1,4-Dioxane in Water

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About 1,4-dioxane

1,4-dioxane is a clear liquid that easily dissolves in water. It can move through soil and enter the groundwater, where it may move long distances. The main use of 1,4-dioxane was as a stabilizer for the industrial solvent 1,1,1-trichloroethane. Groundwater contaminated with 1,4-dioxane is largely a result of the historical use and disposal of this solvent.

1,4-dioxane has had a number of other uses, including the manufacture of chemicals, and as an additive in certain inks, adhesives, automotive fluids, etc. It can also be present in materials used in the production of cleaners, detergents, soaps, and cosmetics, etc. Manufacturing processes have changed over time to somewhat reduce the amount of 1,4-dioxane in these consumer products. EPA acknowledges that consumer products containing 1,4-dioxane may contribute to groundwater contamination (and subsequently drinking water) from liquid that leaches or drains from a landfill and wastewater sources, including septic systems.

How people can be exposed to 1,4-dioxane

- Drinking contaminated water is the main way people are exposed.
- Eating food prepared with contaminated water can add additional exposure.
- Showering or bathing with contaminated water is not a health concern. Exposure from inhalation of water vapor and absorption through the skin is expected to be very small.
  - 1,4-dioxane dissolves completely in water. It does not easily move into the air from water, therefore the potential for inhalation exposure is minimal.
  - Data on human skin absorption of 1,4-dioxane is lacking; animals studies indicate very low skin absorption.
  - Skin effects, such as visible irritation, have not been found in a limited amount of animal studies.
- Eating garden plants watered with contaminated water may be a minor source of exposure, but this has not been well studied.

Health Risk Limits for 1,4-dioxane

Minnesota Department of Health (MDH) uses Health Risk Limits (HRLs) to protect people's health from drinking water contaminants. MDH develops HRLs to protect those most vulnerable (e.g., most

sensitive or most highly exposed) to the potentially harmful effects of a contaminant. Using drinking water that has concentrations of 1,4-dioxane higher than the HRLs may pose a risk of adverse health effects to some people. The concentration of 1,4-dioxane in water that is considered a risk to health depends on many variables, such as the amount of water a person drinks, duration of exposures, their weight, their age, and whether they have other health conditions.

The table below shows the three HRL values for 1,4-dioxane set by MDH, for differing time frames and possible health endpoints they are based on. The lowest and most protective value is applied most often to decisions for protecting water users.

MDH Health Risk Limits for 1,4-Dioxane

HRL (µg/L) *	Duration	Health Basis	Description
Not developed	Acute (1 day)	Insufficient data	--
Not developed	Short term (>1 day up to 30 days)	Insufficient data--	--
300	Subchronic (>30 days up to 10% of a lifetime)	Liver, kidney, and respiratory systems	Protects all people from noncancer effects when exposed for months to years
100	Chronic (>10% of a lifetime)	Liver, kidney, and respiratory systems	Protects all people from noncancer effects when exposed up to a lifetime
1	Lifetime (0-70 years)	Cancer	Protects all people from cancer when exposed for a lifetime

*HRLs are shown in units of micrograms of 1,4-dioxane per liter of water (µg/L). This is the same as parts per billion (ppb).

For more information about MDH health-based rules and guidance to evaluate potential human health risks from exposures to chemicals in groundwater, see:
Guidance Values and Standards for Contaminants in Drinking Water (www.health.state.mn.us/communities/environment/risk/guidance/gw/index.html).

Potential Health Effects

Information about the health effects of 1,4-dioxane comes mainly from studies of laboratory animals. 1,4-Dioxane is considered a likely human carcinogen, based on studies of animals exposed to very high amounts. 1,4-dioxane caused liver, nasal, abdominal cavity, and mammary gland tumors in rodents. There are currently no human studies that show a direct link between exposure to 1,4-dioxane and cancer. The HRL of 1 µg/L is based on a cancer risk of one additional cancer in 100,000 people consuming the water on a daily basis for a lifetime.

Exposure to 1,4-dioxane in drinking water above 100 µg/L for many years, or above 300 µg/L for greater than 30 days, may increase the risk of damage to the liver, kidney, and respiratory systems in some individuals. This is based on effects in laboratory animals given much higher amounts.

1,4-Dioxane in the Body

1,4-dioxane breaks down in the body and is eliminated quickly – on the order of hours to days. Tests to measure 1,4-dioxane or metabolites are not readily available to healthcare providers. There are no recommendations for any increased screening for cancer or other health effects.

Infants and Children

There are no studies of children or pregnant women exposed to 1,4-dioxane. It is not known whether children differ from adults in their susceptibility to the effects of 1,4-dioxane. In a study of pregnant rats exposed to very high levels of 1,4-dioxane, fetuses weighed less and had a slight delay in bone formation. The HRLs are calculated to include protection for early-life exposures.

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