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Tiered Approach for the Application of Diagnostic Tools to Evaluate Remediation Performance at Petroleum-Hydrocarbon Contaminated Sites

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Background/Objectives. Engineered remediation of contaminated sites often involves the injection of a treatment fluid or gas to promote the in situ destruction of contaminants by biological or chemical reactions. However, such intervention can also result in dilution, displacement or volatilization of contaminants rather than their destruction. To assess and optimize the performance of remediation treatments, it is important to differentiate a concentration decrease of the targeted contaminant caused by physical removal from in situ contaminant destruction, and to verify the mechanism(s) of in situ destruction (biological and/or chemical). However, demonstrating the processes affecting contaminant reduction during remediation treatment represents a significant challenge with conventional methods. The objective of this research project was to evaluate selected diagnostic tools that can improve the performance assessment of remediation treatments by providing information about target removal processes on a compound-specific basis. Furthermore, the project aimed at developing a comprehensive methodology for the tool applications taking into account the type of information gained, ease of implementation and cost.

Approach/Activities. The project focused on three diagnostic tools, compound-specific isotope analysis (CSIA), biodegradation metabolites, and functional genes (mRNA). The performance of these tools was evaluated in controlled-field experiments carried out at the Borden experimental aquifer. The experiments consisted of emplacing a well-defined contaminant source followed by a remediation treatment (air sparging, ISCO and sulfate land application). These diagnostic tools were evaluated to identify the dominant removal process by relating their response to VOC concentrations and mass discharge changes and other complementary data (e.g., redox conditions). Then, these tools were applied on actual contaminated sites to assess the performance of a soil vapor extraction system and a sulfate land application treatment.

Results/Lessons Learned. Based on results from the field studies, a tiered approach was developed to assist remediation practitioners in the selection and the deployment of the diagnostic tools at field sites. The tiered approach was established according to a specific compound removal process (e.g., biodegradation, volatilization) that needs to be assessed. In a second step, the tool selection was further narrowed according to the compound of interest. The tiered approach aims to ensure successful deployment, which will lead to lifecycle remediation cost reductions. The tiered approach makes it possible to identify early on if a remediation procedure successfully initiated the intended compound-removal processes and whether remediation optimization actions lead to more effective removal of the compound of interest. The presentation describes the basic principle of the selected diagnostic tools and also provides an overview of the tiered approach for field application of the tools.