

Overcoming Challenging Site Conditions to Remediate High Perchlorate Concentrations in Groundwater Using In Situ Bioremediation

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Background/Objectives. At a former Army Ammunition Plant in Northeast, Texas, in situ bioremediation (ISB) was proposed to address elevated perchlorate concentrations in groundwater under a fixed price performance-based remediation (PBR) contract. The site is approximately ½ acre in size and consisted of a former pilot wastewater treatment plant used from 1984 to 1997 to treat explosives and perchlorate contaminated wastewater from sumps throughout the ammunition plant. Approximately 3,400 cubic yards of mercury and perchlorate contaminated soils were excavated from the site in 2009 and disposed of offsite. Subsequent groundwater investigations identified a plume of perchlorate contamination in the shallow groundwater under the excavated area. The 2016 Record of Decision (ROD) selected ISB and land use controls as the remedy for the perchlorate in groundwater. Native subsurface geology consists of mostly tight clays, silty sands, and silty clays. The shallow groundwater-bearing zone consists of a fine-grained silty sand with an irregular thickness occurring anywhere between 7 to 20 feet below ground surface. The site slopes gently towards a creek to the west and includes a drainage ditch that carries surface water runoff to the creek. Prior to the ROD, sampling in 2010-2011 indicated that perchlorate concentrations as high as 5,410 µg/L were present at the site. Additional sampling was performed in 2018 and 2019 to complete the westward delineation of the plume. One of the wells installed to delineate the plume contained a perchlorate concentration of 10,000 µg/L to the east of the excavated area, more than two times the maximum concentration detected in 2011.

Approach/Activities. Based on a review of the available data following the 2018-2019 sampling events, it was planned to perform ISB injections to treat the area of the plume exceeding five times the PCL (85 µg/L) using 25 direct push injection points to inject emulsified vegetable oil (EVO) and diammonium phosphate (DAP) into the shallow groundwater zone. The injection grid was biased towards the downgradient side of the plume to reduce the chance of flushing the contamination further downgradient with the injections. Approximately 375 gallons of EVO and DAP were mixed with water and injected into 25 direct push injection locations in November 2019. Quarterly groundwater monitoring began in February 2020. Concentrations above the PCL were only detected in two locations during the first quarterly sampling event, and since the second quarterly sampling event, perchlorate has not been detected in any of the monitoring locations for five consecutive quarterly sampling events.

Results/Lessons Learned. The shallow depth to groundwater, the backfilled overburden overlying a significant portion of the injection area, and the presence of the stormwater ditch crossing the downgradient edge of the plume area created a challenging environment for injection of the desired quantity of amendments. The heterogeneous overburden allowed daylighting of injected amendments at much lower pressures than expected, even at reduced pressures planned due to the shallow depth to water. The presence of the drainage ditch inhibited the ability to inject into multiple locations along the downgradient edge simultaneously, as was initially planned to limit downgradient spread of contaminants. Injecting the desired quantities required careful management of which locations were injected simultaneously, what pressure to use at each location, and when to “rest” a location to allow full completion of the planned injection volumes. The field crew adapted well to the changes in planned injection

rates, location selection, and pressures and successfully completed the injections without significant amendment volume lost to daylighting.