

## Rethinking Bioventing: It's Not Just for BTEX and TPH in Soil

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**Background/Objectives.** Research on natural source zone depletion (NSZD) rates at petroleum-affected sites has demonstrated that the rate of natural LNAPL depletion is typically on the order of hundreds to thousands of gallons of LNAPL per acre, per year. Both academic and industry research studies and measurements made by practitioners have shown that the rate of LNAPL mass depletion by NSZD is often greater than what can be or has been achieved through active LNAPL recovery efforts.

Conceptual models of NSZD show that the soil gas within the LNAPL smear zone is rich in methane and depleted of oxygen. These observations suggest that bioventing may be an effective technology to enhance biodegradation rates and deplete LNAPL source mass.

Best practices for bioventing field screening, system design, and performance monitoring have been in place since the 1990s. While the remediation science behind bioventing has not changed, the conceptual understanding of biological LNAPL depletion processes and the framework for evaluating remedial efficacy for different LNAPL remediation technologies has changed markedly since the 1990s. Bioventing has historically been considered applicable for reducing concentrations of BTEX and TPH in soil. However, advances in our understanding of biodegradation of LNAPL and a review of bulk LNAPL mass removal rates that can be achieved through bioventing indicate that bioventing is an effective approach for addressing LNAPL saturation concerns in favorable settings.

**Approach/Activities.** The presentation will discuss how bioventing has been traditionally applied and how the conceptual model for NSZD has changed our thinking on source zone biodegradation. NAPL case study sites where bioventing was implemented will be used to demonstrate the application and monitoring methods, including the use of temperature to quantify mass loss rates. Petroleum removal rates via bioventing will be compared to hydraulic recovery performance and baseline NSZD rates.

**Results/Lessons Learned.** Bioventing is a potentially cost-effective and sustainable remediation alternative that not only degrades the mobile fraction but also the residual fraction of LNAPL. Remedial efficiency for many conventional remediation technologies declines exponentially over time and performance ultimately reaches a point where continued operation no longer provides meaningful reduction in contaminant mass or potential risk to receptors. The observation that biologically-mediated LNAPL depletion processes do not appear rate limited under most circumstances indicate that mass removal through enhanced biological depletion can be sustained over longer periods of time than for technologies that rely on mechanisms, like hydraulic recovery, that inherently become less effective over time.