Performance of Injected Powdered and Liquid Activated Carbon at a Petroleum Hydrocarbon Site

Rick McGregor (rickm@irsl.ca) (InSitu Remediation Services Ltd., St. George, ON, Canada)

Background/Objectives. The injection of powdered and liquid activated carbon at sites with petroleum and chlorinated hydrocarbon groundwater impacts has increased during the past few years. Until recently, injection of activated carbon was problematic due to distribution issues and consumption of the adsorption sites which limited the lifespan of the activated carbon. To overcome the adsorption issue, the injectable activated carbon is usually enhanced with an electron donor or acceptor depending on the compounds of concern. This allows for the adsorption sites to be regenerated. As with most insitu programs the distribution of the reagents is usually the greatest challenge. Due to the physical differences between powdered and liquid activated carbon a comparison study was completed at a site where petroleum hydrocarbons had impacted the shallow groundwater.

Approach/Activities. The silty sand aquifer was impacted by benzene, toluene, ethylbenzene and xylenes (BTEX) along with gasoline range organics at concentrations up to 2,500 µg/L. As part of a technology-evaluation program, the plume was divided in half with one half of the plume being injected with powdered activated carbon enhanced with sulfate, whereas the other half of the plume was injected with liquid activated carbon enhanced with oxygen releasing material. Both forms of activated carbon were injected using direct push technology over a dense network with similar masses of activated carbon being injected into each half of the plume. Hydrogeologic, geochemical and microbiological monitoring was completed using a high-definition monitoring network composed of monitoring wells and CMTs. In addition, cores of the soil near injection locations were collected within 24 hours of injection and analyzed for the presence of activated carbon and the supplements added (i.e., sulfate and oxygen-releasing material) to gain an understanding of the distribution of the activated carbon following injection.

Results/Lessons Learned. Geochemical and microbiological monitoring of the groundwater over a 24-month period indicated a clear difference in behavior of the groundwater chemistry over the short and long term. Both forms of activated carbon were effective at removing the dissolved compounds of concern over the short term however, long-term monitoring indicated that adsorption sites of the powdered activated carbon had become saturated and that biodegradation reactions were not occurring at a rate great enough to overcome the mass loading onto the powdered activated carbon. The results suggested that the liquid activated carbon was effective over the course of the study period. Analyses of soil cores taken in the area of injection suggested that the distribution of the liquid activated carbon was more uniform both vertically and laterally. Examination of cores indicated that the powdered activated carbon was observed 4.5 m away from the point of injection with less than 5% of the mass injected being observed within the target injection zone. The liquid activated carbon distribution was observed at a distance of 2.5 m from the point of injection with up to 64% of the mass injected being observed within the target injection zone.