Guidelines at a Glance

Canadian Water Quality Guidelines February 2005

Nitrate

This fact sheet describes the interim Canadian Water Quality Guidelines for nitrate to protect freshwater and marine life. It is part of the series *Guidelines at a Glance*, which summarizes information for the Canadian public 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 does nitrate come from?

Nitrate (NO_3^-) is only one of several forms of nitrogen that occur in surface waters. Nitrate tends to be the dominant form of nitrogen in waters with normal levels of dissolved oxygen. It can be converted naturally in soils and waters from other forms of nitrogen with the help of bacteria, or it can be released directly to surface waters from industrial, residential, and agricultural sources. Nitrate is used extensively in the production of fertilizers because it is readily taken up by plants for growth. Nitrate is also used in a variety of industrial applications, including as oxidizing agents in explosives, matches and pyrotechnics. Other uses are in photography, glass making, engraving, textile dyes, food preservatives, and as a raw material for manufacturing nitric acid.

Nitrogen undergoes a complex cycle through the terrestrial and aquatic environments. The form of nitrogen present in surface waters is dependent on several factors, including pH, the amount of available oxygen, and the types of biological communities that are present. All forms of nitrogen released to surface waters may be transformed by bacteria to nitrate. Nitrate can also get directly into surface waters through atmospheric deposition, from surface water runoff, or through the seepage of groundwater to streams and lakes. More nitrogen (including nitrate) is released to surface waters from diffuse sources such as atmospheric deposition and agricultural and domestic runoff than from point sources such as municipal wastewater effluents or industrial discharges.

What happens to nitrate released into the environment?

Nitrate is highly mobile in the environment. Although it is often released in the form of a salt (e.g., sodium nitrate, potassium nitrate, or ammonium nitrate), these will quickly dissolve and liberate the free nitrate ion. Nitrate does not bind to soils or particles in the water and is therefore easily transported along with water. During rainy periods, nitrate not taken up by plants in surface soils will travel downwards through the soil and be carried away by groundwater, or will be carried overland to surface waters. If nitrate ends up in waters with very little dissolved oxygen, certain types of bacteria will convert it to nitrite (NO_2^-), and ultimately to nitrogen gas (N_2), which can then escape to the atmosphere. In well-oxygenated waters, nitrate is readily taken up by aquatic plants and algae and used for growth.

What effects can nitrate have on our fish and other forms of aquatic life?

Nitrate is an essential plant nutrient, and high levels of nitrate in lakes and coastal areas can therefore contribute to the excessive growth of plants and algae. This may result in indirect toxic effects to other aquatic organisms. Algal “blooms” can reduce oxygen levels in the water, putting stress on aquatic animals, and some types of algae can produce toxins that are hazardous to other aquatic organisms (and people). Excessive levels of nitrate are also directly harmful to aquatic animals. Aquatic invertebrates and fish exposed to nitrate may be smaller, slower to mature, or have lower reproductive

success. Under extremely high exposure levels, aquatic invertebrates and fish may die. Early life stages of aquatic animals are more sensitive to nitrate than are juvenile and adult animals. Larval stages of amphibians appear to be particularly sensitive to subtle effects from nitrate exposure. For example, nitrate can reduce the overall size and weight of frog tadpoles by the time they change into adults. This may reduce their ability to compete for food or mates or to escape from predators.

What levels of nitrate are safe for plants and animals that live in Canadian waters?

It is not possible to recommend a single nitrate value that will protect against algal blooms in water bodies because algal growth also relies on the abundance of other nutrients (e.g., ammonia, phosphorus, and silica), water movement, and the amount of available sunlight. Therefore, this Canadian Water Quality Guideline (CWQG) is intended to protect aquatic organisms from only the direct toxic effects of nitrate. Because excessive algal growth can occur at nitrate concentrations that are lower than the CWQG, the role that nitrate plays in this process needs to be assessed at the local level.

The interim CWQG to protect freshwater life is 13 milligrams of nitrate per litre of water. This freshwater guideline is based on a number of scientific studies that examined the impacts of nitrate on animals that live in our lakes and rivers.

The interim CWQG to protect marine life is 16 milligrams of nitrate per litre of water. This marine guideline is based on a number of scientific studies that examined the impacts of nitrate on animals that live in temperate estuaries and coastal waters.

If the level of nitrate measured in surface waters is less than the corresponding guideline, one would not expect to see direct adverse health effects in even the most sensitive species. In places where the CWQGs for nitrate are exceeded, adverse effects will not necessarily occur. Whether direct effects will occur depends on the amount by which the guideline levels are exceeded, and on site-specific factors, such as the kinds of animals that live there and how quickly the nitrate is used by aquatic plants and algae. Further investigation at a particular site is needed to determine whether or not there is a negative impact.

How do nitrate levels in Canadian waters compare to the guidelines?

In most Canadian lakes and rivers, concentrations of nitrate are less than 4 milligrams per litre of water, and concentrations in coastal waters are generally less than 1 milligram per litre of water. Higher levels, which may exceed the freshwater or marine guideline, typically occur in waters near heavy urban or agricultural development, or immediately downstream from municipal wastewater discharges. As nitrate concentrations in groundwater are most often higher than in surface waters, particular attention should be paid in areas where groundwater comes into contact with surface waters (i.e., upwellings in stream beds).

How can CWQGs be used to make a difference?

In general, Canadian Water Quality Guidelines can be used by Canadian federal, provincial and territorial governments on a voluntary basis to set local guidelines, discharge limits for industry, and clean-up targets. CWQGs 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 nitrate measured in a sample of water has the potential to cause direct adverse environmental effects.

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