Development of Site-Specific Dilution-Attenuation Factor and Soil Screening Level for Perchlorate Soil Contamination

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Perchlorate, a highly soluble salt, is often considered a conservative tracer, given that little or no adsorption in soils has typically been observed. Leaching of perchlorate-impacted soils to groundwater would be expected to be rapid, particularly in a moist environment. On the subject site, however, perchlorate soil contamination in a source area has been found to be persistent after a decades-old release. No applicable soil screening level for perchlorate was available for the ongoing facility investigation. In an effort to guide the investigation, a study was conducted using site-specific soil data to develop a dilution attenuation factor (DAF) and soil screening level (SSL) for perchlorate to be protective of groundwater.

The shallow soil profile at the site includes quartz silt from 0 to 5 feet overlying clay from 5 to 15 feet. The piezometric surface of the shallow groundwater aquifer falls within the clay unit and fluctuates by approximately 10 feet annually. Perched groundwater occurs seasonally within the silt unit. Site-specific soil properties were evaluated for each soil type using data collected through techniques including batch sorption testing to estimate distribution coefficient (K_d); Unsaturated Flow Apparatus (UFA™; ASTM D6527) Methods to determine unsaturated hydraulic conductivity, matric potential, and retardation factor; X-Ray diffraction to evaluate soil mineralogy; and standard geotechnical tests to estimate grain size, porosity, and water content.

Batch sorption testing of representative composite samples of each unit indicated K_d values of 0.76 and 0.55 L/kg, respectively, for the clay and silt samples tested - indicating limited soil sorption of perchlorate. UFA Methods, used because of the low permeability of the clay, indicated unsaturated hydraulic conductivity and matric potential values typical of silt and clay soils. UFA Method testing for retardation factor indicated limited to no sorption. X-Ray diffraction identified the clay as predominantly smectite, a swelling clay that expands reversibly with incorporation of water or other compounds between the structural layers. These findings suggest that the low hydraulic conductivity of the clay and its swelling behavior under wetting conditions may be more important factors than sorption in slowing the migration of perchlorate from soil to groundwater.

The site-specific DAF was calculated using a standard EPA dilution model. Conservative inputs included the state regulatory guideline for perchlorate in groundwater, median unsaturated hydraulic conductivity to estimate the infiltration rate, and site-specific aquifer hydraulic conductivity and hydraulic gradient from previous site investigations. Using these data, a DAF of 15.25 and a corresponding SSL of 0.081 mg/kg were derived for the site. These preliminary values may be updated as new site data are collected and upon adoption of alternative regulatory standards for perchlorate.