



# Dioxins and Furans

This fact sheet describes the Canadian Soil Quality Guidelines for dioxins and furans to protect environmental health. It is part of the series *Guidelines at a Glance*, which summarizes information on toxic substances and other parameters for which there are Canadian Environmental Quality Guidelines.

The National Guidelines and Standards Office of Environment Canada coordinates the development of Canadian Environmental Quality Guidelines in cooperation with the Canadian Council of Ministers of the Environment (CCME).

## Where do dioxins and furans come from?

Dioxins and furans are chemical compounds that contain chlorine and can occur in 210 different configurations, called congeners. Dioxins and furans do not have a known use. They are produced unintentionally by human activities, including waste incineration, chemical manufacturing, petroleum refining, fuel combustion in vehicles, wood burning, and electric power generation. In the past, pulp and paper mill effluents were a major source of dioxins and furans, but regulations that came into effect in 1992 significantly reduced this source. Dioxins and furans are also produced by natural events such as forest fires and volcanic eruptions. In 1997, nearly half of the dioxin and furan load to Canada's environment was produced by releases to the atmosphere from combustion sources. Atmospheric transport can occur over long distances, taking dioxins and furans far from their original source.

Dioxins and furans are considered toxic under the Canadian Environmental Protection Act, and federal toxic management policies aim to virtually eliminate them from the Canadian environment.

## What happens to dioxins and furans released into the environment?

Dioxins and furans are hydrophobic, meaning that they repel water. Because of this characteristic, dioxins and furans released into the environment become attached to organic particles and get into the fatty tissues of organisms. Dioxins and furans bind strongly to soils, and they can persist for long periods without being broken down. They can be broken down by light, however, and this process happens on soil surfaces exposed to air. Some terrestrial animals can take up dioxins and furans through direct contact with soil, and others accumulate dioxins and furans by eating contaminated prey. Dioxins and furans accumulate in the lipids (fats) of organisms, and there is some evidence that these chemicals can magnify in terrestrial food webs.

## What effects can dioxins and furans have on terrestrial forms of life?

The effects of dioxins and furans on plants, soil microbes, and invertebrates are not well known. A single study on earthworms found that they are killed at high levels of exposure to dioxins and furans. In mammals and birds, dioxins and furans bind to a specific protein in their cells and this results in many different effects on the animal. Sensitivity to dioxin and furan exposure varies widely among species: some survive exposure to very high levels while others die at low levels of exposure. Effects on animals include decreased food consumption, less weight gain, lower growth rates and problems with the reproductive and nervous systems. Dioxins and furans have also been shown to cause cancer in some animal species.

## What levels of dioxins and furans are safe for plants and animals that live in or on Canadian soils?

A variety of different dioxins and furans typically occur together in the environment, so their combined effects should be considered. Some dioxins and furans are more toxic than others. The Canadian Soil Quality Guidelines (CSoQG) for dioxins and furans are based on the 17 congeners that are thought to be the most toxic. The toxicity of a mixture of dioxins and furans can be expressed by converting the concentrations of each dioxin and furan to an equivalent toxicity of the most toxic one known (the dioxin



# Guidelines at a Glance

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2,3,7,8-TCDD). Each converted toxicity is called a dioxin and furan toxic equivalent (TEQ). The TEQs are based on data from measuring the responses of organisms to many different dioxins and furans. The TEQ gives a standardized toxicity for dioxins and furans.

The CSoQG for dioxins and furans depend on the type of land and its use. The four land uses considered are: agricultural, residential and parkland, commercial, and industrial. There were very few data available on plants, microbes, and invertebrates, so guidelines for environmental health could not be determined for any of the four land uses. There were enough toxicity studies, however, to calculate guidelines for human health. These have been adopted as the CSoQGs to protect environmental health.

The CSoQG for soil on any of the four land types is 4 nanograms of dioxin and furan TEQs per kilogram of soil. This guideline was determined from the average background soil concentration in Canada because exposure to higher levels is not recommended.

If the level of dioxin and furan toxic equivalents measured in the soil is less than the guideline, one would not expect to see adverse health effects in even the most sensitive species. In places where the CSoQGs for dioxins and furans are exceeded, adverse effects will not necessarily occur. Whether effects will occur depends on the amount by which the guideline levels are exceeded, the sensitivity of individual species, and the soil characteristics (e.g., organic carbon content). Further investigation at a particular site is needed to determine whether or not there is a negative impact. Also, some dioxins and furans have toxic effects similar to the effects of some polychlorinated biphenyls (PCBs), which are also synthetic compounds. PCBs often occur together with dioxins and furans at a site, so guidelines for PCBs should also be considered.

### How do levels of dioxins and furans in Canadian soils compare to the guidelines?

Dioxins and furans are found at low levels in the soil at most sites tested. They have even been measured in remote areas. The average background level of dioxins and furans in most Canadian soils is 4 nanograms of dioxin and furan TEQs per kilogram of soil. The background level is much lower at northern sites.

Levels of dioxins and furans are high in some soils that have received effluent or waste releases. In British Columbia, soil affected by pulp and paper mills had levels of 255 nanograms of dioxin and furan TEQs per kilogram of soil. In Quebec, a level of 1,124 nanograms of dioxin and furan TEQs per kilogram of soil was measured at the site of a PCB warehouse fire. At an abandoned military site in the north, levels of 2.6 nanograms of dioxin and furan TEQs per kilogram of soil were measured.

### How can CSoQGs be used to make a difference?

In general, Canadian Soil Quality Guidelines can be used by Canadian federal, provincial, and territorial governments on a voluntary basis to set local guidelines and clean-up targets. CSoQGs are most commonly used in environmental assessments as benchmarks or yardsticks to which measured levels are compared. Anyone can use the guidelines to determine if the level of dioxin and furan toxic equivalents measured in a soil sample has the potential to cause adverse environmental effects.

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