Engineered Mineral Stabilization for Contaminated Soil Remediation/Reclamation: Field-Based Evidence and Pathways to Circular Land Recovery

Mining and industrial activities across Canada and globally have left thousands of sites with persistent geochemical risks linked to heavy metals, hydrocarbons, sulfates, and emerging contaminants. Traditional remediation approaches—such as excavation, capping, transport, and disposal—primarily shift liabilities rather than resolve long-term leachability, while landfilling continues to consume critical capacity. This paper evaluates Engineered Mineral Stabilization (EMS) as a next-generation remediation methodology to transform contaminated soils into chemically inert and geotechnically reusable materials. EMS combines chloride-free mineral crystallization with cement hydration to create a dense, impermeable matrix that immobilizes contaminants through microencapsulation and reduced matrix porosity.

Drawing from multi-site laboratory programs validated by SGS North America, SGS Perú, and Verdantas, as well as large-scale field demonstration during the redevelopment of the historic Titanic Quarter in Belfast (24,000 m^3 of contaminated soils), the study assesses: Immobilization performance: up to 95% reduction of heavy metal and hydrocarbon leachability under TCLP/SPLP, often below detection thresholds (≤0.17 mg/L Fe). Durability: 10–30% increase in unconfined compressive strength vs. conventional soil-cement; 35% lower porosity; high resistance to water penetration, acids, salts, and freeze-thaw cycling. Sustainability impacts: up to 70% lower CO_2 emissions, reduced excavation requirements, and full onsite treatment enabling infrastructure reuse.

A framework for circular reuse of reclaimed soils and tailings is presented, enabling integration into brownfield redevelopment, landfill cover systems, mine site rehabilitation, and civil construction elements. The accumulated evidence demonstrates that EMS can reduce lifecycle cost, eliminate transport of hazardous soils, and rapidly move contaminated lands toward regulatory compliance and beneficial re-use, positioning the technology as a practical and scalable remediation pathway for Canadian mining and industrial sites.

Learning Objectives

After this presentation, attendees will be able to:

Evaluate Engineered Mineral Stabilization (EMS) as a scientifically validated alternative to excavation-and-disposal for contaminated soil management.

Interpret geochemical and geomechanical performance data, including contaminant immobilization under TCLP/SPLP and strength improvements in stabilized soils.

Understand field-scale design considerations for incorporating EMS into brownfield redevelopment, mining reclamation, and landfill closure.

Assess sustainability and circular economy benefits, including CO_2 reduction, landfill diversion, and conversion of waste materials into construction resources.

Identify regulatory compliance pathways that support reclassification and reuse of previously hazardous or non-inert soils.

References

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As President of CORE Environmental, Shawn brings 30 years of experience in environmental operations, liability management, and waste services. He is committed to delivering responsible, high-quality environmental solutions across manufacturing, energy, mining, and other industrial sectors. Shawn is dedicated to mentoring his team, driving innovation, and creating sustainable value for clients. He takes a science-first approach to projects and is skilled in financial analysis, cash-flow forecasting, and evaluating the performance of complex operations. Outside of work, Shawn is a committed community builder, dad, volunteer, musician, and travel enthusiast.