Minnesota Pollution Control Agency

Environmental Outcomes Division

Ground Water Monitoring & Assessment Program

Copper, Chromium, Nickel and Zinc in Minnesota's Ground Water

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What are copper, chromium, nickel and zinc?

Copper, chromium, nickel and zinc are metals that occur in significant quantities in rocks. Concentrations in rocks range from about 10.0 to 100.0 mg/kg (parts per million). Concentrations in soil are similar. These metals are somewhat mobile in soil, with the exception of trivalent chromium, which is immobile. These are important metals in many industrial uses.

What are sources of copper, chromium, nickel and zinc in ground water?

The primary sources of these metals are rocks. Concentrations in ground water are usually well below the amount that could potentially occur (based on solubility). Consequently, these metals' concentration in geologic materials generally limits their concentration in ground water.

There are many anthropogenic sources of these chemicals. Industrial uses include alloys, paints, pigments, electroplating, batteries, automotive parts, coatings and electrical wiring. Copper and zinc are also used as insecticides or fungicides. All these metals are present in industrial wastes and sewage sludges. These metals have limited mobility in soil, and anthropogenic impacts to ground water are small.

What are considered safe levels of copper, chromium, nickel and zinc in ground water?

The Minnesota Department of Health (MDH) established health risk limits (HRLs) of 20, 0.10, 0.10 and 2.0 mg/L (parts per million) for trivalent chromium, hexavalent chromium, nickel and zinc, respectively. A HRL is the concentration of a contaminant in ground water that is safe to ingest daily over a lifetime. The HRL was established based on certain effects in animal studies. A health-based value (HBV) of 1.0 mg/L has been established for copper. A HBV is similar to a HRL except that the value has not been promulgated into law.

How are copper, chromium, nickel and zinc distributed in Minnesota ground water?

Drinking water standards were exceeded once each for nickel and zinc in wells sampled from the Ground Water Monitoring and Assessment Program (GWMAP) statewide baseline network of 954 wells. There were no exceedances for copper or chromium.

Overall median concentrations were 0.0058, 0.00040, less than 0.006, and 0.016 mg/L for copper, chromium, nickel and zinc, respectively. These are well below the drinking water standards.

The concentration of these chemicals was approximately evenly distributed between aquifers. Elevated concentrations were observed in some Precambrian aquifers, such as the Sioux Quartzite. Concentrations of these metals were correlated with each other and with iron, aluminum, cobalt and vanadium. Consequently, concentrations of all these metals increased with residence time and were highest in geologic deposits that have higher concentrations of the metals. There is evidence of elevated concentrations in unconfined portions of the Paleozoic bedrock aquifers (such as the Jordan and Prairie du Chien aquifers). Concentrations increase toward the east, where the aquifers are most likely to be unconfined, and they increase with increasing concentrations of dissolved oxygen, which may reflect recharge. Despite these relationships, concentrations of these metals remain low in all aquifers.

Which aquifers are most sensitive to contamination with copper, chromium, nickel and zinc?

Ground water does not appear to be sensitive to contamination with copper, chromium, nickel and zinc. Even though some aquifers have higher concentrations than others, concentrations remain well below drinking water standards. Shallow, unconfined aquifers may show slight evidence of inputs from the unsaturated zone. Despite these observations, copper, hexavalent chromium, nickel and zinc can contaminate shallow ground water as a result of human activity. An example is improper disposal of these metals in low-pH wastes, which greatly enhances their mobility.

Why is it important to measure copper, chromium, nickel and zinc concentrations in ground water?

Copper, chromium, nickel and zinc have relatively high drinking water standards and are found at low concentrations. They will only be important to sample in aquifers that are potentially contaminated with them. These contaminated aquifers may occur near coal-burning plants, metal plating facilities, metal recyclers and other industries that utilize these metals or generate wastes containing them.

What are some management strategies for reducing risks from copper, chromium, nickel and zinc?

Copper, chromium, nickel and zinc do not represent drinking water concerns in ambient ground water. Proper disposal of industrial wastes represents the best management strategy for reducing potential impacts of these metals on ground water quality.

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*.**