Combined Remedial Approaches for CVOC Treatment in Soil and Groundwater: Excavation, MPE, and ISCR

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Background/Objectives. Operations at a former manufacturing plant located in São Paulo State (Brazil site), resulted in subsurface contamination by chlorinated volatile organic compounds (CVOCs), mainly tetrachloroethylene (PCE), trichloroethylene (TCE), *cis*-1,2-dichloroethylene (1,2-DCE) and vinyl chloride (VC). The contamination was due to leaking subsurface pipelines with infiltration of wastewater resulting in two primary localized source areas. The primary source area had groundwater PCE concentrations up to 54,000 ppb and a surface area of approximately 10,760 $ft^2$with vertical distribution extending to approximately 108 ft bgs The secondary hotspot area had groundwater PCE concentrations up to 6,000 ppb with dimensions of 1,290 ft^2 and a vertical distribution of approximately 23 ft bgs.

Approach/Activities. SGW employed a combination of remedial technologies to treat vadose and aquifer impacts: i) soil excavation, ii) multi-phase extraction (MPE), and iii) in situ chemical reduction (ISCR). An additional mitigation approach employed soil vapor extraction (SVE) to manage vapor intrusion and enable workspace utilization. The design process entailed a bench test to assess the potential effectiveness of the ISCR approach, followed by a field-scale pilot test that consisted of direct-push injections of 1,875 Kg Provect-IR® Antimethanogenic ISCR amendment in the secondary hotspot area. The approach for the primary source area utilized soil excavation to remove the highest concentration soils (approximately 90 metric tons) followed by the installation of an MPE system and will include the injection of Provect-IR® antimethanogenic ISCR amendment as the final treatment approach. In addition to these technologies an SVE system including 10 extraction wells was installed to mitigate the potential for vapor intrusion and enabled building occupation.

Results/Lessons Learned. The ISCR pilot test validated the results obtained in a previous bench test predicting the effectiveness of the remedial technology. From September of 2017 to June of 2018 the concentration of total CVOCs in groundwater was reduced from 31,200 to 500 ppb (>98%) without the accumulation of catabolites. Site-specific knowledge gained regarding remedial construction (injection flow rates, injection pressure, radius of influence, etc.) was used to optimize the future full-scale design and gain regulatory enabled approval of ISCR as the final treatment approach. For the excavated area after 12 months of MPE operation, the concentration of total CVOCs in groundwater within the primary source area was reduced from 383,000 to 212,000 ppb (>44%). Cost and performance monitoring of the remedial program will be reviewed that confirm the efficacy of the implemented approaches.