Will LNAPL recovery be effective? Tier 3

LNAPL Conceptual Site Model (LCSM): **"**The LCSM is the collection of information that incorporates key attributes of the LNAPL body with site setting and hydrogeology to support site assessment and corrective action decision-making. The LCSM integrates information and considerations specific to the LNAPL body relating to the risks of the contaminant source, exposure pathways, and receptors. The content of the LCSM will typically evolve over time as different phases of the corrective action process require different information. What remains consistent is the emphasis in the LCSM on characterizing and understanding the source component, the LNAPL." (ITRC, 2018). At sites where LNAPL recovery is the key remediation question, the LSCM can be refined and improved by using computer models and/or LNAPL transmissivity to better understand the potential for LNAPL recovery.

Computer Models: Several computer models are available to help understand if LNAPL can be recovered effectively:

1. The API's LDRM model can be used to determine how much LNAPL can be recovered. For an overview of LDRM, see Tier 3 of "How much LNAPL is present?"
2. The USEPA's REMFuel model allows users to develop a simple box model of BTEX and oxygenates in an LNAPL source zone, simulate a historical release, and see the effects of removing some fraction of LNAPL in the current timeframe or sometime in the future. For an overview of REMFuel, see Tier 3 of "How long will LNAPL persist?"
3. The UTCHEM model can simulate LNAPL recovery and is particularly useful for extremely complex LNAPL problems and for modeling surfactant remediation projects. For an overview of UTCHEM, see Tier 3 of "How far will LNAPL migrate?"
4. The API LNAST model can be used to see the impact of LNAPL recovery on dissolved plumes. For an overview of LNAST, see Tier 3 of "How will LNAPL risk change over time?"

Videos: Short videos re available to learn more about each of these computer models:

- LDRM
- REMFuel
- UTCHEM
- LNAST

LNAPL Transmissivity: More recently there has been a move to use LNAPL transmissivity as a key metric to evaluate LNAPL recoverability (e.g., ITRC, 2018). The ITRC's "Top Three Things To Know about LNAPL Transmissivity" is reproduced to the right.

Top Three Things to Know about LNAPL Transmissivity (T_n)

1. T_n describes a basic relationship between LNAPL drawdown in a well and LNAPL flow to that well. This makes it a representative metric for LNAPL recoverability by any hydraulic method—including skimming, pumping, vacuum extraction, or manual bailing.
2. T_n measurements must be used in context of the overall LCSM; identifying potentially confined or perched conditions and understanding seasonal changes are important to accurately measuring and appropriately using T_n as a metric.
3. T_n measurements are relevant to LNAPL saturation remedial objectives (e.g., recovering NAPL to the maximum extent practicable, or controlling LNAPL migration) and are not directly relevant to composition-based remedial objectives (e.g., meeting dissolved-phase groundwater standards).

The use of transmissivity has been catalyzed by a general consensus that hydraulic recovery of LNAPL (skimmer wells, trenches, groundwater pumping, etc.) has a **Technology Threshold Metric** consisting of LNAPL transmissivity greater than 0.1 to 0.8 ft^2/day (0.0093 to 0.074 m^2/day). This metric may be used as a decision point for remedial system operation or technology transitions (ITRC, 2018). For example, in the State of Michigan, LNAPL guidance states "*if the NAPL has a transmissivity greater than 0.5 ft^2/day, it is likely* *that the NAPL can be recovered in a cost-effective and efficient manner unless a demonstration is made to show otherwise."* (ITRC, 2018). ITRC also describes five sites in detail that were used as the basis of this range (Section 1.3).

LNAPL transmissivity can be determined in two general ways:

1. Computer Models: Using a multiphase LNAPL model to calculate transmissivity based on soil type, LNAPL properties, and other factors. The Tier 2 LNAPL Subsurface Volume and Extent Model can be used to easily estimate LNAPL transmissivity, as can LDRM. Sale (2001) provide methods for determining inputs to environmental petroleum hydrocarbon and recovery models.

2. Field Measurements (ITRC, 2018, Section 2.0): Conduct field data and analyze the data to calculate the LNAPL transmissivity. ITRC (2018) and ASTM (2013) prescribe three approaches:

    1. *LNAPL Baildown Testing.* Note a computer spreadsheet is available to process the data from baildown tests to determine transmissivity (Charbeneau et al., 2012) (no metric units, however).

    2. *Manual LNAPL Skimming Testing*.

    3. *LNAPL Recovery System Evaluation.*

References

ASTM. 2013. Standard Guide for Estimation of LNAPL Transmissivity. ASTM International.

Charbeneau, R. Kirkman, A., Muthu, R., (2012) API LNAPL Transmissivity Workbook: A Tool for Baildown Test Analysis.

ITRC, 2018. LNAPL-3: LNAPL Site Management – LCSM Evolution, Decision Process, and Remedial Technologies. Interstate Technology and Regulatory Council.

Sale, T. (2001). Methods for Determining Inputs to Environmental Petroleum Hydrocarbon Mobility and Recovery Models, American Petroleum Institute Publication No. 4711.