# Canadian Water Quality Guidelines for the Protection of Aquatic Life

# CHLORINATED BENZENES
### 1,2,3-trichlorobenzene

Solid 1,2,3-trichlorobenzene (CAS 87-61-6, molecular weight 181.45) is used industrially as a dye carrier, an intermediate in chemical productions (especially herbicides), a degreasing agent, and a lubricant (CIS 1991). Trichlorobenzene congeners are not produced or widely used in Canada; however, approximately 2 600 000 t of trichlorobenzene are present in transformer dielectric fluids either in use or stored before disposal, and modest amounts (<2000 kg) 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 of trichlorobenzenes as an industrial solvent, and via industrial effluents and landfill leachates are also expected. There is evidence of production of trichlorobenzenes from microbial degradation and plant metabolism of more highly chlorinated benzenes, but it is not considered to be a major source (Government of Canada 1993). There are no quantified estimates of source contributions for trichlorobenzenes in Canada (Government of Canada 1993).

1,2,3-Trichlorobenzene has been reported at low levels at various sites in the Great Lakes basin ranging from 0.005 to 30 $\mu g \cdot L^{-1}$. Higher levels were reported in the early 1980s. More recently, maximum levels from the Niagara River at Niagara-on-the-Lake were reported to be 0.0006 $\mu g \cdot L^{-1}$ (NRDIG 1990). As well, elevated concentrations have been found in the effluents from various municipal and industrial facilities in Ontario and Nova Scotia (Government of Canada 1993).

Levels of 1,2,3-trichlorobenzene in invertebrates and fish ranged from 0.1 to 29 $\mu g \cdot kg^{-1}$ (ww). The values in the upper part of the range are for organisms collected in the lower Niagara River and its plume in Lake Ontario. Levels at other locations were in the lower part of the range or not detectable (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-trichlorobenzene tends to partition mainly into air, some into soil, and a small amount into water, because of its vapour pressure (28 Pa) and low water solubility (21 $mg \cdot L^{-1}$). Level II modelling indicates that the primary removal processes for all chlorobenzenes are in air. For 1,2,3-trichlorobenzene, removal is mainly by advection (e.g., deposition, sedimentation) and chemical reaction. Photodegradation is slow, resulting in atmospheric half-lives of 2–6 weeks. In the aquatic environment, 1,2,3-trichlorobenzene 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 4.1), with half-lives of 6–18 weeks in the water and 1.1–3.4 years in the sediment.

## Water Quality Guideline Derivation

The interim Canadian water quality guideline for 1,2,3-trichlorobenzene 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 lowest acute results for fish are a 96-h $LC_{50}$ of 340 $\mu g \cdot L^{-1}$ for the guppy *(P. reticulata)* (van Hoogen and Opperhuizen 1988) and a 48-h $LC_{50}$ of 710 $\mu g \cdot L^{-1}$ for rainbow trout *(Oncorhynchus mykiss)* (Calamari et al.

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

| Aquatic life | Guideline value ($\mu g \cdot L^{-1}$) |
|---|---|
| Freshwater | 8.0* |
| Marine | NRG† |

*Interim guideline.
†No recommended guideline.

1983). Acute data for invertebrates consist of a 24-h $IC_{50}$ (immobilization) of 350 μg·L$^{-1}$ for *Daphnia magna* (Calamari et al. 1983), and a 48-h $LC_{50}$ of 1700 μg·L$^{-1}$ (NOEC of 340 μg·L$^{-1}$) for the midge *(Chironomus riparius)* (Roghair et al. 1994). A recent study with the midge *(C. riparius)* by van der Zandt et al. (1994) reported a 96-h LOEC at 200 and a 96-h NOEC at 18 μg·L$^{-1}$ based on some behavioural changes. Even though this study reports the lowest effects concentration, it was not used in the guideline derivation, as behavioural changes are not acceptable endpoints.

Chronic information for fish consists of a 28-d NOEC of 250 μg·L$^{-1}$ for zebra fish *(Brachydanio rerio)* (van Leeuwen et al. 1990). Results for invertebrates consist of a 14-d $EC_{50}$ and 14-d $EC_{16}$ (reduced fertility) of 200 μg·L$^{-1}$ and 80 μg·L$^{-1}$, respectively, for *D. magna*, and an acute 48-h NOEC of 340 μg·L$^{-1}$ for the midge *(C. riparius)* (Roghair et al. 1994).

Calamari et al. (1983) reported a 96-h $EC_{50}$ of 900 μg·L$^{-1}$ for the alga *Selenastrum capricornutum*, based on growth inhibition, and a 3-h $EC_{50}$ of 2200 μg·L$^{-1}$, based on inhibition of photosynthesis. Sicko-Goad and Andresen (1993) showed that diatoms *(Cyclotella meneghiniana, Melosira italica, Melosira varians,* and *Synedra filiformis)* can be adversely affected by exposure to approximately 300 μg·L$^{-1}$ of 1,2,3-trichlorobenzene within 1–10 d. Reductions of 20–50% in the cell count has been observed for *Melosira italica*.

The interim water quality guideline for 1,2,3-trichlorobenzene for the protection of freshwater life is 8.0 μg·L$^{-1}$. It was derived by multiplying the LOEC of 80 μg·L$^{-1}$ (Roghair et al. 1994) for the most sensitive organism to 1,2,3-trichlorobenzene, *D. magna*, by a safety factor of 0.1 (CCME 1991).

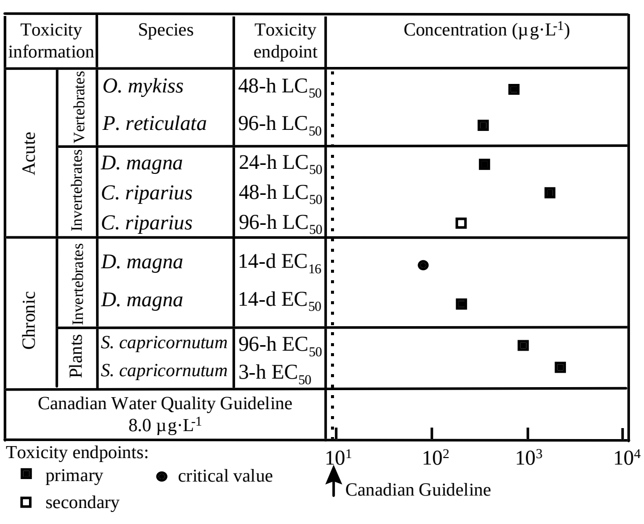


**Figure 1. Select freshwater toxicity data for 1,2,3-trichlorobenzene.**

## Marine Life

Insufficient information exists to derive a marine interim guideline for 1,2,3-trichlorobenzene.

Heitmuller et al. (1981) reported a 96-h $LC_{50}$ of 2 100 μg·L$^{-1}$ for sheepshead minnows *(Cyprinodon aggregata)*. Mortimer and Connell (1994) reported a 96-h $LC_{50}$ of 570 μg·L$^{-1}$ for the sand crab *(Portunus pelagicus)*, and Abernethy et al. (1988) reported a 24-h $LC_{50}$ of 2 340 μg·L$^{-1}$ for *Artemia nauplii*. Mortimer and Connell (1995) reported growth rate reductions of 10% and 50% after 40-d exposures of 53.5 μg·L$^{-1}$ (the lowest effect level) and 172.9 μg·L$^{-1}$, respectively, for the sand crab *P. pelagicus*.

### References

Abernethy, S.G., D. Mackay, and L.S. McCarty. 1988. "Volume fraction" correlation for narcosis in aquatic organisms: The key role of partitioning. Environ. Toxicol. Chem. 7:469–481.

Calamari, D., S. Galassi, F. Setti, and M. Vighi. 1983. Toxicity of selected chlorobenzenes to aquatic organisms. Chemosphere 12:253–262.

CCME (Canadian Council of Ministers of the Environment). 1991. Appendix IX—A protocol for the derivation of water quality guidelines for the protection of aquatic life (April 1991). In: Canadian water quality guidelines, Canadian Council of Resource and Environment Ministers. 1987. Prepared by the Task Force on Water Quality Guidelines. [Updated and reprinted with minor revisions and editorial changes in Canadian environmental quality guidelines, Chapter 4, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

———. 1993. Appendix XV—Protocols for deriving water quality guidelines for the protection of agricultural water uses (October 1993). In: Canadian water quality guidelines, Canadian Council of Resource and Environment Ministers. 1987. Prepared by the Task Force on Water Quality Guidelines. [Updated and reprinted with minor revisions and editorial changes in Canadian environmental quality guidelines, Chapter 5, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

CCREM (Canadian Council of Resource and Environment Ministers). 1987. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines.

CIS (Camford Information Services). 1991. CPI product profiles: Chlorobenzenes (mono, di, tri, tetra, penta, hexachlorobenzenes). CIS, Don Mills, ON.

Environment Canada. 1997. Canadian water quality guidelines for chlorinated benzenes. Supporting document. Environment Canada, Science Policy and Environmental Quality Branch, Ottawa. Unpub. draft doc.

Government of Canada. 1993. Trichlorobenzenes. Canadian Environmental Protection Act Priority Substances List Assessment Report. Health and Welfare Canada and Environment Canada, Ottawa.

Heitmuller, P.T., T.A. Hollister, and P.R. Parrish. 1981. Acute toxicity of 54 industrial chemicals to sheepshead minnows *Cyprinodon variegatus*. Bull. Environ. Contam. Toxicol. 27:596–604.

Mackay, D., W.Y. Shiu, and K.C. Ma. 1992. Illustrated handbook of physical-chemical properties and environmental fate for organic chemicals I. Monoaromatics, chlorobenzenes, and PCBs. Lewis Publishers Inc., Boca Raton FL.

Mortimer, M.R., and D.W. Connell. 1994. Critical internal and aqueous lethal concentrations of chlorobenzenes with the crab *Portunus pelagicus* (L). Ecotoxicol. Environ. Saf. 28:298–312.

———. 1995. Effect of exposure to chlorobenzenes on growth rates of the crab *Portunus pelagicus* (L). Environ. Sci. Technol. 29 (8): 1881–1886.

NRDIG (Niagara River Data Interpretation Group), 1990. Joint evaluation of the upstream/downstream Niagara River monitoring data. Niagara River Data Interpretation Group, River Monitoring Committee.

Roghair, C.J., A. Buijze, E.S.E. Yedema, and J.L.M. Hermens. 1994. A QSAR for base-line toxicity to the midge *Chironomus riparius*. Chemosphere 28:989–997.

Sicko-Goad, L., and N.A. Andresen. 1993. Effect of diatom lipid composition on the toxicity of trichlorobenzene. Arch. Environ. Contam. Toxicol. 24: 243–248.

van der Zandt, P.T.J., F. Heinis, and A. Kikkert. 1994. Effects of narcoticindustrial pollutants on behaviour of midge larvae *Chironomus riparius* (Meigen) (Diptera): A quantitative structure-activity relationship. Aquat. Toxicol. 28:209–221.

Van Hoogen, G., and A. Opperhuizen. 1988. Toxicokinetics of chlorobenzenes in fish. Environ. Toxicol. Chem. 7:213–219.

van Leeuwen, C.J., D.M.M. Adema, and J. Hermens. 1990. Quantitative structure-activity relationships for fish early life stage toxicity. Aquat. Toxicol. 16:321–334.

Reference listing:

Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life: Chlorinated benzenes—1,2,3-Trichlorobenzene. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

For further scientific information, contact:

Environment Canada
Guidelines and Standards Division
351 St. Joseph Blvd.
Hull, QC K1A 0H3
Phone: (819) 953-1550
Facsimile: (819) 953-0461
E-mail: ceqg-rcqe@ec.gc.ca
Internet: http://www.ec.gc.ca

For additional copies, contact:

CCME Documents
c/o Manitoba Statutory Publications
200 Vaughan St.
Winnipeg, MB R3C 1T5
Phone: (204) 945-4664
Facsimile: (204) 945-7172
E-mail: spccme@chc.gov.mb.ca


Excerpt from Publication No. 1299; ISBN 1-896997-34-1

Aussi disponible en français.