

SIP

Evaluating MNA at a Manufactured Gas Plant



PROJECT SUMMARY



- Site stakeholders needed conclusive evidence that biodegradation of benzene and naphthalene was occurring under existing site conditions to accept MNA instead of a more aggressive strategy.
- Stable isotope probing (SIP) studies using Bio-Traps[®] amended with ¹³C benzene or ¹³C naphthalene conclusively demonstrated *in situ* biodegradation occurred under existing site conditions.
- MNA was accepted as the remediation strategy.

PROJECT CHALLENGE



At a former manufactured gas plant (MGP), groundwater benzene and naphthalene concentrations were stable to decreasing. QuantArray[®]-Petro demonstrated growth of moderate to high concentrations of BTEX and naphthalene degraders within the dissolved plume and site managers were considering monitored natural attenuation (MNA). To support the decision however, stakeholders wanted an additional line of evidence conclusively demonstrating that benzene and naphthalene biodegradation was occurring under existing site conditions and that more aggressive remediation was not warranted.

MBT ANALYSIS



Stable Isotope Probing (SIP) is an innovative molecular biological tool (MBT) that uses a Bio-Trap amended with a ¹³C “labeled” contaminant (e.g., ¹³C benzene) to conclusively determine whether biodegradation has occurred. The ¹³C label serves much like a tracer which can be detected in the end products of biodegradation – microbial biomass and CO₂.

Briefly, Bio-Traps amended with either ¹³C benzene or ¹³C naphthalene were deployed in impacted monitoring wells near the source area and adjacent to the former MGP operations. Following a 60 day in-well deployment period, the Bio-Traps were retrieved and shipped to Microbial Insights for analysis.

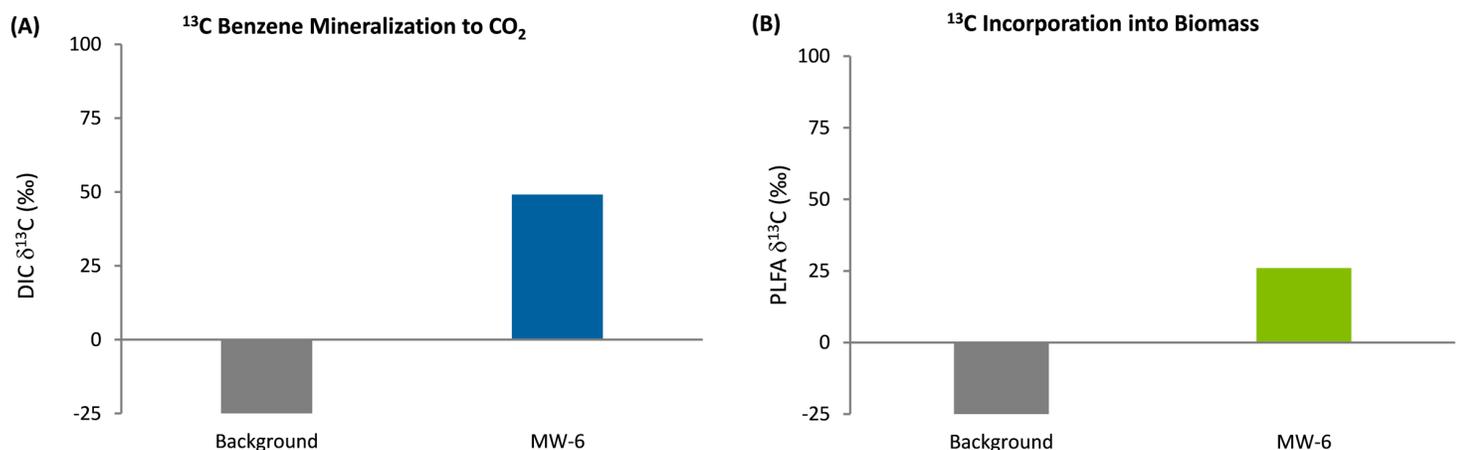
STABLE ISOTOPE PROBING (SIP) RESULTS



While the nomenclature may be unfamiliar, interpretation of SIP results is straightforward. Biodegradation of benzene, naphthalene, and other petroleum hydrocarbons is a process whereby some microorganisms use the contaminant as a carbon and energy source.

- When used as an energy source, contaminant carbon is oxidized to CO₂ as part of cellular metabolism. Therefore, the detection of ¹³C enriched dissolved inorganic carbon (DIC) in a SIP study demonstrates mineralization of the contaminant.
- When used as carbon source, contaminant carbon is incorporated into biomolecules such as phospholipid fatty acids (PLFA) and proteins supporting growth of new cells (biomass). Thus, the detection of ¹³C enriched PLFA in a SIP study indicates incorporation into microbial biomass.

In other words, the detection of ¹³C enriched DIC and/or ¹³C enriched PLFA during a SIP study conclusively demonstrates *in situ* biodegradation of the contaminant of concern.



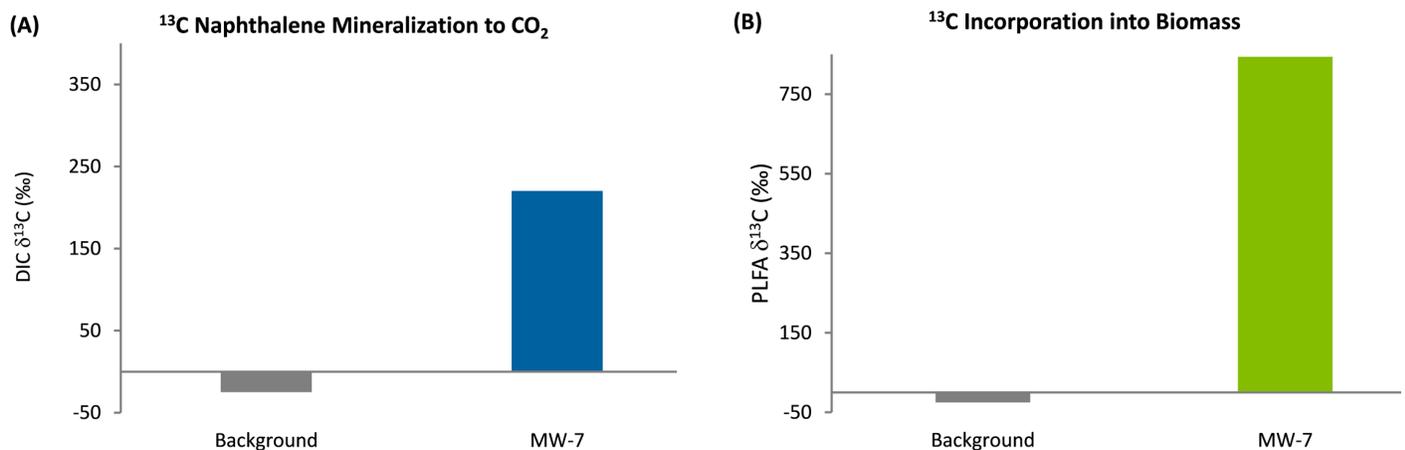
Benzene: As shown in Figure 1 above, SIP results conclusively demonstrated that benzene biodegradation occurred in monitoring well MW-6 during the deployment period.

- More specifically, the detection of ¹³C enriched DIC (blue bar, 49‰) compared to a background level (typically -25‰) conclusively demonstrated *in situ* mineralization of benzene (Figure 1A).
- Likewise, the detection of δ¹³C enriched PLFA (green bar, 26‰) compared to a typical background level of -25‰ conclusively demonstrated incorporation of ¹³C into biomass (Figure 1B).

STABLE ISOTOPE PROBING (SIP) RESULTS (CONT.)



Naphthalene: SIP results conclusively demonstrated that naphthalene biodegradation occurred during the deployment period in MW-7. Quantification of $\delta^{13}\text{C}$ DIC (220‰) showed moderate levels of ^{13}C naphthalene mineralization. In addition, the detection of $\delta^{13}\text{C}$ enriched PLFA in MW-7 (844‰) compared to a background level conclusively demonstrated substantial incorporation of ^{13}C into biomass.



Decision: Continue MNA. SIP results conclusively demonstrated that *in situ* biodegradation of benzene and naphthalene was occurring under the existing site conditions providing a key line of evidence supporting the decision to accept MNA as the site management strategy.

KEY BENEFITS



- **Conclusive:** SIP results conclusively demonstrated that *in situ* biodegradation of benzene and naphthalene occurred under existing site conditions.
- **Confidence:** Increased stakeholder confidence in MNA.
- **Saved Money:** Aggressive remediation strategies were not warranted.
- **In Situ:** The SIP study was performed in existing monitoring wells at the site – not on a lab bench.