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Remediation and Institutional Controls as Vapor Intrusion Mitigation

ITRC has developed a series of fact sheets that summarizes the latest science, engineering, and technologies regarding vapor intrusion (VI) mitigation. This fact sheet describes:

- the use of remediation systems and institutional controls (ICs) as a means of VI mitigation
- differences between remediation and mitigation
- various remediation methods that can serve as VI mitigation
- benefits and disadvantages of ICs and remediation as mitigation
- additional considerations for assessing the impact of remediation on VI mitigation

1 INTRODUCTION

VI describes the migration of volatile chemicals from the subsurface into overlying buildings. When the resulting indoor air concentrations of these chemicals exceed levels of concern, vapor control strategies can include environmental remediation, building mitigation, or ICs (ITRC, 2007a).

VI mitigation includes actions that prevent or limit the exposure of the building occupants to the intruding vapors. VI mitigation has become a significant environmental issue for regulators, potentially responsible parties, and concerned citizens.

In some instances, environmental technologies designed for source remediation can also serve as VI mitigation. ICs can also provide protection and serve as an administrative assurance for mitigation of a known or potential VI concern. This guidance will help the reader evaluate the applicability of environmental remediation and ICs as means of VI mitigation.

The following ITRC technology information sheets discuss in more detail technologies presented in this fact sheet:

- ***Soil vapor extraction (SVE) Technology Information Sheet***
- ***Multiphase extraction (MPE) Technology Information Sheet***
- ***Institutional controls (ICs) Technology Information Sheet***

2 MITIGATION VS. REMEDIATION

Some VI investigations will indicate that corrective actions should be taken to reduce the indoor air concentrations to acceptable levels. “Remediation” commonly refers to an action that reduces the level of contamination in the environmental medium (e.g., groundwater) that is acting as the source of the volatile organic compounds (VOCs) in indoor air. “Mitigation,” on the other hand, is generally applied to actions that prevent or limit exposure.

VI mitigation is aimed at eliminating or reducing human exposure to impacted indoor air due to contaminated subsurface soil vapors. VI mitigation selection typically relies on methods that eliminate or reduce the migration of vapors from the subsurface to indoor air (e.g., sub-slab depressurization, building pressurization, vapor barrier, or slab reinforcement), or that treat (e.g., indoor air purifiers, increased ventilation) vapors already inside a structure. VI mitigation is typically a building-specific measure implemented within a relatively short time frame (e.g., immediately for acute exposure risk, weeks to months for chronic exposure risk).

Environmental remediation is aimed at reducing source area concentrations to below response action levels. However, it can also serve as VI mitigation. Examples of common remediation technologies that could serve as VI mitigation include soil vapor extraction (SVE) and multiphase extraction (MPE). Remediation performance metrics and site closure are based on achieving soil or groundwater cleanup goals, and remediation of VI sources generally requires more extensive investigation, design, and regulatory activities than VI mitigation. Consequently, the implementation of remediation is typically over a longer time frame (e.g., months or years).

3 REMEDIATION AS VI MITIGATION

For remediation to serve dually as VI mitigation and site cleanup, it must accomplish the same objective as a dedicated VI mitigation system, which is to rapidly reduce concentrations of the constituents of concern (COCs) in indoor air below the applicable regulatory levels. Remediation technologies that potentially can serve this purpose include SVE and MPE. An overview of each of these technologies is presented below; the main features are summarized in Table 3-1. Additional information can be found in the accompanying ***Soil Vapor Extraction Technology Information Sheet*** and ***Multiphase Extraction (MPE) Technology Information Sheet***.

Table 3-1. Remediation technologies that can serve as VI mitigation.

Remediation Technology	Site Type				COC Type		
	Basement		Scale				
	Wet	Dry	Single Structure	Site-wide	Volatile Chlorinated Hydrocarbons	Volatile Petroleum Hydrocarbons	Methane
SVE		✓	✓	✓	✓	✓	✓
MPE	✓	✓	✓	✓	✓	✓	✓

3.1 SVE

SVE is a remediation technology that relies on the extraction of soil vapor to reduce or eliminate the source of VOCs in the subsurface (see Figure 3-1). The soil vapor is extracted by creating low pressure in the subsurface by means of extraction wells or trenches connected to blowers. SVE can provide VI mitigation as long as the system intercepts soil vapors before they reach the building or creates a negative pressure below the building. SVE is directly applicable as a method of VI mitigation for relatively small sites, such as a single building, where it can be installed relatively quickly. SVE can also be effective as VI mitigation at larger sites; however, the implementation is longer than the VI mitigation timeframe typically required by regulatory agencies. A temporary VI mitigation system may need to be installed while a large SVE system is being constructed. See ***ITRC fact sheets*** for more information on VI mitigation approaches.

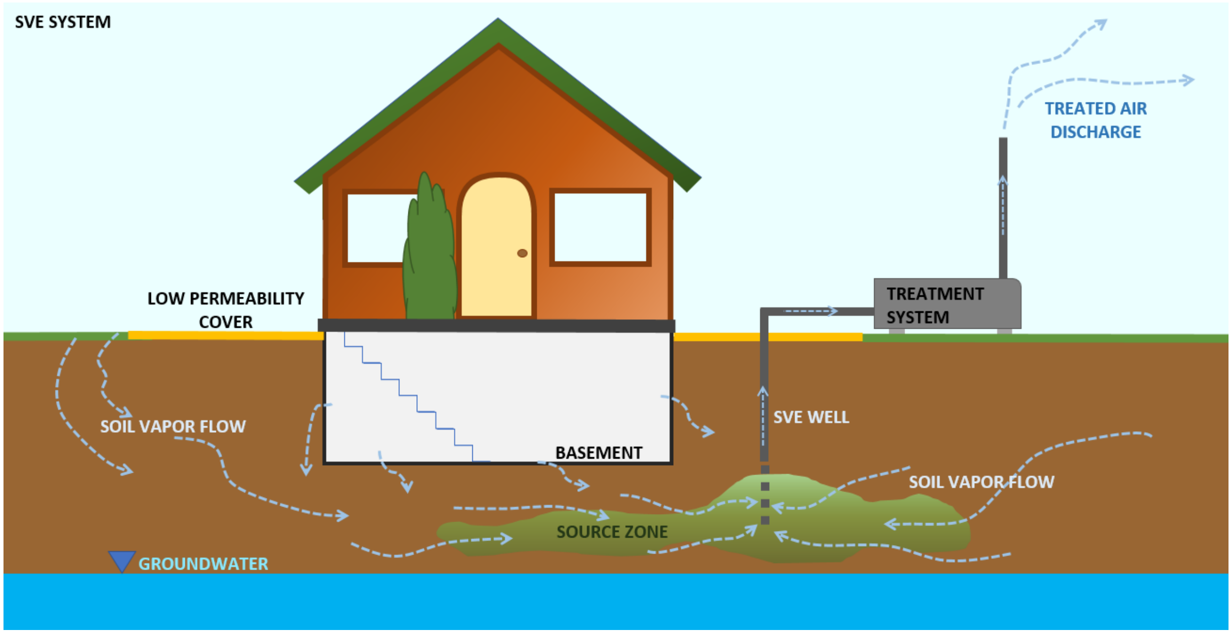

Figure 3-1. Conceptualization of a soil vapor extraction system. (Source: Laura Trozzolo, used with permission.)

3.2 MPE

MPE is a remediation technology that relies on the extraction of both liquids (groundwater and free product) and soil vapor to reduce or eliminate the source of VOCs in the subsurface (see Figure 3-2). The soil vapor is extracted by creating low pressure in the subsurface using extraction wells or trenches connected to suction. During MPE the thickness of the unsaturated zone is increased by depressing the water table through groundwater extraction to enhance the recovery of soil vapor. VOCs in the induced unsaturated zone undergo volatilization from the source material and are removed with the extracted soil vapor. VOCs in the saturated zone are recovered with the extracted liquid, which must be managed in accordance with applicable federal, state, or local laws and regulations. MPE can provide VI mitigation if the system intercepts soil vapors before they reach the building or creates a negative pressure below the building. MPE is directly applicable as a method of VI mitigation for relatively small sites. At larger sites, the implementation is longer than the VI mitigation timeframe typically required by regulatory agencies. A temporary VI mitigation system may need to be installed while a large MPE is being constructed.

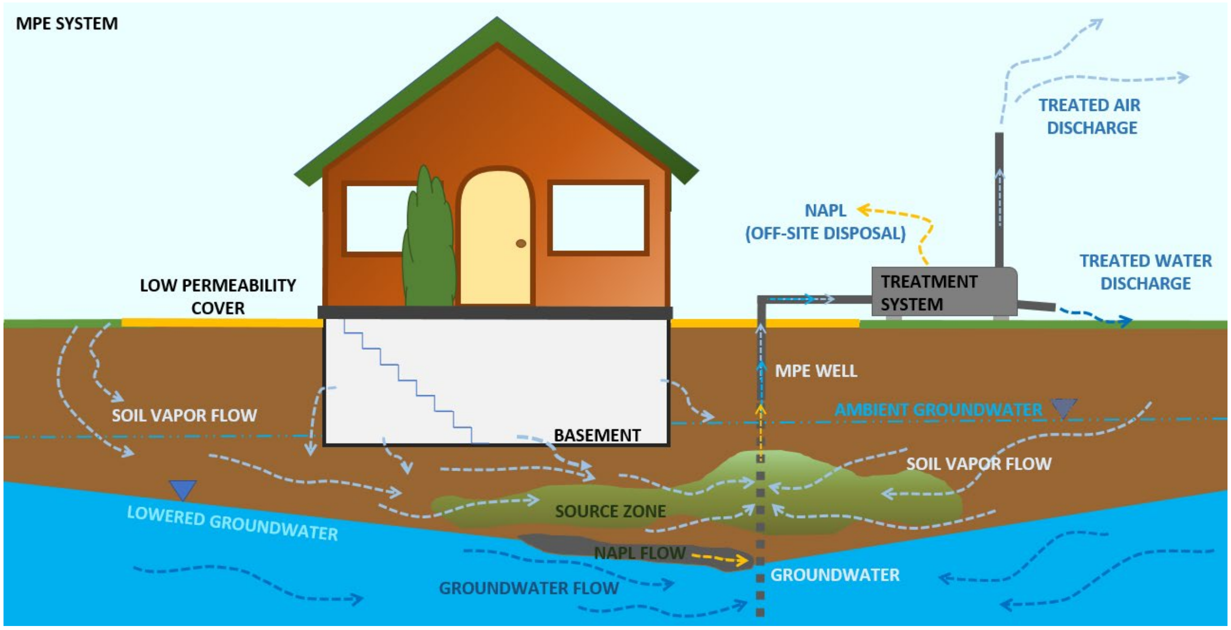

Figure 3-2. Conceptualization of a multiphase extraction system. (Source: Laura Trozzolo, used with permission.)

4 INSTITUTIONAL CONTROLS AS VI MITIGATION

ICs are a form of land use controls that provide protection from exposure to site-related contaminants. While ICs consist of administrative or legal restrictions on a site, land use controls can also use physical measures, which are called engineering controls or ECs (e.g., physical barriers). In contrast to ECs, ICs are primarily government controls, proprietary controls (e.g., deed restrictions), enforcement or permit mechanisms, and informational devices. Planning that protects human health and the environment and uses all aspects of an IC life cycle (ITRC, 2016) is essential for long-term success (e.g., a long-term stewardship plan). As it relates to the VI pathway, ICs can be applied as a stand-alone remedy (for undeveloped lands or restricted use on developed land), as part of an overall remedy selection, or as a mechanism that requires ongoing monitoring and maintenance of the mitigation system. More details are provided in the accompanying ***Institutional Controls*** Technology Information Sheet.

For further information on the various types of ICs, also refer to ITRC's Long-term Contaminant Management Using Institutional Controls (ITRC, 2016).

5 ADVANTAGES AND DISADVANTAGES OF REMEDIATION AND INSTITUTIONAL CONTROL AS VI MITIGATION

The advantages and disadvantages of environmental remediation and/or ICs as VI mitigation should be assessed on a site-specific basis. Several advantages and disadvantages of these methods are listed below:

5.1 Advantages

- Remediation may be less intrusive than mitigation and can avoid inconvenience to residents and businesses.
- Remediation can reduce the length of time required for mitigation by eliminating the source of impacts.
- Remediation can lessen or eliminate future on-site or off-site impacts and liability.
- ICs ensure that the VI exposure pathway is addressed in the future for undeveloped lands or buildings that have a change in use or zoning.
- ICs can limit or prevent human exposure when site-wide remedies are not immediately effective in eliminating VI.

5.2 Disadvantages

- Implementation time is longer for remediation; consequently, only relatively small remediation systems (prebuilt or made with off-the-shelf components) that can be implemented rapidly can serve as VI mitigation.
- Remediation requires more specialized installation and greater costs than typical VI mitigation systems.
- Remediation operation and maintenance requirements are typically more complex than mitigation systems and need to be addressed by an appropriately qualified consultant.
- An additional treatment system for extracted soil gas and/or groundwater may be necessary in a remediation system in accordance with applicable federal, state, or local laws and regulations.
- ICs may be difficult to implement and enforce over time.
- ICs may limit or prevent future development activities.

6 OTHER CONSIDERATIONS

Some types of remediation, while not directly employed with the intent to affect the soil vapor, may influence the operation of the existing or future VI mitigation systems. Some examples include:

- addressing the source of VI impacts, such as contaminated soils, nonaqueous phase liquid, or groundwater, may result in the improvement of soil vapor quality and reduction of the time frame when VI mitigation needs to be conducted (e.g., excavation, sparging, in situ treatment, hydraulic containment)
- performing remediation using technologies that result in the generation of emissions or altering of the soil vapor flow patterns may require that VI mitigation be applied to previously unaffected areas (e.g., sparging, in situ chemical treatment, thermal treatment)

Due to the potential threat/liability posed by identified, ongoing VOC sources, regulatory agencies may request that:

- interim measures be implemented before completion of typical VI mitigation systems

- remedial actions be taken at undeveloped land or unoccupied buildings, prior to implementing VI mitigation at new construction or re-occupancy of existing buildings
- remediation be performed independently of the VI mitigation

7 OCCUPANT, COMMUNITY, AND STAKEHOLDER CONSIDERATIONS

Carefully designed public outreach is an essential part of any aspect of the VI mitigation. This includes ICs, including informational devices, and remedial actions. ICs may be established to ensure the occupants, owners, and managers are informed and involved as partners in the long-term management of mitigation systems and, if necessary, monitoring of the affected building. See ITRC's ***Public Outreach during Vapor Intrusion Mitigation Fact Sheet*** for more information.

8 REFERENCES AND ACRONYMS

The ITRC VI Mitigation Training web page includes lists of acronyms, a full glossary, and combined references for the fact sheets. The user is encouraged to visit the ITRC VI Mitigation Training web page to access each fact sheet and supplementary information and the most up-to-date source of information on this topic.