Unlocking Bedrock Remediation Using an Innovative Targeted Access Method for Difficult Sites

Remediation of contaminated fractured bedrock remains one of the most persistent challenges in environmental restoration, particularly where conventional injection methods fail to achieve meaningful amendment distribution or contact with contaminant mass. Borehole instability, preferential flow pathways, and short-circuiting frequently undermine remedial effectiveness, leading to stalled projects and extended timelines. These limitations are especially pronounced at sites impacted by chlorinated solvents and petroleum hydrocarbons, where fractured bedrock serves as a continuing source of groundwater contamination.

This presentation introduces a delivery-focused approach designed to overcome these constructability barriers. Rather than relying on traditional injection techniques, the method employs targeted access points created through a pre-drill and backfill sequence. Boreholes are drilled precisely to the target bedrock interval, backfilled with hydrated bentonite to stabilize the column, and then advanced using direct-push tooling through the sealed borehole to place particulate amendments directly into transmissive fractures. This strategy reframes fractured bedrock remediation as an execution and delivery challenge rather than a chemistry problem, enabling practitioners to deploy proven amendments more effectively under complex geological conditions.

Three Canadian case studies illustrate the practical application and benefits of this approach:

Chlorinated Solvent PRB at a Former Steel Facility (Ontario): Initial packer-based injection attempts failed due to cave-ins in weathered shale. Converting boreholes to targeted access points enabled successful placement of approximately 90,000 L of amendment suspension across the full permeable reactive barrier alignment, completing a project previously stalled by constructability issues.

LNAPL and Dissolved PHCs at an Industrial Site (Gananoque, Ontario): Following multi-phase extraction that removed 75% of LNAPL mass, targeted injections of 2,200 kg of activated carbon-based amendment were completed in two days. Eight-month monitoring confirmed continued LNAPL destruction, no rebound, and significant reductions in dissolved PHCs at the till/bedrock interface.

Dissolved PHCs at a Commercial Site (Southern Ontario): Unstable limestone bedrock rendered packer-based injection infeasible. By adapting to targeted access points, injections were completed with minimal additional cost. Post-injection monitoring revealed non-detectable PHC concentrations within three months.

Collectively, these projects demonstrate how targeted access point injection improves amendment contact, reduces injection losses, and enhances predictability compared to conventional methods. The presentation synthesizes lessons learned to define practical decision criteria for when this approach provides measurable advantages, as well as scenarios where traditional methods remain appropriate. Key considerations include site characterization requirements, constructability constraints, and QA/QC practices necessary for defensible implementation.

By reframing fractured bedrock remediation as a delivery and execution challenge rather than a chemistry problem, this presentation provides practitioners with transferable insights into how remediation strategies can be more effectively implemented under challenging subsurface conditions common to Canadian sites.

Eric Cowan
VEI Contracting Inc.

Mr. Cowan is a Senior Project Manager at VEI Contracting Inc. and specializes in in-situ remediation. Mr. Cowan has been involved in the design and implementation of remediation programs across Canada involving permeable reactive barriers, adsorptive technologies, chemical oxidation/reduction, and biodegradation, in soil, groundwater, and bedrock for a variety of contaminants, including petroleum hydrocarbons, chlorinated solvents, and heavy metals.