The Application of In-Situ Chemical Oxidation to Remediate Chlorinated Ethenes at Former Dry Cleaning Facilities in Alberta

by

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Outline

Terms and Definitions

- Project 1 – History, Site Assessment, Remedial Approach, Remediation, Results
- Project 2 – History, Site Assessment, Remedial Approach, Risk Assessment, Results
- Summary and Conclusions
PCE – perchloroethylene, tetrachloroethylene, tetrachloroethene

ISCO – in-situ chemical oxidation

CCME – Canadian Council of Ministers of the Environment. CCME commercial soil guidelines were used to assess the soil impacts
Project 1 - History

- Original tenant (dry cleaner) operated from 1978 – late 1990s.
- New retail grocery store was constructed on-site in 2002, in the area of the former dry cleaner.
- Grocery store and asphalt parking lot currently cover area of former dry cleaner.
Project 1 – Site Assessment

- Phase I ESA (2003) identified former dry cleaner as potential concern.
- Phase II ESA (2003) identified soil impacted with PCE in three boreholes at two depths.
- Additional Phase II ESA (2003) identified no groundwater impacted above standards.
ISCO – Potassium permanganate (KMnO₄)

\[ 4\text{KMnO}_4 + 3\text{C}_2\text{Cl}_4 + 4\text{H}_2\text{O} \rightarrow 6\text{CO}_2 + 4\text{MnO}_2 + 4\text{K}^+ + 8\text{H}^+ + 12\text{Cl}^- \]

Solution of 2.5 g/L introduced to the infiltration tile system.

Estimated two 14- to 17-day injections would be required over a two- to three-month period.

Cost of conventional remediation approach (dig & haul) was 10 times that of in-situ remediation proposed by XCG.
Project 1 - Remediation

- Developed health and safety plan
- Utility locates
- Design, installation, and operation of potassium mixing and injection system
- Installation of two infiltration tiles under building and one exterior
- Installation of four sampling points
Project 1 – Injection System

Injection System to deliver KMnO₄

- 2 x 200L drums
- Concentrated Potassium Permanganate
- CONCRETE
- Valve
- Flush-mounted valve box
- Infiltrator
- 2" slotted PVC (approx. 2% slope)
- Granular base
- Fill
Project 1 - Results
Project 1 - Results
Project 1 - Results

[Diagram of project results with labels and measurements]
Project 1 - Results
Project 1 - Results
Removal of PCE in soil was achieved. Soil verification sampling was carried out one year later. The rate of removal was limited by the low permeability of the soil. No more investigations were recommended. Client received holdback from financial institution based on analytical results.
Project 1 - Results

- PCE has significantly decreased although three samples were still above CCME guidelines.

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<thead>
<tr>
<th>Compound</th>
<th>% Removed</th>
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<tbody>
<tr>
<td>PCE</td>
<td>88%</td>
</tr>
<tr>
<td>TCE</td>
<td>&gt;99%</td>
</tr>
<tr>
<td>cis-DCE</td>
<td>&gt;99%</td>
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<tr>
<td>Vinyl Chloride</td>
<td>&gt;99%</td>
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Project 1 Results

- Injection process was slow.
- KMnO$_4$ did not reach all contaminated soil due to low hydraulic conductivity.
- Numerous verification boreholes were advanced on the property.
Project 2 - History

- Former tenant (dry cleaner) operated at the site until 1985.
- Two USTs containing PCE were discovered and removed in May 1993.
- Approximately 550 tonnes of impacted soil was excavated and removed from the site for landfill disposal.
- Remedial excavation was halted due to the risk of structural failure of an adjacent building.
Phase II ESA (September 2005) identified soil impacted with PCE in all ten boreholes advanced at the site. Groundwater PCE and TCE impacts were also found at the site.

Phase II ESA (December 2005) used to delineate identified PCE impacts to soil and PCE and TCE impacts to groundwater.
Objective of Risk Assessment to develop Property-Specific Risk Assessment Standards for soil and groundwater.

Both human health and ecological risk assessments were completed for the site based on conservation assumptions.

Assuming no remediation effort at the site, calculated health risks to on-site indoor long-term workers, on-site visitors, and remediation/construction worker receptors are unacceptable.

XCG recommended a Risk Management Plan.
Project 2 – Additional Site Assessments

- Supplemental Phase II ESA (February 2006)
- Remedial Action Plan
- Supplemental Phase II ESA (July 2006)
Project 2 - Soil Impacts
Project 2 – Groundwater Impacts
Project 2 – Remedial Action Plan

- Soil Fracturing to increase clay permeability
- Creation of Injection Wells through the specifically placed screens
Soil Fracturing

Schematic of site clean-up using the FRAC RITE™ process at an industrial facility.
**Project 2 – Remedial Action Plan**

- ISCO using Peroxidant

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<tr>
<th>Benefits of Peroxidant</th>
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<tr>
<td>Low treatment cost</td>
<td>Controlled oxidation reaction</td>
</tr>
<tr>
<td>Proven effectiveness</td>
<td>Fast remediation time</td>
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<tr>
<td>Not exothermic</td>
<td>Safe/controls for air emissions</td>
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<tr>
<td>No vinyl chloride is produced in Chlorinated compound reactions</td>
<td>No health or safety issues</td>
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<tr>
<td>Easy to apply by push injection</td>
<td>Regulator supported technology</td>
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Conventional remedial technologies can be too expensive for many business transactions.

Emerging in-situ technologies can be more a cost-effective remedial option for many property owners.
The authors would like to thank the XCG staff member that worked on this project:

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- Hazco
- Frac Rite
Questions?