Minnesota Pollution Control Agency

Environmental Outcomes Division

Ground Water Monitoring & Assessment Program

Chloride and Fluoride in Minnesota's Ground Water

May 1999

What are chloride and fluoride?

Chloride and fluoride are chemicals commonly found in soil and rocks. Although chloride and fluoride belong to the same chemical group (the halogens), their behavior in the environment differs. Chloride is very mobile in ground water, while fluoride is rendered immobile in the presence of aluminum and iron oxides. Bromide is another halogen; but because bromine occurs at very low concentrations in ground water, it is not discussed in this fact sheet.

What are sources of chloride and fluoride in ground water?

The primary source of chloride is halite (salt) and brines. Anthropogenic (human) sources of chloride include fertilizer, road salt, human and animal waste, and industrial applications. These sources can result in significant concentrations of choride in shallow ground water because chloride is readily transported through the soil.

Igneous rocks are a common source of fluoride. Fluoride is used in industrial processes as a strong acid. It is also a common chemical in phosphorus fertilizers. Fluoride is added to many municipal water systems to prevent tooth decay. Because fluoride precipitates when calcium is present in ground water, adding fluoride to municipal water supplies high in calcium is ineffective.

What are considered safe levels of chloride and fluoride in ground water?

Neither chloride nor fluoride has a health-based drinking water standard. Chloride has a secondary maximum contaminant level (SMCL) of 250 mg/L (parts per million). Chloride may impart a bad taste to water. Fluoride has a maximum contaminant level (MCL) of 4 mg/L based on potential mottling of teeth.

How are chloride and fluoride distributed in Minnesota ground water?

There were eight exceedances of the SMCL for chloride in wells sampled from the Ground Water Monitoring and Assessment Program (GWMAP) statewide baseline network of 954 wells. Two of these were in surficial Quaternary aquifers, while four were in buried Quaternary aquifers. The median concentration for all aquifers was 2.4 mg/L, but the distribution between aquifers was uneven. Concentrations were highest in Cretaceous and surficial Quaternary aquifers (both had a median concentration of 5.8 mg/L) and lowest

in the Jordan Aquifer (0.95 mg/L). These results suggest different sources for the chloride, with anthropogenic sources likely for the surficial Quaternary aquifers and natural sources for the Cretaceous aquifers.

There were only two exceedances of the MCL for fluoride. The overall median concentration was 0.30 mg/L. Concentrations were relatively evenly distributed between aquifers. The highest median concentration was for the Cretaceous aquifers (0.43 mg/L), and the lowest was for the Cedar Valley Aquifer (0.27 mg/L).

Which aquifers are most sensitive to contamination with chloride and fluoride?

Aquifers can have high concentrations of chloride under a variety of settings. Well-protected aquifers with large ground water residence times and a source of chloride will have the highest concentrations of chloride. These aquifers include the Cretaceous and buried Quaternary aquifers. Surficial aquifers, however, are also sensitive to contamination from anthropogenic sources. Road salt and animal wastes are the most likely sources of chloride. Even though salt and animal wastes may be distributed on the surface of the land, chloride is readily leached as water infiltrates the soil.

No aquifer appears to be sensitive to elevated concentrations of fluoride. There are localized instances of high concentrations. These are a function of minerals that have high concentrations of fluoride.

Why is it important to measure chloride concentrations in ground water?

Chloride in shallow ground water is a useful indicator of contamination from human sources. Compared to background concentrations, chloride concentrations are typically elevated in shallow ground water under urban land use, around septic systems, near waste impoundments and occasionally under agricultural fields. It moves with ground water, and is therefore an excellent tracer of contaminant sources. Chloride is also used to assess quality control for ground water sampling and laboratory analysis.

What are some management strategies for reducing risks from chloride?

Reverse osmosis, ion exchange and distillation are treatment methods for removing chloride from well water (see Minnesota Department of Health fact sheet *Home Water Treatment Units*).

Impacts from anthropogenic sources can be reduced by proper management of animal and human wastes and reduced use of road salts.

Additional information, including reports and distribution maps, can be found on the Minnesota Pollution Control Agency's Web site at ***http://www.pca.state.mn.us/water/groundwater/gwmap/index.html.***