Top 4 Tips for

Evaluating Remediation Options @ Petroleum Hydrocarbon Sites

Molecular biological tools (MBTs) provide actionable data during site assessment that impact remedy selection at sites contaminated with petroleum hydrocarbons. Below are some of our top tips for evaluating monitored natural attenuation (MNA), enhanced bioremediation, and in situ chemical oxidation (ISCO) as treatment options:

1. Perform an ***In Situ* Microcosm (ISM)** study to simultaneously compare MNA against enhanced bioremediation options including the addition of an electron acceptor (e.g., oxygen releasing material or sulfate) or nutrients (N, P, K).

Results from laboratory microcosms do not always correlate to the field, and pilot studies are too expensive to be used to screen multiple remediation approaches. **ISMs** are field-deployed microcosm units containing passive samplers that provide the microbial, chemical, and geochemical data needed to cost-effectively evaluate multiple remediation options. An ISM assembly for a petroleum hydrocarbon site typically has two types of units: an unamended MNA unit and one or more BioStim units amended with an electron acceptor.

2. Submit groundwater samples or Bio-Trap® samplers from a background well and select monitoring wells within the plume for **QuantArray®-Petro** or **CENSUS® qPCR** analysis.

What are the concentrations of BTEX degraders? MTBE degraders? **QuantArray®-Petro** and **CENSUS® qPCR** are performed to quantify specific functional genes (e.g., anaerobic benzene carboxylase, toluene dioxygenase) responsible for biodegradation of BTEX, PAHs, and other petroleum hydrocarbons. Compare results for impacted monitoring wells to background concentrations. Higher concentrations of these key functional genes in impacted monitoring wells indicates growth of contaminant degraders within the dissolved plume and the potential for biodegradation during MNA. If an enhanced bioremediation strategy is selected for the site, QuantArray®-Petro results during site assessment can also serve as the baseline to compare against post-treatment samples to evaluate the effectiveness of the remedy.

3. Consider a **Stable Isotope Probing (SIP)** study to conclusively determine whether biodegradation of a specific contaminant of concern (e.g., benzene) is occurring under existing site conditions.

Is biodegradation occurring? In a **SIP** study, a Bio-Trap® sampler is amended with a specially synthesized ^{13}C form of the contaminant of concern (e.g., ^{13}C-benzene) and deployed in an impacted monitoring well for approximately 30–45 days. The ^{13}C serves as a "label" or "tracer." If biodegradation of the contaminant occurs during the deployment period, the ^{13}C label will be incorporated into the end

products of biodegradation — biomass and CO_2. Thus, the detection of ^{13}C-enriched biomass or ^{13}C-enriched dissolved inorganic carbon conclusively demonstrates that *in situ* biodegradation of the contaminant occurred providing a strong line of evidence supporting the feasibility of MNA.

Microbiology and ISCO? Yes! **QuantArray®-Petro** and **SIP** are commonly used to evaluate MNA and enhanced bioremediation as follow-up treatments after ISCO.

While subsurface conditions are harsh during ISCO, adverse impacts on microbes are usually temporary and the microbial community rebounds quickly. In fact, residual sulfate from persulfate activated ISCO can serve as an electron acceptor and stimulate microbial growth and biodegradation as the site transitions to MNA. Therefore, **QuantArray®-Petro** and **SIP** are commonly used to evaluate MNA or bioremediation as a polishing step to reach site goals after ISCO.

Don't forget that **SIP** can be incorporated into **ISM** studies to conclusively compare biodegradation of a key contaminant like benzene during under existing conditions and in response to electron acceptor addition for enhanced bioremediation **(Top Tips 1 and 3)**.

For more information on all of our MBTs, please visit the Microbial Insights website (www.microbe.com).

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