Evaluation of Stored Reducing Capacity to Optimize Operations and Maintenance for In Situ Biological Treatment of Cr(VI) in Groundwater

Margaret Gentile (Margaret.Gentile@arcadis.com), Isaac Wood (Isaac.Wood@arcadis.com), ***Lauren Weigt*** (Lauren.Weigt@arcadis.com), Frank Lenzo (Frank.Lenzo@arcadis.com)
(Arcadis U.S. Inc., San Francisco, California, USA)

Background/Objectives. Injection of organic carbon substrates to stimulate in situ biologically mediated reduction of hexavalent chromium (Cr[VI]) for removal from groundwater is an established remedial technology. The key to successful implementation of in situ biological Cr(VI) reduction is the distribution of electrons from the oxidation of the organic carbon substrates throughout the saturated subsurface to establish robust in situ reactive zones (IRZs). The reduction of Cr(VI) is often observed to persist over relatively long timeframes (months to years) after the injected organic carbon substrates are degraded or flux through the IRZ. The longevity of treatment is attributed to residual reducing capacity created by the storage of electrons in the ferrous iron and sulfide bearing minerals and microbial biomass generated by the injection of organic carbon substrates. In this presentation, hydrogeologic data and performance data collected from operations and maintenance of IRZ systems for remediation of a large-scale Cr(VI) plume in a heterogeneous aquifer will be evaluated to examine the factors that influence the longevity of generated reducing capacity. Insights gleaned from this evaluation can be used to optimize IRZ system operation and maintenance and subsequent designs.

Approach/Activities. To evaluate the factors controlling longevity of residual reducing capacity generated by organic carbon injections, data collected from over 10 years of operations of a large-scale IRZ remediating Cr(VI) in groundwater will be analyzed. The area undergoing in situ remediation at the site is a mile long and a half-mile wide, 30- to 70-foot thick impacted groundwater system. This zone varies in Cr(VI) concentration from several parts per billion (ppb) to several parts per million (ppm). The aquifer system is comprised of heterogeneous deposits with groundwater flow velocity between approximately 1 and 4 feet per day. In situ injections are conducted by recirculation of groundwater, amendment with ethanol as an organic carbon substrate, and injection into a network of 92 injection wells. Performance data is collected from a network of over 200 monitoring wells located within the area of influence of the injections and downgradient, yielding a large data set from the 10 years of remedy operation for analysis. Factors that will be evaluated in relation to longevity of residual reducing capacity will include the hydrostratigraphic conditions, amount of electrons introduced, and flux of electron demand through the IRZ, including electron demand from variable concentrations of Cr(VI).

Results/Lessons Learned. Performance data indicate that residual reducing capacity can sustain Cr(VI) reduction at monitoring wells from periods of months to more than 6 years. In addition to determining the key factors that explain this variability, this presentation will discuss how the lessons learned can be applied to optimizing operations and maintenance for small to large-scale projects.