Real-Time Data Monitoring during Source Zone Remediation Using Large Diameter Auger with Steam and Zero-Valent Iron

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Background/Objectives. Geosyntec recently completed rapid remediation of a tetrachloroethylene (PCE) source area at a former manufacturing facility in central Florida via large diameter auger drilling with steam and zero-valent iron injection (LDA/Steam/ZVI). The purpose was to rapidly remediate a source zone and facilitate a transition to natural attenuation. The remedial technology involved using the auger to simultaneously mix the subsurface and introduce hot air/steam to promote thermal volatilization and stripping of chlorinated volatile organic compounds (CVOCs) from soil and groundwater, followed by injection of ZVI as a polishing step to provide treatment of residual CVOCs.

Approach/Activities. During implementation, an 8-foot diameter auger was advanced into the subsurface up to 66 feet below land surface (ft BLS), and a mixture of steam and hot air was injected via ports in the auger bit. Off-gassing steam/hot air was captured at the surface via a 12-foot diameter vacuum shroud, analyzed for CVOCs using four on-site gas chromatographs, and treated with granular activated carbon. Auger depth, off-gas temperature and recovery rates, and other process data were collected at sub-minute frequency; CVOC concentrations were measured approximately every three minutes, with additional measurements collected to capture peak CVOC concentrations. Thermal treatment at each boring was performed until off-gas PCE concentrations were reduced to meet the criteria developed in our treatment protocol. After the completion of thermal treatment, a ZVI slurry was injected to passively treat residual CVOCs and bentonite was injected to generally restore low permeability characteristics of low-permeability clay layers. During the three months of active LDA/Steam/ZVI implementation, an estimated 400 to 500 pounds of PCE were remediated, with most of the recovered mass being removed from the two low hydraulic conductivity layers.

A review of the data as it was being collected allowed us to modify the treatment scheme in real-time, so that treatment could be focused in the areas where it would be most effective. Based on the real-time data, Geosyntec evaluated when thermal treatment could be considered complete at each boring, whether the total boring depth needed to increase, and whether borings should be added or removed from the treatment plan. Based on the mass recovery in adjacent borings, six treatment borings out of 183 planned borings were omitted from the treatment plan, and 17 step-out borings were added where additional treatment was warranted. Post-processing of the data was performed to calculate how much mass was recovered from each treatment boring, and to visually present the distribution of mass recovered throughout the treatment area.

Results/Lessons Learned. A significant portion of the total mass that was removed was from borings that did not specifically correlate with the conceptual site model interpretation of mass distribution, or was at depths below the planned treatment depths. These areas of elevated mass were identified and remediated based on the real-time data. Utilizing real-time data collection and an adaptive treatment protocol enabled Geosyntec to focus remediation efforts on the locations and depths with the most mass, which maximized treatment efficiency and effectiveness. Real-time data analysis enabled Geosyntec to efficiently achieve remediation objectives and transition the site to natural attenuation.