

Combined Ex-situ and In-Situ Remediation of Soil and Groundwater Impacts to Meet Site Closure Requirements

Robert Tossell and Yu Li, Pinchin Environmental Ltd.
Paul Zizek, Hazco Environmental Services

A combined full-scale in-situ and ex-situ remediation was implemented at two Sites located in Ontario, Canada. The purpose of the remediation was to meet generic Ontario Ministry of Environment (MOE) Standards for transaction of both properties over a period of 2 months for Site 1 and 5 to 10 years for Site 2. Characterization at Site 1 indicated that petroleum hydrocarbons (PHCs), vinyl chloride (VC) and cis-1,2-dichloroethene (cis-1,2 DCE) were present in soil and groundwater exceeding the applicable MOE Standards. Maximum concentrations of VC and cis-1,2 DCE were approximately 12 µg/L and 100 µg/L, respectively. The total treatment area measures 40 m by 30 m. Pinchin evaluated in situ bioremediation and in situ chemical oxidation (ISCO) using sodium permanganate for management of groundwater and an excavation program to remove the PHC impacts in soil. A combined excavation/ISCO system was selected using a recirculation system to implement the ISCO system. The recirculation system consisted of a combined extraction well/infiltration gallery installed within the excavation zone. Six injection wells were installed at the perimeter of the groundwater plume creating an inside out recirculation system. System operation was started in March 2009 using the recirculation system (flow only) only with sodium permanganate injection and mixing in a phased approach starting in April 2009. Groundwater characterization conducted within two weeks of injection indicated that concentrations of VC and cis-1,2 DCE had decreased to 2.2 µg/L and 37 µg/L, respectively. Follow-on monitoring at month three of the pilot indicated that concentrations of cis-DCE and VC were either near the MOE standards or below. At Site 2, free phase and dissolved phase PHCs and VOCs (mainly tetrachlorethylene [PCE], trichloroethylene [TCE] and 1,1 DCE) were present in soil and groundwater that exceeded the applicable MOE Standards in soil and groundwater. The total treatment volume is approximately 15,000 m³. A number of remedial technologies were evaluated including pump and treat, monitored natural attenuation (MNA), in situ bioremediation and ISCO using sodium permanganate for management of groundwater. Management of free phase PHCs included excavation of vadose soils. Due to the Site constraints (beneath a large occupied multi-tenant industrial building), a combined excavation/ISCO system and MNA program was selected. Impacted soil from two of the affected units were excavated to remove a large quantity for impacted

soil (source area), however due to slope safety, the wedge of soil between the two units was left in place, as well as some soils in occupied units to the north and south of the excavation area. Prior to backfilling, an extensive injection/infiltration gallery was installed (using directional horizontally drilling) in order to contact the remaining free phase/residual PHCs and dissolved VOCs with a strong chemical oxidant. The system was completed in May 2009 and the modified ISCO and MNA program will commence in June 2009. As part of this presentation/paper, remediation performance monitoring results for both Sites will be discussed.

Robert Tossell, M.Sc.

Robert Tossell is the Director, National Remediation Services based in the company's Mississauga office.

With over two decades of expertise in remediation system evaluation, design and construction oversight, Bob has worked on some of North America's most complex and demanding remediation programs. This includes major project sites contaminated with chlorinated solvents, metals (including arsenic and hexavalent chromium), petroleum hydrocarbons, and pesticides.

Bob has managed numerous large scale, multi-year projects, including the development, evaluation and restoration/remediation of contaminated sites, non-point source and point source contamination. He has designed several award winning remediation systems for the US Air Force and Navy, Government agencies and private sector companies. He has conducted a myriad of evaluations for selection of remediation systems including permeable reactive barriers, biological and chemical treatment, phytoremediation, treatment wetland design and construction and air bio-sparging.

From 1999 to 2005, Bob was a co-chair of the Remedial Technologies Development Forum (RTDF), Phytoremediation of Chlorinated Solvents Workgroup, a consortium of partners from industry, government, and academia that coordinates research and development of innovative remediation/restoration technologies. He has published extensively on various remediation topics and has presented numerous papers, seminars and workshops at industry conferences across North America.

Bob has an M.Sc. (Soil Science) from University of Guelph.