In-Situ Chemical Reduction (ISCR) for Remediation of Groundwater Impacted by Chlorinated Solvents using ZVI and Antimethanogenic Amendments (Brazil Site)

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Background / Objectives

Groundwater at a manufacturing plant located in São Paulo, Brazil was impacted by chlorinated volatile organic compounds (CVOCs) including tetrachloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE) and vinyl chloride (VC). Preliminary remediation approach considered In-Situ Chemical Reduction (ISCR) which was the subject of field-scale pilot testing for site-specific process optimization. The pilot test was performed in June 2018 in one of the four CVOC source areas with an approximate area of 150 m² and 3-m thick, between 7 and 10 meters below ground surface - mbgs.





Following the pilot test, the first stage of the full scale remediation was performed in May 2019, and the second stage between November 2020 and February 2021.

Site lithology consists of unconsolidated fill from 0 to 2 mbgs underlain by a heterogeneous geology with interbedded layers of low (clay) and high (sand) permeability lenses to about 13 mbgs followed by a hard clay confining layer.

Groundwater levels ranged between 2 and 4 mbgs and flowed to the south through the permeable lenses. Prior to treatment, the impacted aquifer was oxic and acidic with ORP levels ranging from +22 to +235 mV and pH from 3.8 to 5.6.

Approach / Activities

C-1B Area

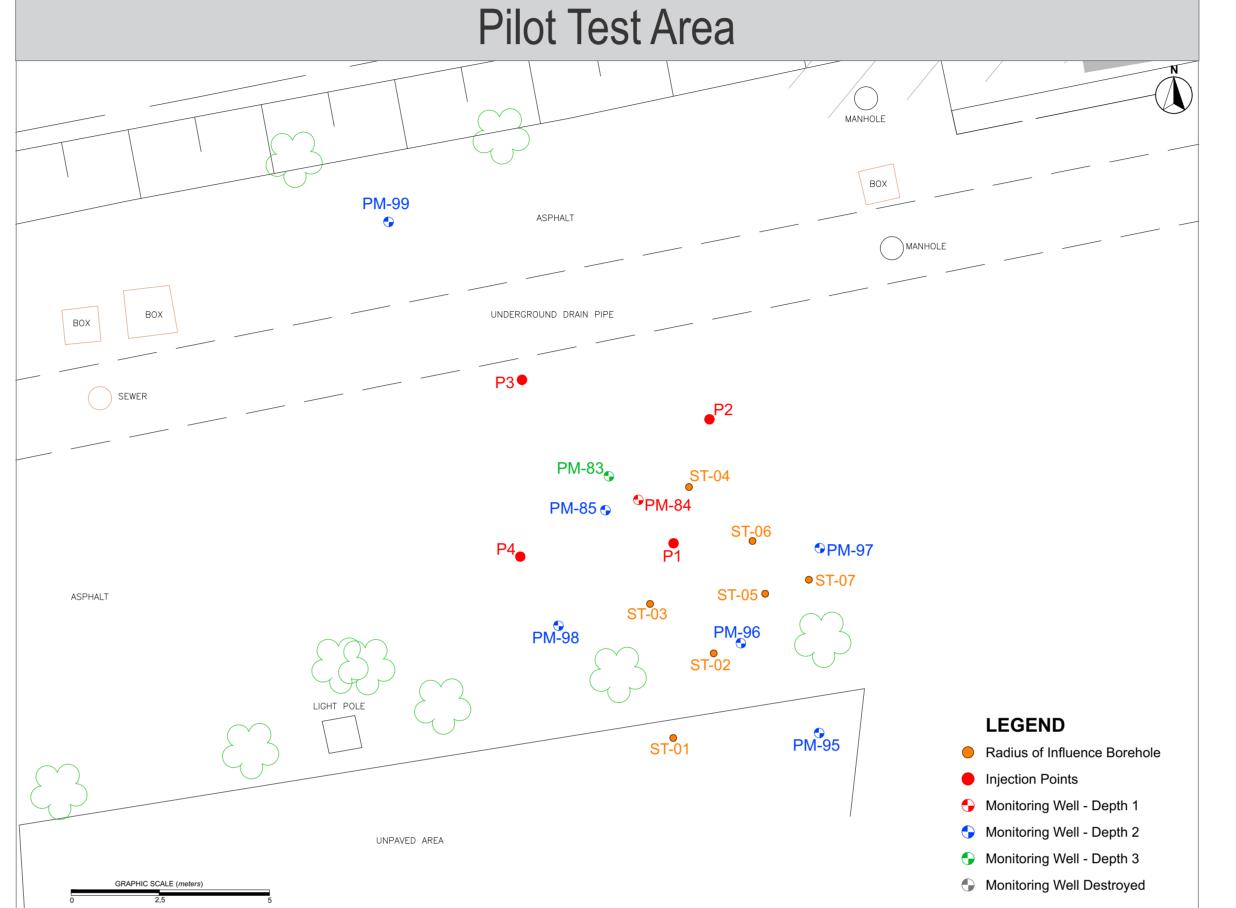
C-1 / C-2 Area

around multi-level monitoring wells located in a source area containing high CVOC concentrations ~130 mg/L of total CVOCs.

In June, 2018 a total of 1,680 kg of Provect-IR® Antimethanogenic ISCR amendment (containing ca. 40% weight basis mixed-grade ZVI + multiple organic carbon sources + other reagents) was injected from 7.0 to 10.1 mbgs via four direct-push injection points.

C-1A Area

C-4 Area

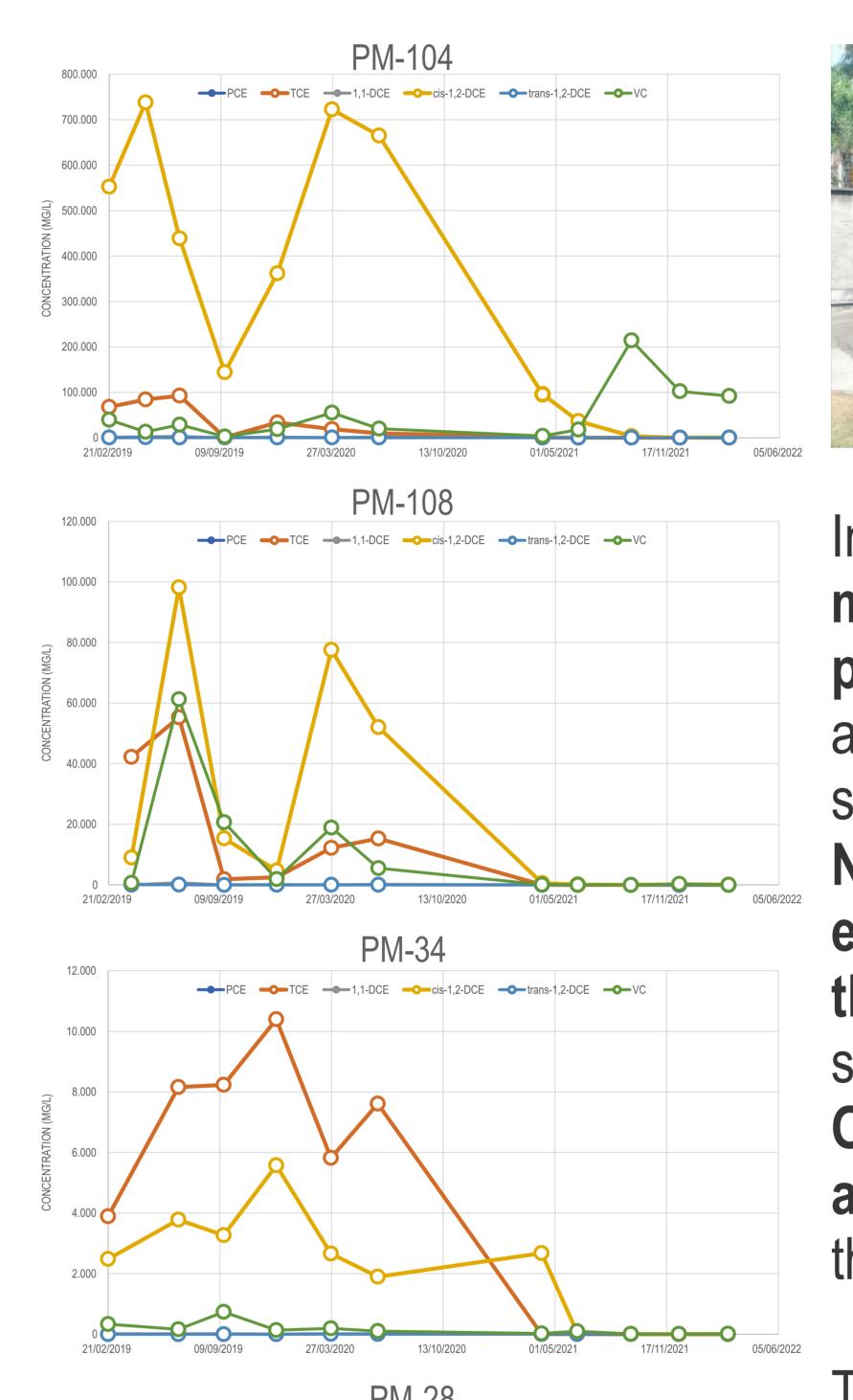


Neutralization of the acidic pH was addressed by addition of a buffer which was injected with the Provect-IR®.

The pilot test results validated the conditions for the continuity of the project (full scale) and calibrated the site-specific metrics such as radius of influence, injection pressure, flowrate and field approaches of equipment and procedures.

The first full scale stage in May 2019 was performed using 15,900 kg of reagent, and the second stage concluded in February 2021 used around 38,000 kg in 84 injection points for both stages.

Results / Lessons Learned







In the pilot test the aquifer ORP decreased from >+22 mV to < -164 mV, remained after 120 days. Aquifer pH increased from acid conditions below 5.6 to around 6.8, and groundwater, 18 days after injections, showed >80% of mass reduction of total CVOCs.

Natural attenuation existed on-site and that were enhanced by ISCR. Full-scale remediation showed the same effects in aquifer. Post injection monitoring showed the maintaining of reducing conditions with ORP levels below the original measurements around - 150 mV and favorable pH above 6 in most of the monitoring wells.

The combined physical-chemical condition were important to establish the favorable environment for rapid dechlorination of VOCs as observed. The analytical data showed reduction above 90% of PCE and TCE with low daughter products generation as a result of antimethanogenic ISCR amendment additional injected.



This project is the result of a successful technical partnership between SGW Services and Golder Associates. SGW provides in Brazil its exclusive integrated solutions for remediation of contamination by chlorinated solvents and metals for other environmental consultancies in the implementation of projects for their customers.

