A Case Study of the Anatomy of a Dynamic High Concentration Chlorinated Solvent Plume and Consequences on Remedial Strategy

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Background/Objectives. The Orica Botany site had undergone extensive investigations to characterize the nature and extent of groundwater contamination from 1989 to 1990 (Stage 1) and again between 1993 and 1996 (Stage 2). The investigations had identified a number of potential DNAPL sources from the manufacturing of chlorinated solvents, and had identified a complex mixture and distribution of multi-sourced dissolved phase chlorinated solvent plumes. A strategy had been developed at the conclusion of the Stage 2 survey which had prioritized remedial activities to mitigate risks to human health and the environment. This case study describes the discovery of a dynamic high concentration chlorinated solvent plume during the implementation of groundwater remediation at the Orica Botany chemical manufacturing facility, and the consequences for the overall remedial strategy.

Approach/Activities. Many chlorinated solvent plumes are discovered a long time, often many decades, after sources commenced and the plumes are largely static and have often attained steady state through attenuation within the aquifer. The Orica Botany site had an extensive network of groundwater wells and a monitoring program in place which was largely aimed at confirming the stability of the plumes and supporting the monitoring of proposed remedial activities. In March 1998, the concentration of 1,2-dichloroethane (1,2-DCA), also known as ethylene dichloride (EDC), in a sentinel monitoring well, within the C1 Plume, increased in concentration from approximately 100 mg/L to over 1000 mg/L. Immediate re-sampling confirmed that the reported concentration was not a laboratory error.
Investigations were implemented to understand the potential cause of the sudden increase in EDC concentrations which involved the installation a series of new multilevel piezometers along the projected plume axis which included a number of new sentinel wells to monitor the migration of the plume.

Results/Lessons Learned. The high resolution of the groundwater monitoring both spatially and temporally was able to establish with a high degree of precision the rate of plume migration which was estimated to be in the order of 110 m/year. The plume velocity was similar to estimated groundwater seepage velocity with a retardation factor of 1.36, consistent with the low sportive properties of this compound. Characterization and monitoring of the plume between the inferred source and the plume front confirmed the presence of a high concentration core or "slug" of EDC with concentrations in excess of 5000 mg/L. The mass flux of the plume core was estimated to be over 600 kg/day. It was postulated that the slug was likely caused by the remobilization of DNAPL within the source zone by intrusive investigations (Cone Penetrometer Testing) at the start of the Stage 2 Survey. The monitored plume velocity and distance travelled correlated well with timing of intrusive investigations. Other observations of the intensive monitoring of the plume suggested downwards vertical migration within the aquifer, contrary to the vertical hydraulic gradient, potentially as a result of density driven flow due to the high concentration of the plume core.
The discovery of the high concentration and rapidly moving plume, which migrated beyond the site boundary, eventually resulted in the issue a cleanup notice from the EPA, which mandated implementation of a hydraulic containment system and which effectively resulted in significant adjustment of the existing remedial strategy.