Solid 1,2,3,4-tetrachlorobenzene (CAS 634-66-2, molecular weight 215.9) is used industrially mainly as an intermediate in the production of fungicides, herbicides, and defoliants (2,4,5-T), and insecticides (USEPA, 1980). It has also been used in the formulation of dielectric fluids for transformers. 1,2,3,4-Tetrachlorobenzene is not produced in Canada and imports are negligible (CIS 1991), however, approximately 1 300 000 kg of tetrachlorobenzenes are present in transformer dielectric fluids either in use or stored before disposal. Small amounts (about 660 kg of tetrachlorobenzene congeners) were imported into Canada in 1992 for the maintenance of existing transformer dielectric fluid (E.D. Brien 1993, Environment Canada, Ottawa, pers. com.). The principle sources of environmental contamination are likely spillage of these dielectric fluids, and long-range transborder transport and deposition. Losses associated with the use as an industrial reagent, residue in the final product, and via industrial effluents and landfill leachates are also expected. The releases of tetrachlorobenzenes to the Canadian environment are likely more than 2000 $kg \cdot a^{-1}$ (Government of Canada 1993).

Although chlorobenzenes have previously been considered to be entirely anthropogenic, there is now some evidence that some congeners can be produced naturally by both biotic and abiotic processes (e.g., 1,2,3,4-tetrachlorobenzene is found naturally in the Mississippi salt marsh needlerush *(Juncus roemerianus)* (Gribble 1994).

There are few data on the levels of tetrachlorobenzenes found in groundwater in Canada. The only reported values are 0.004 and 0.005 $\mu g \cdot L^{-1}$ for 1,2,3,4- and 1,2,3,5-tetrachlorobenzene, respectively, in a landfill leachate from Sarnia, Ontario (Government of Canada 1993).

1,2,3,4-Tetrachlorobenzene has been found in various watercourses in Canada, primarily in the Great Lakes basin. When present above detection limits, concentrations have been reported to range from <0.000 01 to 0.126 $\mu g \cdot L^{-1}$. Levels near the upper part of the range are usually near known sites of contamination on the St. Clair and Niagara Rivers. Elevated levels, some above the ranges previously noted, have been reported in industrial effluents in Ontario and Nova Scotia (Government of Canada 1993).

Levels of 1,2,3,4-tetrachlorobenzene in invertebrates and fish ranged from <0.01 to 26.8 $\mu g \cdot kg^{-1}$ (ww). The values in the upper part of the range are for organisms collected near sites in the Great Lakes basin known to be contaminated (Government of Canada 1993).

Mackay et al. (1992) have modelled the environmental fate of each of the chlorobenzenes using several versions of a fugacity-based model and available information. These modelling results indicate that chlorobenzene behaviour varies as a function of the degree of chlorination. The simplest model, Fugacity Level I, demonstrates that 1,2,3,4-tetrachlorobenzene tends to partition mainly into soil, some into the sediment, and a small amount into air, because of its low vapour pressure (5.2 Pa) and very low water solubility (7.8 $mg \cdot L^{-1}$). Level II modelling indicates that the primary removal processes for all chlorobenzenes are in air. For 1,2,3,4-tetrachlorobenzene, removal is mainly by advection (e.g., deposition, sedimentation) and, to a much lesser degree, by chemical reaction. Photodegradation is very slow, resulting in atmospheric half-lives of 6-18 weeks. Fugacity Level III modelling indicates that the more highly chlorinated chlorobenzenes tend to accumulate and persist primarily in soils and sediments, with transfer between media being slow, and move in the environment largely by long-range airborne transport and atmospheric deposition. As the primary removal process is advection, soils and sediments end up being long-term sinks/storage sites. In the aquatic environment, 1,2,3,4-tetrachlorobenzene is found mostly in organic phases (organisms, sediments) or associated with suspended/ dissolved organic material rather than dissolved in the water phase (log octanol–water partition coefficient 4.5), with half-lives of 4.2–14 months in the water and 1.1–3.4 years in the sediment.

Table 1. Water quality guidelines for 1,2,3,4-tetrachlorobenzene for the protection of aquatic life (Environment Canada 1997).

Aquatic life	Guideline value ($\mu g \cdot L^{-1}$)
Freshwater	1.8*
Marine	NRG†

*Interim guideline.

†No recommended guideline.

Water Quality Guideline Derivation

The interim Canadian water quality guideline for 1,2,3,4-tetrachlorobenzene for the protection of freshwater life was developed based on the CCME protocol (CCME 1991). For more information, see the Canadian Environmental Protection Act (CEPA) assessment report and supporting document (Government of Canada 1993) and the supporting document (Environment Canada 1997).

Freshwater Life

The interim water quality guideline for 1,2,3,4-tetrachlorobenzene for the protection of freshwater life is 1.8 µg·L^{-1}.

The lowest acute information for fish is a 96-h LC_{50} of 497 µg·L^{-1} for rainbow trout *(Oncorhynchus mykiss)* (Hodson et al. 1988) and a 96-h LC_{50} of 1070 µg·L^{-1} for fathead minnows *(Pimephales promelas)* (Ahmad et al. 1984). In an acute study, Roghair et al. (1994) reported a 48-h LC_{50} of 730 µg·L^{-1} and a 48-h NOEC of 110 µg·L^{-1} for the midge *Chironomus riparius*. Two acute invertebrate studies report a 96-h LC_{50} of 184 µg·L^{-1} for *D. pulex* (Ikemoto et al. 1992) in conjunction with a safety factor of 0.01 (acute study), the basis for the interim freshwater guideline of 1.8 µg·L^{-1}, and a 48-h LC_{50} of 1 080 µg·L^{-1} for *D. magna*. (Abernethy et al. 1988).

Chronic fish data consist of a 28-d NOEC and a 28-d NOLC (no observed lethality concentration) of 100 and 310 µg·L^{-1}, respectively, for zebra fish *(B. rerio)* (van Leeuwen et al. 1990), and a 30-d MATC of 245 µg·L^{-1} for fathead minnows *(P. promelas)* (Ahmad et al. 1984). De Wolf et al. (1988) reported a chronic invertebrate study with a 16-d NOEC of 55 µg·L^{-1} for *D. magna*.

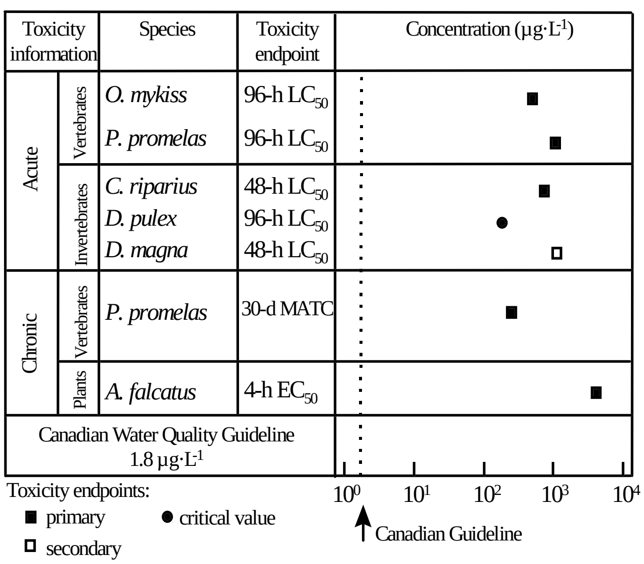

Figure 1. Select freshwater toxicity data for 1,2,3,4-tetrachlorobenzene.

Wong et al. (1984) reported a 4-h EC_{50} of 4100 µg·L^{-1} for the alga *A. falcatus*, based on reduction in primary production (photosynthesis).

It was decided, that a guideline derived from the lowest chronic endpoint (245 µg·L^{-1} for fathead minnows) may not be protective to sensitive invertebrates, as the lowest known acute endpoint for invertebrates (184 µg·L^{-1} for *D. pulex*) is below the lowest known chronic effects level for fish. The guideline is, therefore, based on the acute effect on invertebrates, even though chronic data is available. It was derived by multiplying the 96-h LC_{50} of 184 µg·L^{-1} for *D. pulex* (Ikemoto et al. 1992) by a safety factor of 0.01 (CCME 1991).

Marine Life

Insufficient information exists to derive an interim marine guideline for 1,2,3,4-tetrachlorobenzene.

There are no toxicity data for marine fish with 1,2,3,4-tetrachlorobenzene. Mortimer and Connell (1994) reported a 96-h LC_{50} of 399 µg·L^{-1} for the sand crab *P. pelagicus*. Mortimer and Connell (1995) reported growth rate reductions of 10 and 50% for the sand crab after 40-d exposures of 36.1 µg·L^{-1} (the lowest effect level) and 125.0 µg·L^{-1}, respectively.

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