Estimating Time to Reach NSZD Endpoints – Using Active Remediation Analogs

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Natural source zone depletion is widely recognized as an effective means for source mass control and risk reduction at petroleum LNAPL sites. However, it is a relatively slow process when compared to well-engineered remediation systems such as soil vapor extraction, air sparging, and multiphase extraction that can achieve remedial endpoints in less than a year to a few years. As with all remedial alternatives, a key question when evaluating the feasibility of NSZD, is "how long will it take to reach remedial endpoints?" While the answers for the faster aforementioned alternatives has a large range of uncertainty, the upper bound, almost certainly less than a decade, is still within the range of durations of industry LNAPL remediation experience, and, perhaps more importantly, within the range of career durations of those involved. On the other hand, when the answer for NSZD is at least a decade to potentially longer than a century, it raises questions about the level of confidence in the estimates not in small part because there is associated uncertainty around the who, how, and when of validating endpoints. There is also uncertainty about the natural depletion rate over time. In most environmental applications, decaying rates of mass depletion (e.g., first order decay) provide a reasonable description of the expectations for remedial system performance. However, NSZD appears to be a zero-order process, i.e., it has a constant rate, at least for the relatively short duration that it has been studied, though some have also used first order decay to fit NSZD data. It is the objective of this study to draw on well characterized sites and remediation systems (in particular bioremediation systems) to provide insight into possible lifetimes for NSZD and NSZD rates over time.

Sites where the pre- and post-remediation conditions are well characterized and where the mass depletion is well and completely characterized (i.e., enhanced NSZD processes, a.k.a., bioremediation, are measured) are selected for evaluation. These data provide independent measures of mass depletion to get to an endpoint and estimates of percentage mass removal. Initial and final characterization data are used to evaluate the change in specific LNAPL volume, and LNAPL mass depletion estimates are also derived from remedial system performance data. In some cases, composition change can also be characterized, though this is by processes that may not be exactly the same as NSZD. Remedial system performance data for enhanced natural depletion (or the enhanced natural depletion portion of remedial systems) is used to gain insight into the variation of depletion rates with time.

Site data will be presented including the initial conditions at the site, the remedial processes applied, remediation performance data, and final conditions at the site. From these data, conclusions will be presented about the specific volume reductions observed over the course of remediation, the mass depletion estimated from remedial performance data, the variation of mass depletion rates over time, and insights into composition change. These analogs will then be extrapolated to NSZD performance.

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Rick has been practicing groundwater and remediation hydrology since 1995. He has worked for a broad range of clients, many in the oil and gas and aerospace industries, providing in-depth knowledge of approaches for characterization, risk evaluation and remediation of sites affected by non-aqueous phase liquids (NAPLs, e.g., crude and refined petroleum, solvents, and other oils). He has experience across numerous U.S. and international sites developing remedial strategies and remedial system designs for mitigation of NAPL, groundwater, soil and soil vapor concerns; and evaluating the performance, progress, and reasonable end-points of remediation.

Rick is an experienced project technical director with the ability to communicate effectively with regulators and other technical experts as well as non-technical stakeholders. He has served as the technical lead and/or engineer in responsible charge on numerous projects, guiding them from investigation through remediation to closure, and also provides strategic peer-review for clients' projects. Rick regularly advocates for application of NAPL science through contributions to guidance documents; training regulators, liability owners, as well as other stakeholders and consultants; and organizing and chairing NAPL-related conference sessions.

Mr. Ahlers has an M.S. in Hydrology, Civil, and Environmental Engineering from the University of California, Berkeley, and a B.A. in Physics from Occidental College. He is a Licensed Professional Engineer in California.