Separate Excel file)

APPENDIX D: HUMAN HEALTH TOXICOLOGICAL REFERENCE VALUES

(Separate Excel file)

APPENDIX E: WATER QUALITY BENCHMARKS

(Separate Excel file)

APPENDIX F: HALF-LIFE AND SOIL QUALITY GUIDELINES

(Separate Excel file)