| Line of Evidence | Description | Relative Weight | Cautions / Comments |
|---|---|---|---|
| Well Gauging Data (in-well fluid levels) | Persistent absence of LNAPL in sentinel wells suggests that the LNAPL body is not expanding appreciably, whereas detection of LNAPL in previously non-impacted wells (with originally clean soil boring logs) would suggest that LNAPL may not yet have stabilized. | High | • Requires that an adequate and consistent network of monitoring wells is in place (e.g., sufficient well density at the leading edge of the LNAPL body) and sufficient temporal data density.<br>• Care should be taken to ensure that newly incorporated LNAPL occurrence data is not automatically interpreted as evidence of plume advancement, when it may just represent increased data set density.<br>• Evaluate historical soil boring logs for evidence of LNAPL (e.g., staining, odors) and assess potential influence of changing water table conditions on the occurrence of mobile LNAPL in wells. Ephemeral LNAPL occurrence in wells can be mis-interpreted as evidence of LNAPL migration when it may simply reflect changing water table conditions. |
| Dissolved Phase Plume Stability | Expansion of the LNAPL body footprint will be reflected by expansion of dissolved phase LNAPL constituents in groundwater. Temporal trend analysis can be completed on individual wells, or for the plume as a whole, to evaluate whether the dissolved phase center of mass is advancing, retreating, or stable. | High | • As with fluid level gauging data, evaluation of dissolved phase plume stability requires an adequate network of wells with sufficient density and temporal data.<br>• Note that a stable or shrinking dissolved phase plume condition is consistent with a stable or shrinking LNAPL body; however, an expanding dissolved phase plume does not necessarily require that the LNAPL body is also expanding.<br>• Some old, weathered releases (e.g., diesel) have no associated dissolved phase COC plume downgradient of the LNAPL footprint; therefore, this line of evidence is not applicable to all LNAPL bodies. |
| Estimate LNAPL Velocity Potential | Based on Darcy's Law applied to the LNAPL phase. Requires estimates of LNAPL conductivity, LNAPL gradient, soil porosity, and LNAPL saturation.<br>An estimated velocity $\leq 1 \times 10^{-6}$ cm/sec can be inferred to indicate de minimus LNAPL migration potential (ASTM E2531 2007). | Low | • Not applicable for evaluating LNAPL migration potential in fractured systems, where LNAPL migration is typically governed by the geometry and interconnection of fractures, along with the frequency and magnitude of groundwater fluctuations.<br>• Requires a relatively large number of lab analyses and/or parameter estimates, each with potential for significant uncertainty. |
| LNAPL Pore Entry Pressure/Critical LNAPL Thickness Comparison | Compare theoretical LNAPL entry pressures based on site-specific soil and fluid properties to measured LNAPL thicknesses in wells located near the fringes of the LNAPL body (Charbeneau et al. 1999). | Low | • As with estimated LNAPL velocity, this line of evidence applies to porous media and does not account for migration via preferential pathways (e.g., fractures/macropores).<br>• Calculation is only applicable for LNAPL migration into water-saturated soils not previously impacted by LNAPL.<br>• It is noted that stable LNAPL bodies may exhibit significant LNAPL thicknesses in wells, and these occurrences may not be indicative of LNAPL body instability/migration. |
| Age of Release | LNAPL bodies originating from older releases are more likely to be stable than more recently released LNAPL due to dissipation of LNAPL head over time, smearing/residualization of LNAPL, and mass depletion through remediation and/or NSZD processes. Based on numerical simulations for a large range of release conditions, most LNAPL bodies stabilize within 3 to 10 years after a release has been abated (Beckett and Lyverse, 2005). | High | Assumes release details (e.g., location, timing, and volume) are known. |
| Recovery System Performance Trends | Declining LNAPL recovery rates and/or decreasing LNAPL transmissivity reflect a reduction in LNAPL saturation (relative permeability to LNAPL) and increasing LNAPL stability. | High | • Quantitative line of evidence, but it applies only to recovery system zone of influence. |
| Laboratory Petrophysical Testing Results | Collect intact soil cores from the LNAPL smear zone and perform pore fluid saturation (e.g., Dean Stark) and lab mobility tests (e.g., water drive) at conditions representative of the subsurface. Observe drainage from mobility tests and compare LNAPL saturation to laboratory-determined range of residual LNAPL saturation values. | Low-medium | • Potential sample disturbance/fluid drainage during collection using conventional core collection techniques. Recent advancements in methods for in situ freezing of unconsolidated soil cores (e.g., Kiaalhosseini et al. 2016) may help overcome these challenges.<br>• Limited volume of subsurface interrogated at laboratory scale may not capture variability present at the field-scale. |
| Comparison of LNAPL Mass Flux and NSZD Rates | Quantification of LNAPL loss rates through NSZD measurement in conjunction with LNAPL flux measurements from the leading edge of the LNAPL body, estimated from LNAPL tracer tests or a combination of LNAPL transmissivity and LNAPL gradients, can be used in a mass balance approach (Mahler et al., 2012; Lundy 2014). Calculated migration distances that are less than or equal to the distance to the leading edge of the LNAPL body suggest a stable or shrinking LNAPL body. | Medium | NSZD rate estimates apply to losses that occur over the entire vertical interval of LNAPL, including residual LNAPL that does not contribute to lateral LNAPL flux. The mass balance approach assumes that NSZD rates are representative of losses within the mobile LNAPL interval only. |