Delivery of a Permeable Injection Network for Enhanced Reductive Dechlorination Treatment: Adapting to Site Challenges

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Background/Objectives. In Fall 2016, GeoSierra teamed with TetraTech to design an in situ remedy for treatment of a dissolved phase trichloroethene (TCE) plume in northern New Jersey. Previous pilot injections of emulsified vegetable oil (EVO) in 2013 targeted two overburden zones: shallow from 28 to 38 feet below ground surface (bgs) and deep from 45 to 55 feet bgs, resulting in decreasing TCE trends, but ineffective lateral distribution due to tight lithology of an un-stratified glacial till preventing better results. In order to increase the radius of influence for full-scale implementation, pneumatic fracturing and proppant injection were selected to directionally fracture and emplace horizontal lenses of permeable sand upwards of 15 to 20 feet to sustain longevity of the fractures for future treatment. The fracture network was comprised of 24 temporary fracture/injection points (FIPs) oriented in varying directions to create an interconnected grid of fractures throughout the plume while minimizing contaminant migration. Twelve locations would be converted to injection wells for subsequent EVO and bioaugmentation injections.

Approach/Activities. Pneumatic fracturing is well documented as a means of increasing formation porosity for distribution of amendments. The technology uses pressurized inert gas to create horizontal fractures that are in-filled with media for treatment or aperture longevity. In non-cohesive formations such as tills, media transport occurs by fluidization where the injected gas velocity is sufficient to suspend the geologic particles; thereby allowing the passage of solid media through the geologic matrix. The success of the technology relies on interconnected fractures or overlapped continuous lenses of media. However, to successfully achieve horizontal distribution, the method must be able to maintain fluidization with minimal short-circuiting upward along the FIP tooling.

The formation presented challenges during FIP tooling installation and proppant emplacement. Multiple drilling methods were attempted to achieve a tight seal around the tooling, and only one ton of frac sand was injected in 12 of 204 fractures in 12 field days. To stay on schedule and budget, GeoSierra regrouped and revised the approach to vertical inclusion propagation (VIP) using single azimuth expansion casings for delivery of the sand proppant and future amendment injections. This technique uses hydraulic fracturing versus pneumatic. Fifteen VIPs were aligned to form three continuous panels of proppant perpendicular to horizontal groundwater flow with four additional locations located in the hot spot, creating a lattice network of interconnected fractures to the three panels. All locations were subsequently injected with a carbon donor and microbial culture to reduce the formation to anaerobic conditions and for bioaugmentation for reduction of TCE concentrations.

The use of VIP for proppant emplacement resulted in 19 vertical panels of 44 tons of frac sand approximately 10 feet high and 2 inches thick. Total field time was 16 days of which 7 were VIP installation and 9 were frac sand emplacement. Subsequent EVO and microbial culture injections were performed in the VIP wells and newly installed deep overburden wells, totaling approximately 48,000 gallons. Ultimately, GeoSierra was successful in providing an alternative successful solution, and maintained the schedule and budget for the project while achieving a more desirable outcome.

Results/Lessons Learned. Although pneumatic fracturing/proppant emplacement is successful in many lithologies, the site challenges posed implementation issues. It is critical to adapt midstream on a project and provide a solution to successfully meet the client's objectives while still satisfying the original budget and schedule. Geosierra' s extensive experience with both approaches enabled the project team to adapt and overcome the challenges. The design/construction of a VIP network of interconnected sand lenses met those goals, resulting in successful amendment distribution. Two rounds of groundwater sampling have indicated successful reduction of TCE and increases in other parameters, which was the goal of the ERD program. A discussion of the technologies and alternative design will be presented as well as results from continued groundwater sampling events.