K2 InfoLites

Perchlorate Update

EPA

As of January 26, 2006, the United States Environmental Protection Agency (USEPA) issued new guidance, in which the USEPA, following the review by the National Academy of Sciences National Research Council (NRC), adopts a reference dose (RfD) for perchlorate of 0.0007 milligram/kilogram-day (mg/kg-day) for all CERCLA programs and the National Contingency Plan. The RfD is used to characterize potential noncancer health hazard. The previous guidance endorsed use of a provisional RfD range of 0.0001 to 0.0005 mg/kg-day. This new reference dose leads to a Drinking Water Equivalent Level of 24.5 micrograms/liter or 24.5 parts per billion (ppb) (USEPA, 2006b, Bodine.) www.epa.gov/iris/subst/1007.htm

California

In September 2006 CDHS proposed a primary drinking water standard (Maximum Contaminant Level, MCL) of 6 micrograms per liter or 6 ppb for perchlorate in drinking water based on human health risk assessment. The Department of Health Services (CDHS), has established a notification level for perchlorate, currently at 6 ppb, based on the final Public Health Goal. www.dhs.ca.gov/ps/ddwem/Regulations/default.htm

Health Effects

Exposure to perchlorate, primarily by ingestion, is found to inhibit iodine uptake in the thyroid gland (NRC 2005), which can lead to hypothyroidism. The effect of hypothyroidism leads to lower metabolic function. It also is known to cause abnormal fetal and child growth and development (including brain development). A key question of concern according to the Center for Disease Control (CDC) is, "Does exposure to relatively low levels of perchlorate in the environment significantly impair thyroid function?"

Exposure

According to the USEPA, perchlorate contamination of water is widespread in groundwater, lakes, and rivers in over 30 states. Direct ingestion of contaminated water or of crops grown using contaminated water or fertilizer containing perchlorate, may pose the broadest human exposure. Plants, including those grown for human consumption, bio-concentrate perchlorate after uptake from contaminated water, soil, and/or fertilizer (USGS, GRAC Perchlorate, 2006). Additionally, perchlorate is detected in human blood and breast milk.

Sources

Perchlorate has been found extensively in the environment. The sources are both anthropogenic (man-made) and naturally occurring. Distinguishing between the anthropogenic and the naturally-occurring perchlorate can be very important to apportioning liability for clean-up costs. Several assessment techniques are becoming available, including the use of stable isotope geochemistry (GSA, 2005, Bohlke et al.). http://Gsa.confex.com/Gsa/2005AM/finalprogram/abstract_96016.htm.

Naturally-occurring perchlorate, particularly in Chilean nitrate fertilizers has been known for many years (ES&T, 2004, Bao and Gu). Recent research by government and academic institutions has brought to light numerous additional natural sources (GRAC, 2006, Jackson et al.) Additionally, the list of anthropogenic sources is growing significantly. Tables 1 and 2 list anthropogenic and natural sources of perchlorate.

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Table 1: Anthropogenic Sources of Perchlorate

Matches, Pyrotechnics, Fireworks Fallout, Safety Flares, Manufacturing Use

Solid Rocket Fuel, Missiles, Munitions, Blasting/Construction, Explosives, Mining, Car Air Bags (igniter)

Medical Sterilization, Industrial Sterilization, Perchloric Acid, Batteries, Electropolishing, Metal Etching

Waste Water Sterilization, Pools, Septic Systems
Chlorine Bleach Degradation, Chlorination processes, Well Chlorination

Leather Tanning, Fertilizer, Defoliant, Herbicides

Table 2: Natural Sources of Perchlorate

Chilean Nitrate Fertilizers used in the US for over 100 years. Sources are primarily from the Atacama Desert area in Chile.

Aerosol formation in the atmosphere. Possibly a photochemical reaction. May also form during electric storms. Deposited during precipitation – rain and snow events.

Playa Lakes and Caliches in arid and semi-arid climates with high evaporation rates.

Marine Carbonates and Seaweed

Plants grown in soils or water containing perchlorate. Multiple studies have shown plants appear to bio-accumulate perchlorate.

Author's Biographical Sketch

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Dr. Kulla is a geochemist and hydrogeologist with over 23 years experience. She has conducted environmental site investigations, feasibility studies, and remediation of impacted properties. Dr. Kulla also provides litigation support and expert witness testimony.

Dr. Kulla has specialized expertise in the geochemical fate of contaminants and forensic geochemistry. She applies the science of stable isotope geochemistry, dating of transporting water masses, chemical tracer interpretation, organic fingerprinting compounds, and the interpretation of chemical reaction signatures to decipher the source, age, and transport history of chemical contaminants. She uses forensic geochemistry to delineate responsibility for contamination in soil and groundwater with multiple contaminants and sources. She also uses geochemistry to evaluate the timing of contaminants release and distribution, cost-effective remediation technologies, to defend and minimize client liabilities, and to document and justify natural attenuation as a remediation solution.

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