



Nonylphenol and its Ethoxylates

This fact sheet describes the interim Canadian Sediment Quality Guidelines for nonylphenol and nonylphenol ethoxylates to protect freshwater and marine life. 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 nonylphenol and nonylphenol ethoxylates come from?

Nonylphenol ethoxylates (NPEs) are a group of synthetic chemicals produced for their surfactant properties; that is, their ability to make liquids spread out on flat surfaces rather than collecting in droplets, and their ability to bind non-mixable substances such as oil and water. NPEs are made from nonylphenol (NP), also a synthetic chemical, by adding as many as one hundred ethoxylate groups. Ethoxylate groups are made of carbon, hydrogen and oxygen. Most of the commonly used NPEs have six to twelve ethoxylate groups. NPEs are used in a wide variety of residential and commercial cleaning products, including detergents, shampoos, and surface cleaners. They are also used in pesticides and spermicides. Industry uses NPEs as detergents, emulsifiers, wetting agents, and dispersing agents in textile processing. Other industrial uses are in paint and protective coatings, the manufacturing of plastics, pulp and paper production, oil extraction and petroleum production, metal processing, leather manufacturing, and building and construction.

Many of the NPEs in use today are found in cleaners, detergents, and shampoos which subsequently are washed down household drains to municipal wastewater treatment plants. Some NPEs are degraded in the treatment plants, some end up in sludge, and some are released to surface waters. Some industries using NPEs may also discharge effluents containing these chemicals directly into the aquatic environment.

What happens to nonylphenol and nonylphenol ethoxylates released into the environment?

NP and NPEs in the environment and in wastewater treatment plants are broken down (biodegraded) by bacteria and other microorganisms. Initially, NPEs are rapidly biodegraded into intermediate breakdown products which include NP itself. Eventually these intermediates are completely biodegraded to carbon dioxide, water, and inorganic salts, but this process occurs over several weeks. The intermediate breakdown products therefore remain in the environment longer than the parent NPEs.

When released to surface waters, NP and NPEs may also cling to particles and concentrate in the sediments at the bottom of waterbodies. NP and some intermediate breakdown products tend to cling to particles more than other NPEs do. The amount of total organic carbon in sediments will affect the amount of NP and NPEs that cling. Aquatic plants, invertebrates, and fish that come in contact with the sediments can take up NP and NPEs from the sediment.

What effects can nonylphenol and nonylphenol ethoxylates have on sediment-dwelling forms of aquatic life?

Sediment-dwelling invertebrates that are exposed to NP and NPEs may be smaller, slower to mature, and have lower reproductive success. At very high concentrations these invertebrates may die and their populations may decrease in size. NP and some NPEs can also disrupt the hormone-regulating systems of aquatic animals. For example, they can cause male fish to produce chemicals in their bodies that are normally only produced by female fish as they form eggs. NP and NPEs can also cause



and fish to form both male and female reproductive organs, and they can affect the ratio of males to females within a population. These changes have the potential to alter normal breeding activity in the affected species.

What levels of nonylphenol and nonylphenol ethoxylates are safe for plants and animals that live in or near Canadian sediments?

As NP and NPEs typically occur together in the environment, their combined effects should be considered. NP is about 2 to 200 times more potent than NPEs, depending on the number of ethoxylate groups on the NPEs. The toxicity of a mixture of NP and NPEs can be expressed by converting the concentrations of each NPE to an equivalent potency of NP. Each converted potency is called a nonylphenol toxic equivalent (TEQ).

The interim Canadian Sediment Quality Guideline (CSeQG) to protect freshwater life is 1.4 milligrams of nonylphenol TEQs per kilogram of dry sediment that contains 1% total organic carbon.

The interim Canadian Sediment Quality Guideline (CSeQG) to protect marine life is 1.0 milligram of nonylphenol TEQs per kilogram of dry sediment that contains 1% total organic carbon.

Both the freshwater and marine guideline values should be adjusted to reflect the actual amount of total organic carbon at a given site. Very few sediment toxicity data were available for NP when the sediment quality guidelines were derived, so the guidelines will be considered interim until more data become available.

If the level of nonylphenol toxic equivalents measured in freshwater or marine sediments is less than the corresponding guideline, one would not expect to see adverse health effects in even the most sensitive species. In places where the interim CSeQGs for NP and NPEs are exceeded, adverse effects will not necessarily occur. Whether effects will occur depends on the amount by which the guideline levels are exceeded, the kinds of plants and animals that live there, and the sediment characteristics (e.g., organic carbon content). Further investigation at a particular site is needed to determine whether or not there is a negative impact.

How do levels of nonylphenol and nonylphenol ethoxylates in Canadian sediments compare to the guidelines?

Data on NP and NPEs in Canada's freshwater sediments have been collected from two systems: Great Lakes-St. Lawrence and Fraser River, BC. Concentrations of NP range from below detectable levels to 110 milligrams per kilogram of dry sediment. Therefore, in some places the CSeQG is greatly exceeded and adverse effects could occur. Concentrations of individual NPEs can differ greatly. For example, levels of NPEs with one ethoxylate group are typically 75 milligrams per kilogram or less, and levels of NPEs with two ethoxylate groups are 18 milligrams per kilogram or less. When converted to nonylphenol TEQs, concentrations that exceed the freshwater guideline typically only occur in sediments near industrialized areas or near municipal wastewater discharges. Levels of NP and individual NPEs measured in Canadian marine sediments are generally less than the guideline value of 1.0 milligram per kilogram of dry sediment.

How can CSeQGs be used to make a difference?

In general, Canadian Sediment Quality Guidelines can be used by Canadian federal, provincial, and territorial governments on a voluntary basis to set local guidelines, dredging disposal limits, and clean-up targets. CSeQGs 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 nonylphenol toxic equivalents measured in a sediment sample has the potential to cause adverse environmental effects.

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