

**Technical and Regulatory Guidance for
In Situ Chemical Oxidation of
Contaminated Soil and Groundwater**

Second Edition

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The Interstate Technology & Regulatory Council
In Situ Chemical Oxidation Team**

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EXECUTIVE SUMMARY

The contamination of groundwater and subsurface soil in the United States is a widespread and challenging problem. There are estimated to be in excess of 200,000 sites requiring some form of remediation, and many of these sites potentially threaten groundwater resources. In areas where the groundwater resources are not considered at risk, there are frequently impediments to the reuse of “brownfield” sites. In addition, for many subsurface geological settings, conventional treatment methods, such as pump-and-treat technology, can be costly and inefficient. Emerging in situ groundwater and subsurface soil treatment technologies may provide effective, lower-cost alternatives, and it is important to fully understand all aspects of any new and innovative technology.

This guidance document was developed to outline the technical and regulatory requirements of in situ chemical oxidation (ISCO), a group of technologies involving various combinations of oxidants and delivery techniques. The primary oxidants addressed in this document are hydrogen peroxide, potassium and sodium permanganate, sodium persulfate, and ozone. The effectiveness of some of these oxidants can be enhanced through activation (Fenton’s reagent, activated persulfate) and used in conjunction with other oxidants (perozone). Additionally, this document is intended to expedite movement to a consensus on regulatory requirements through the Interstate Technology & Regulatory Council concurrence process. It should prove useful to regulators, stakeholders, consultants, and technology implementers.

The document is divided into sections consisting of technology overview and applicability, remedial investigations, safety concerns, regulatory concerns, injection design, monitoring, stakeholder concerns, and case studies. From a regulatory perspective, the most important sections of the document are identification of injection restrictions, implementation, and post-closure monitoring. Appendix D provides case studies of ISCO implementations, and the reference list includes documents with additional case study data.

Site characterization is a critical step in effectively applying any remedial technology. A complete understanding of the site geology, hydrogeology, and geochemistry, as well as the contaminant profile, is necessary for successful ISCO projects. To obtain a complete understanding of the site, it is important to develop a conceptual site model to integrate all data (contamination, potential sources, geology, major migration pathways, etc.) in three dimensions. Numerous hydrogeological and geochemical models are available to assist in site evaluations.

Regulatory issues associated with ISCO include the state or federal programs associated with underground injection control (UIC) and air quality. Permitting will typically not be an extensive process in ISCO deployment, as required permits may be limited to UIC concerns. Air quality concerns are limited to controlling fugitive vapors that may be produced. Monitoring requirements are discussed in Section 6 of this document.

Health and safety issues for ISCO include the following:

- Oxidants must be safely handled and stored.
- Permanganate and persulfate dust is hazardous.
- The presence of ozone increases the flammability of many materials.

- The generation of ozone can involve high-voltage-equipment concerns.
- There is a potential for uncontrolled exothermic reactions.
- There is a potential for preferential migration of oxidants and/or contaminants (liquid or vapor) through underground utilities.

As with all remediation technologies, it is important to address tribal and stakeholder concerns in detail. This process requires frank public discussion about the potential risks and benefits of the technology and about site-specific issues. This document provides detail on tribal and stakeholder concerns in Section 7.