TECHNICAL GUIDANCE DOCUMENT
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Indiana Department of Environmental Management

Mobile Vacuum Extraction (MVE)

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Notice

IDEM Technology Evaluation Group (TEG) completed this evaluation of Mobile Vacuum Extraction (MVE) systems based on review of items listed in the "References" section of this document. The criteria for performing the evaluation are generally described in the IDEM OLQ technical memorandum, Submittal Guidance for Evaluation of Remediation Technologies.

This evaluation does not approve this technology nor does it verify its effectiveness in conditions not identified here. Mention of trade names or commercial products does not constitute endorsement or recommendation by IDEM for use.

Background

MVE technology removes liquid and vapor phase contamination from surface soil or subsurface soil and groundwater. MVE is typically used for immediate removal of recent releases of light non-aqueous phase liquid (LNAPL). This guidance also addresses its use as a pilot test for older impacts[1] that are unstable to assess the feasibility of multiphase extraction (MPE) or other treatment technologies and how IDEM wants to see this information reported.

A MVE event is typically performed using a truck mounted vacuum system consisting of a large liquids storage tank, a high flow velocity and high vacuum pump, and various fluid handling piping, gauges, and sampling fixtures. The common name for a MVE vehicle is "Vac Truck".

A typical MVE process consists of attaching the system vacuum hose(s) to one or two wells, and operating the system for up to eight hours. Wells can be either monitoring or extraction wells, and up to eight wells can be vacuumed with one truck.

[1] An impact refers to the non-aqueous pure phase liquid (NAPL) released and surrounding dissolved plume and contaminant vapors. (See EPA 2005)

Liquids and vapors in surrounding soil and groundwater are vacuumed into a well, and travel through the hose into the vacuum truck tank. Vapors captured during the event are subsequently released to the surrounding air, while captured liquids are typically disposed at an appropriate wastewater treatment facility. Other performance monitoring equipment includes liquid and vapor sampling ports, and a phase separator attachment to measure LNAPL recovery.

Typical performance capabilities for LNAPL removal include:

- Vacuums produced at the truck up to 29 inches-mercury.
- Flow rates up to 900 cfm.
- Extraction of water at depths up to 30 feet below ground surface without modifications to the well.
- Typical liquid tank volume of 3000 gallons.

NOTE:

- Using monitoring wells for anything other than their intended purpose (to monitor groundwater quality) is generally discouraged.
- Water or groundwater samples taken during or after shutdown of the system can be used to evaluate system performance, but the samples are not necessarily representative of natural or ambient groundwater conditions.
- If more than four MVE events are proposed for one well, a separate dedicated extraction well (generally 4-inches in diameter) should be installed.
- If a monitoring well is compromised or damaged, it needs to be properly abandoned and replaced per 312 IAC 13.
- Use of MVE for LNAPL recovery is far more common than DNAPL recovery.

Purpose/Objectives for Removal

- To determine the LNAPL recovery rate, volume, and chemical characteristics. LNAPL recovery is the primary objective of MVE.
- To address recent releases and mitigate the migration of mobile LNAPL or dissolved contaminants. Recent releases include leaks or spills from LNAPL system tanks, piping, or other equipment during operation or after tank system removal.

Purpose/Objectives for Pilot Test

- To determine zones of extraction influence: These zones include vacuum influence above the saturated zone, as well as groundwater influence in the saturated zone.

- To assess the feasibility of full-scale MPE technology or other technologies, and assist with the design of full scale systems.
- To re-evaluate or update the conceptual site model (CSM).

Performance Parameters for Pilot Test

The objectives can be evaluated using performance parameters. The MVE event should include sampling or field readings at various times, including prior to operation (time zero), several times during operation, and just prior to shutdown. Post shutdown field readings or water grab samples can also be collected. Results should be presented in the following or equivalent data tables:

NOTE:

- Summary tables should be created for driving contaminants, whereas comprehensive tables for other measured chemicals can be separated and submitted as an attachment. For example, typical driving contaminants for petroleum are benzene, naphthalene, and MTBE, since they often have concentrations significantly above screening levels.
- Columns and rows can be reversed, and data can be combined into one or two tables as applicable.

Each extraction well:

- The table should include columns for time (hrs.), extraction point depth, groundwater depth, and vacuum levels. If sampling or monitoring equipment is available, include a vapor field screening reading, and total mass removed.
- Include groundwater data prior to starting system operation (at time zero).

Above ground system:

- The table should include columns for time (hrs.), vacuum levels, product removed (pure phase), each driving contaminant concentration for vapors and for influent water, vapor mass removed, water mass removed, and total mass removed.
- Measure vapor at an influent point and exit stack.

Monitoring points, such as monitoring wells, piezometers, soil gas points:

- The table should include columns for time (hrs.), screen interval, groundwater depth, product thickness, vacuum levels, and each driving groundwater and vapor contaminant.
- Prior to start-up, measurements should be taken (at time zero).

NOTE: Emulsions - In cases where emulsions (NAPL emulsions) form from the high velocity created by the pump, especially in diesel fuel applications, NAPL volumes can be estimated based on the concentration of the NAPL present in the emulsion. (USACE 1999, Keet 1995) Emulsions can be analyzed using the following methods:

- Method 5520-B 2001, Standard Methods for the Examination of Water and Wastewater, 22nd Edition.
- EPA Method 1664, Revision B; Environmental Protection Agency, February 2010.

General Limitations

If an MVE event uses a monitoring well, MVE performance monitoring can be conducted prior to and after an event. Commonly, at least 30 days should be allowed before water quality samples are collected to evaluate ambient conditions.

MVE is not likely to be justified with immobile petroleum impacts. The extent of most petroleum related releases will stabilize within approximately five years. A stable impact may not require mass removal to meet closure objectives. Establishing a threshold LNAPL transmissivity value at the outset of the LNAPL recovery action may be used as a trigger for stopping LNAPL recovery. LNAPL recovery is likely ineffective if the LNAPL transmissivity is less than 0.1 ft^2/day (ITRC 2009).

Limitations for Pilot Test

EPA recommends MPE technology (MVE) for soils with hydraulic conductivities between 10^{-3} to 10^{-5} cm/sec (EPA 2005). Consequently, MVE is not recommended for impacts in silty-clay or clay soils, since these soils typically have conductivities less than 10^{-5} cm/sec.

USACE also states, “Recent research, including results from several USACE pilot tests, indicates that silty-clay and clay soils will resist undergoing any significant desaturation during MPE.” (USACE 1999).

Permitting

Use of MVE assumes that all applicable permits are obtained. Also, all discharges must be appropriately monitored for regulatory compliance, and treated when the effluent or emissions would exceed permitted standards.

Further Information

If you have any additional information regarding *MVE* or any questions about the evaluation, please contact the Office of Land Quality, Science Services Branch at (317) 232-3215. IDEM TEG will update this technical guidance document periodically or on receipt of new information.

References:

EPA, A Decision-Making Framework for Cleanup of Sites Impacted with Light Non-Aqueous Phase Liquids (LNAPL), 2005.

EPA, Multi-Phase Extraction: State-of-the-Practice, EPA 542-R-99-004, June 1999 clu-in.org.

EPA/600/R-96/031 Engineering Design of Free Product Recovery Systems, 1996.

USACE, Engineering and Design: Multi-Phase Extraction
1999. U.S. Army Corps of Engineers. EM 1110-1-4010, 285 pp.

ITRC, Evaluating LNAPL Remedial Technologies for Achieving Project Goals, 2009.

Ecovac Services: http://www.ecovacservices.com/Mobile-Dual-Phase-Extraction-EFR--Enhanced-Fluid-Recovery-6-5249.html

Chemviron Midwest:
http://www.cesremediation.com/pdf/Chemviron%20Brochure%20101816.pdf

Keet, B.A. 1995. Bioslurping State of the Art. pp. 329-344. In: Hinchee, R.E., Kittel, J.A. and Reisinger, H.J. (Eds.) Applied Bioremediation of Petroleum Hydrocarbons. Battelle Press, Columbus, OH.

Method 5520-B, Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Water Works Association, Water Environment Federation, 22nd Edition, 2012.

EPA Method 1664, Revision B: n-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry, February 2010.