# New Tools to Support Monitored Natural Attenuation Remedies

WSP has optimized a set of diagnostics to use when traditional assessments of chlorinated solvent and 1,4-dioxane releases fall short.

Properly considered monitored natural attenuation (MNA) remedies result in favorable outcomes, often at lower costs than other remedial options. For most chlorinated solvent and 1,4-dioxane plumes, regulatory considerations for natural attenuation implementability are straightforward, and assessment data needs and evaluation techniques are well defined. However, there are some naturally attenuating plumes where traditional evaluation techniques are incapable of demonstrating destructive attenuation; a key regulatory consideration for MNA remedy applicability.

Typically, plumes exhibiting characteristics outside of the norm, including aerobic conditions and lack of sequential reductive daughter products, were not candidates for further natural attenuation assessment. Often, these plumes are large and have relatively low contaminant concentrations.

WSP has identified diagnostics that definitively demonstrate natural attenuation of chlorinated solvents and 1,4-dioxane along less familiar degradation pathways that don't yield daughter products that are familiar to many environmental professionals. Together these diagnostics quantify degradation, yielding degradation rates, and identify the mineralogical or microbial degradation mechanism. These diagnostics use the same sampling techniques as conventional diagnostics and costs are reasonable, especially when compared to active remedial alternatives.

## REGULATORY CONSIDERATIONS for MNA Implementability

**IS IT SAFE?**
Does it pose a threat to the community or site workers?

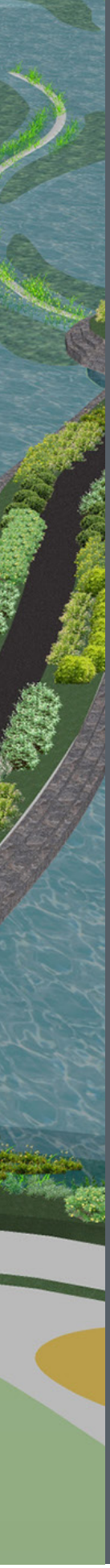
**DOES IT WORK?**
Does the combination of natural attenuation mechanisms destruction (biodegradation and chemical reactions), sorption, evaporation, and dilution, result in a stable or shrinking plume? Regulators often place emphasis on demonstrating destruction.

**HOW LONG DOES IT TAKE?**
Relative to other technologies.

## LESS FAMILIAR DEGRADATION PATHWAYS - *How They Work*

- **Abiotic degradation** – Naturally occurring ferrous iron minerals degrade chlorinated solvents along abiotic elimination pathways, similar to zero-valent iron-based *in situ* remedies.
- **Aerobic cometabolism** – Engineered systems that stimulate cometabolic degradation of chlorinated solvents, 1,4-dioxane, and other contaminants have a long history of use. More recently, naturally occurring cometabolism has been demonstrated as an effective MNA mechanism.
- **Non-diagnostic end products** – Abiotic degradation and aerobic cometabolism yield degradation products that are difficult to quantify. WSP uses set of economical advanced diagnostics based on $^{14}C$ assays that label the contaminant and precisely quantify the label in degradation products.

WSP is leading the industry with this innovative MNA tool



# $^{14}C$ Assay Case Study

## Fortune 500 Manufacturer Legacy Facility, Nebraska (2017 to present)

Large, dilute plumes pose unique and often costly remediation challenges. WSP was commissioned to address a newly identified low-concentration trichloroethene (TCE) plume (nearly a half a million cubic yards in volume) which was approaching an agricultural well field.

WSP recognized that the distribution of the TCE indicated natural attenuation; a lower cost remedial alternative. But, telltale conditions that support degradation along the most common pathway (sequential reduction) were clearly absent (high dissolved oxygen and no sequential daughter products). An innovative $^{14}C$ assay-based testing approach designed to definitively identify degradation along cometabolic and abiotic pathways was implemented to gather data to support a natural attenuation remedy.

Assay results demonstrated contaminant degradation and provided rate information for input into a robust fate and transport model which showed there was no risk to the downgradient well field. After a brief technical discussion, regulators agreed that natural attenuation monitoring was appropriate and after appropriate monitoring to validate the rate of attenuation the site can be closed.

# Other Successful MNA Projects

WSP has a strong track record of science-based advocacy and has implemented MNA at numerous sites across the country. We leverage advanced diagnostics including $^{14}C$ assays (*see case study to the left*), compound specific stable isotope analysis (CSIA), genetic/genomic diagnostics, and *in situ* microcosms in a targeted manner to quickly define activity along degradation pathways and end iterative rounds of traditional data collection. Here are some project examples that demonstrate MNA advocacy success across contaminant classes and regulatory programs.

### Superfund Site PRP Committee, New York

**Contaminant:** Chlorinated VOCs
**Status:** 1992 to 2011 Amended ROD (MNA and TI Waiver); Ongoing MNA monitoring and 5-year reviews

WSP was retained to provide environmental consulting support for the Respondents identified for the a New York Superfund Site beginning in 1992. Initial investigations resulted in EPA including presumptive remedies for affected soil (excavation and offsite disposal) and groundwater (extraction and treatment) within the record of decision (ROD). Subsequent groundwater investigations definitively attributed plume stability to natural attenuation processes throughout the bulk of the plume and further indicated that these processes are sustainable and will result in the complete remediation of site groundwater in a timeframe consistent with other remedial technologies considered for implementation at the site (e.g., pump and treat). Natural attenuation processes were absent in an isolated smaller plume that was also shown to be recalcitrant to enhancement. Based on the results of these investigations, the ROD was amended to include MNA for the bulk of the plume and a Technical Impracticability (TI) waiver for the recalcitrant plume. Annual MNA monitoring and the 5-year remedy reviews are ongoing.

### Middlesex Sampling Plant FUSRAP Superfund Site - New Jersey

**Contaminant:** Uranium
**Status:** MNA proposed

Low concentrations of uranium remained in shallow groundwater after soils contaminated with uranium ore were removed from the site. The dissolved uranium concentrations were shown to be decreasing over time. A targeted investigation of redox conditions and native iron oxyhydroxides identified ion exchange as the mechanism of attenuation.

### Midstream Oil and Gas Client, Wyoming

**Contaminant:** natural gas production fluids
**Status:** 2016 MNA documented Ongoing Periodic Soil Monitoring

A release of natural gas production fluids from a remote pipeline impacted soil across nearly a mile of drainage. WSP quickly determined that the nature of the release and affected soils made MNA a strong remedial option. Targeted MNA assessment identified a high abundance of petroleum degrading microbes, a sufficient supply of nutrients to drive contaminant attenuation to completion and most importantly calculated a first order degradation rate that showed rapid attenuation. Periodic monitoring results demonstrate compliance with cleanup criteria across much of the affected area. Site regulatory closure is expected in 2021.

### Oil and Gas

**Montana** - Product recovery followed by natural source zone depletion (NSZD) and MNA

**Kansas** - Heat-based NSZD quantification

**Michigan** - Baited *in situ* microcosms demonstrated that the MNA remedy was preferred over enhanced bioremediation

### Commercial/Industrial

**Georgia** - Aggressive source zone chemical oxidation of chlorinated solvents with MNA polishing

**South Carolina** - $^{14}C$ assay and CSIA-based demonstration of chlorinated ethenes natural attenuation in saprolite

**New Jersey** - innovative rock matrix diffusion testing supports TI waiver

**Florida** - Hundreds of dry cleaning sites closed with source treatment and MNA combined remedy

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