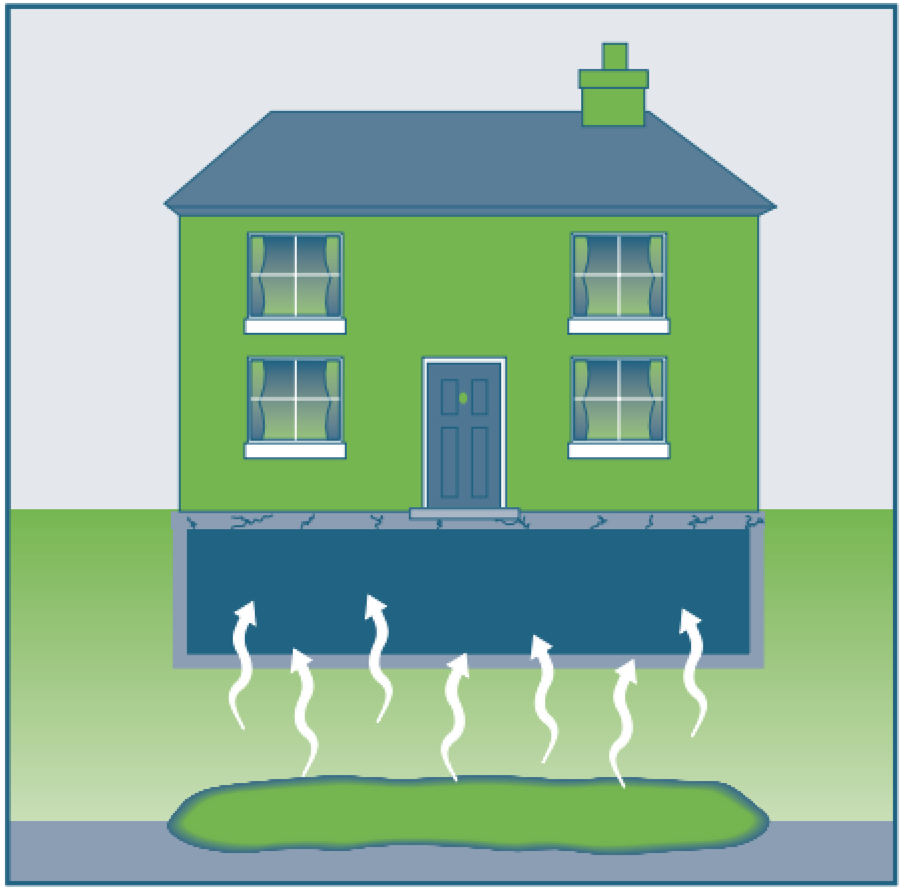
Starting Soon: VIM Session 2

- ITRC Resources:
  https://itrcweb.org/vapor-intrusion-toolkit

- CLU-IN Training Page (slides available):
  www.clu-in.org/conf/itrc/vim-1/



Housekeeping

- This event is being recorded; Event will be available On Demand after the event at the main training page: www.clu-in.org/conf/itrc/vim-1/

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Vapor Intrusion Mitigation – A Two-Part Series Training

2026 ITRC Vapor Intrusion Toolkit

Sponsored by: Interstate Technology and Regulatory Council (www.itrcweb.org)
Hosted by: US EPA Clean Up Information Network (www.clu-in.org)

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ITRC Vapor Intrusion Toolkit

- Compiled ITRC VI guidance into new updated toolkit
  - Vapor Intrusion Pathway: A Practical Guidance (VI-1, 2007)
  - Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management (PVI-1, 2014)
  - Technical Resources for Vapor Mitigation Training (VIM-1, 2021)
- Toolkit provides best practices and most defensible approaches to support VI data driven decision making

Today's Training Topics

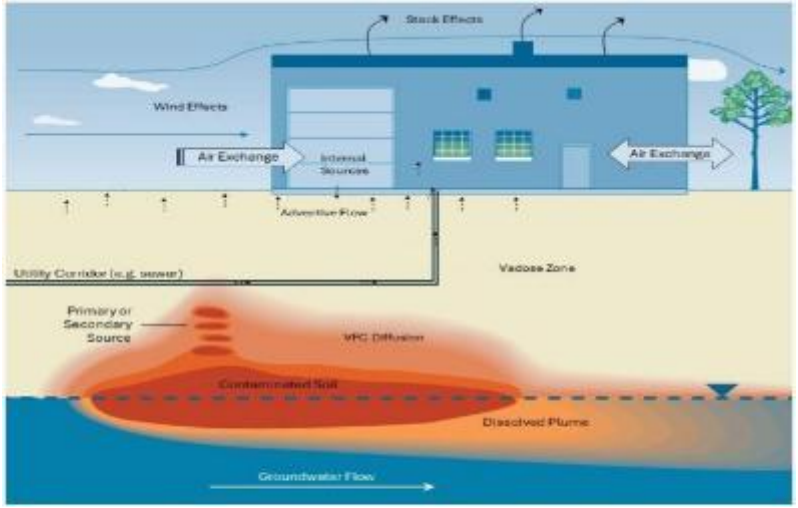
VIM Session 1

- Introduction
- Conceptual Site Model for VI Mitigation
- Community Engagement for VI Mitigation
- Rapid Response and Ventilation
- Remediation and Institutional Controls
- Active Mitigation Approaches
- Passive Mitigation Approaches
- System Verification, OM&M, Curtailment and Shutdown
- Closing

VIM Session 2

Vapor Intrusion (VI) Reminder

- Contaminants in soil and groundwater can volatilize into soil vapor.
- VI occurs when these vapors migrate upward into overlying buildings and contaminate indoor air.
- VI addresses vapor-forming chemicals (VFCs) including volatile organic chemicals, semi-volatile organic chemicals, pesticide compounds, elemental mercury, and Per- and Polyfluoroalkyl substances.
- Petroleum Vapor Intrusion (PVI) is a subset of VI that deals exclusively with petroleum hydrocarbon contaminants.

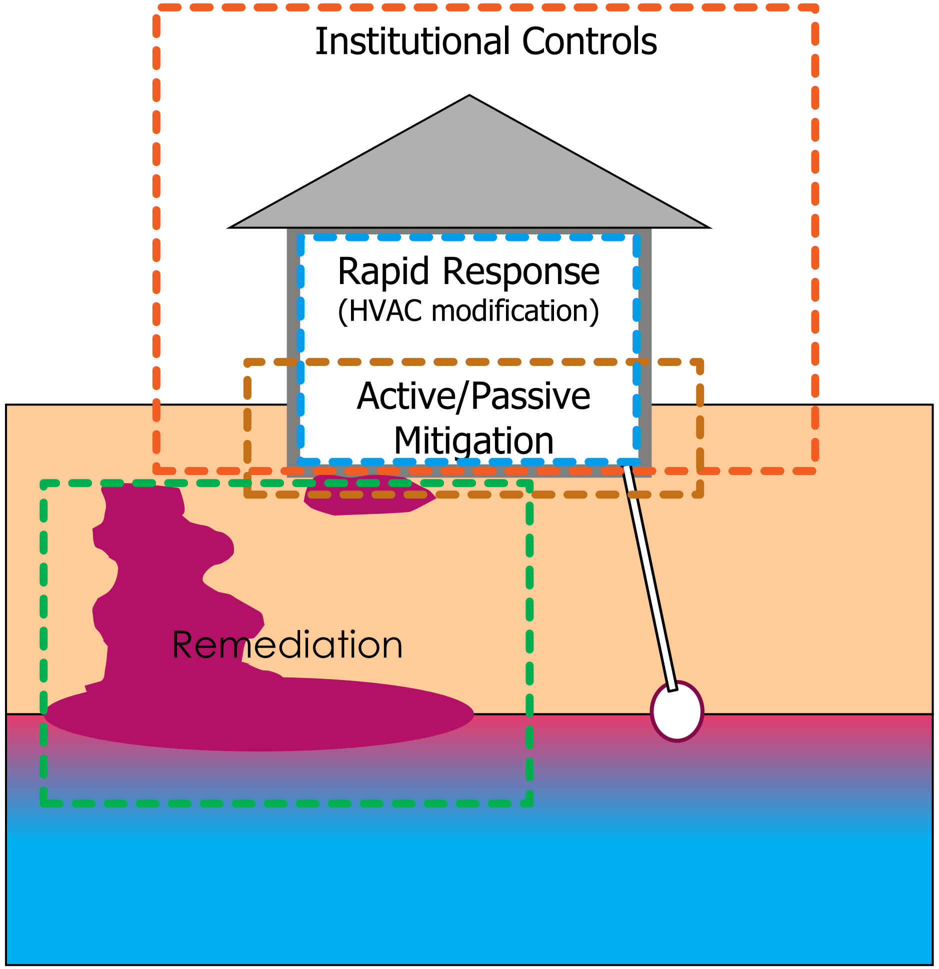


Source: ITRC Vapor Intrusion Toolkit Guidance (VIT-1, 2026)

Source: ITRC Petroleum Vapor Intrusion Guidance (PVI-1, 2014)

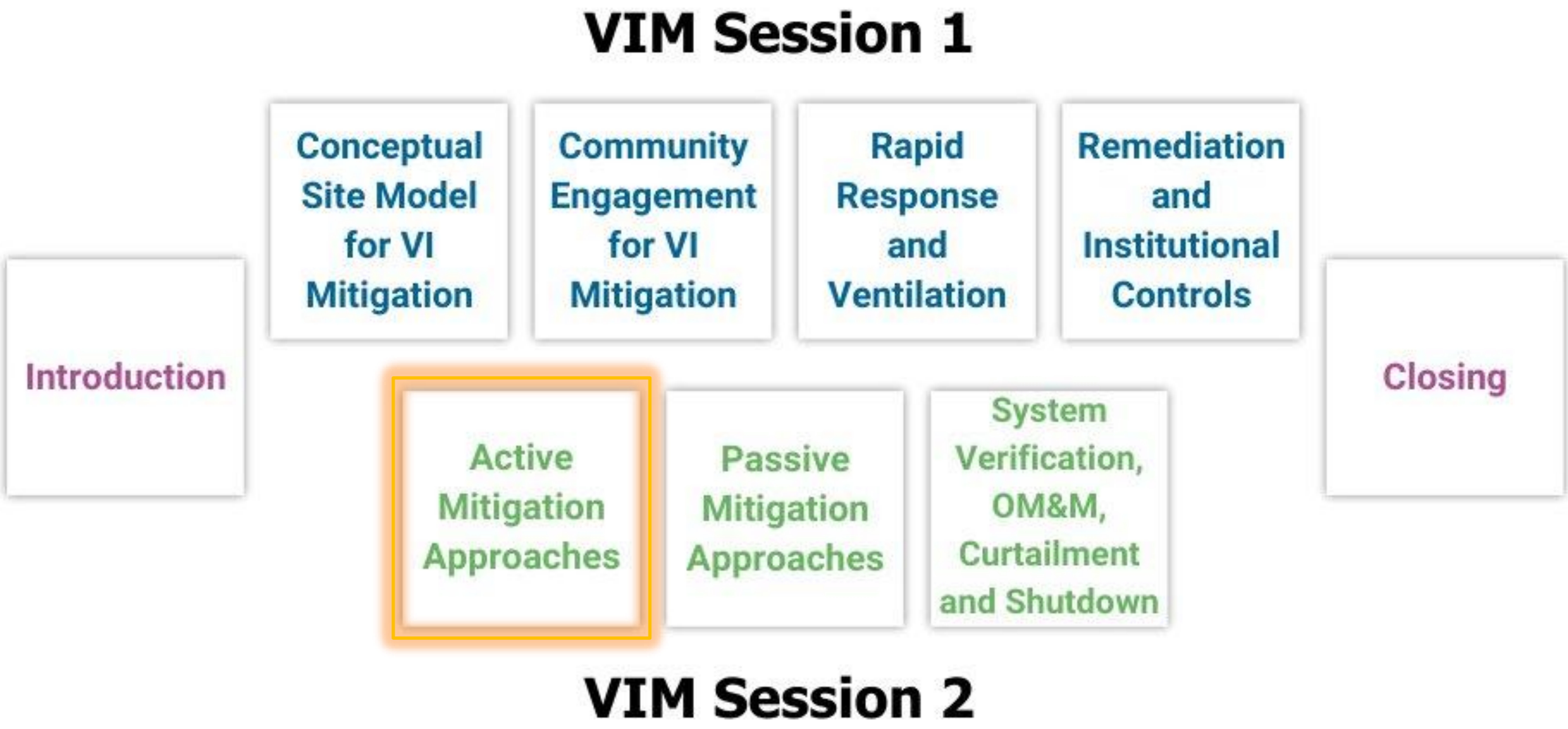
What is VI Mitigation (or Vapor Control)?

- VFC Vapor control can include
  - Source remediation (Session 1)
  - Rapid response (Session 1)
  - Institutional controls (Session 1)
  - Active or passive mitigation (Session 2)



Source: Geosyntec & GSI Environmental, 2020. Used with permission.

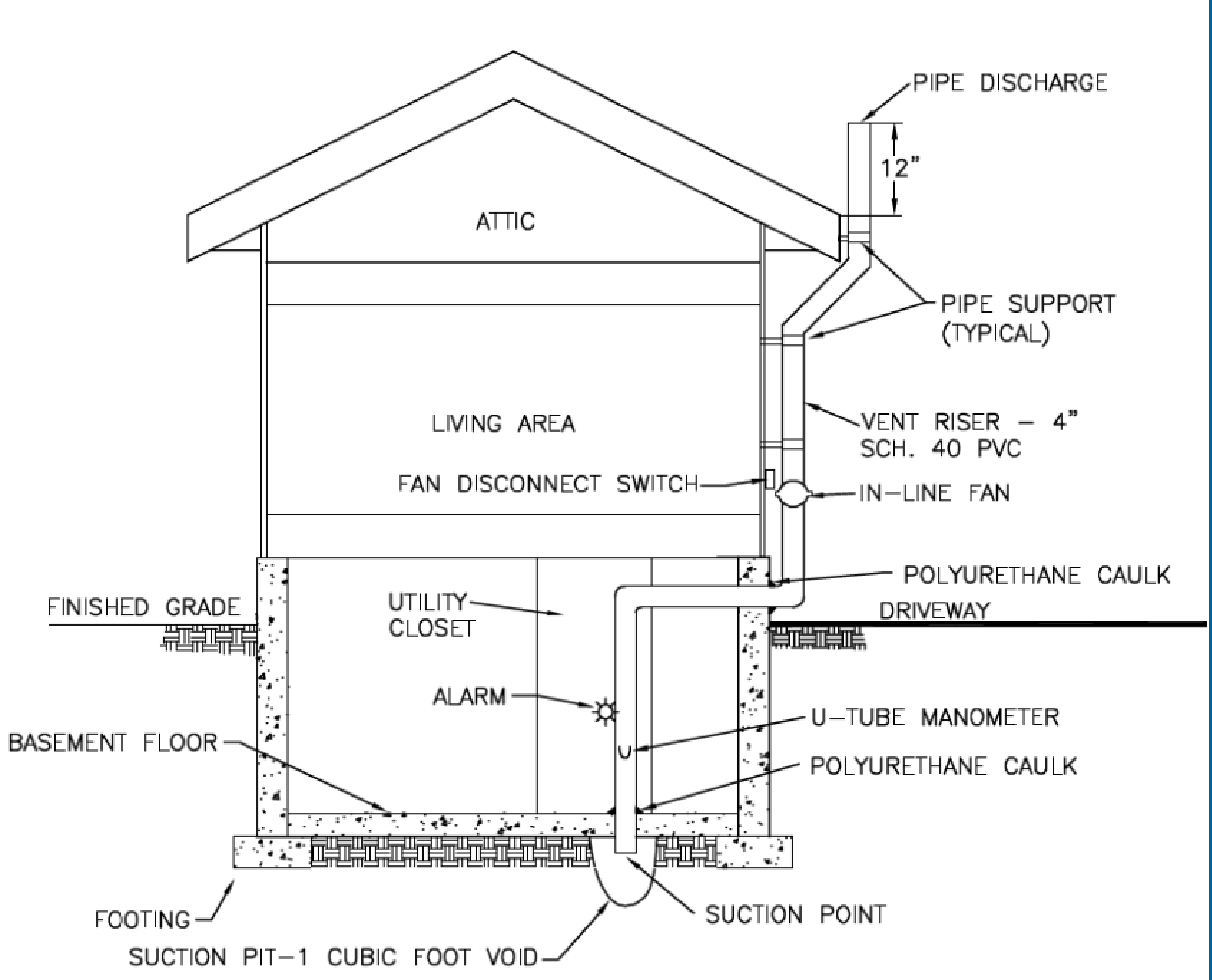
Coming Up Next…



Q&A Session to be conducted after each module

Active Mitigation Approaches

- Active mitigation definition
- Technology overview
- Design considerations

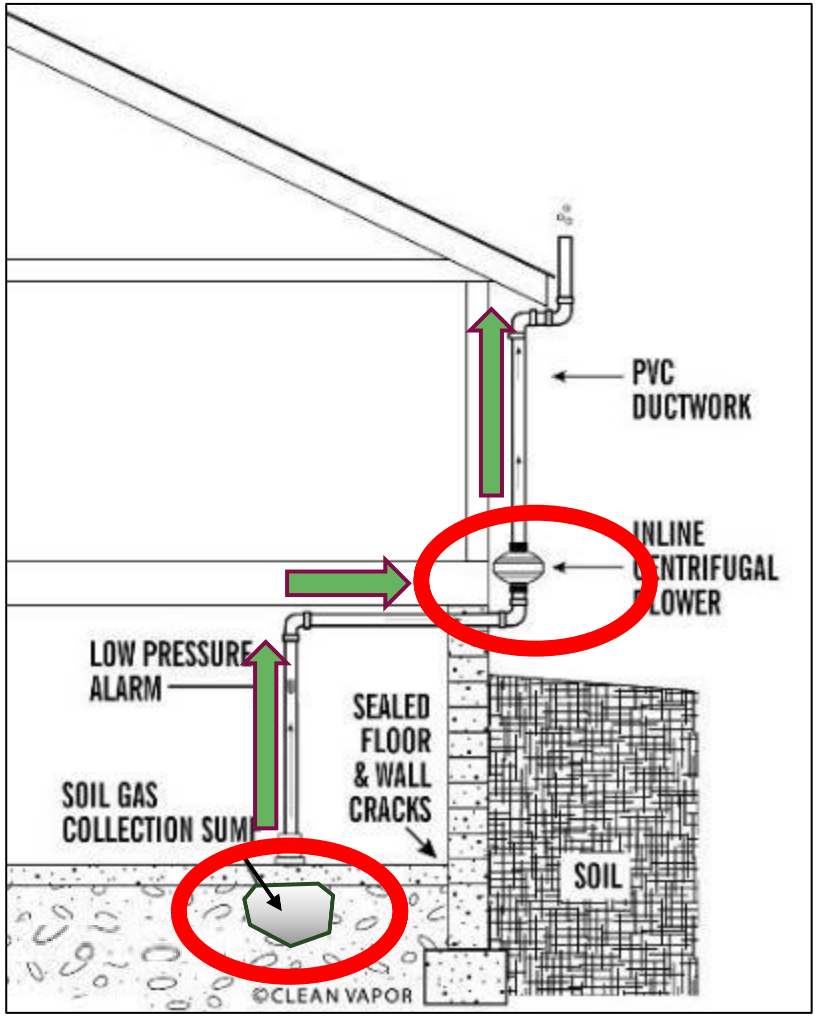


Source: Arcadis, 2025. Used with permission.

What is Active Mitigation?

- Continuous interception, dilution, diversion of soil gas
- Mechanized features (e.g., fan)
- Quantifiable data, may include
  - Vacuum
  - Flow rate
  - Mass flux
  - Differential pressure (ΔP)
  - Reduction in sub-slab vapor concentration

Sub-slab Depressurization (SSD) Technology Information Sheet



Source: Clean Vapor, LLC, adapted from USEPA (1993), used with permission.

Active Mitigation Fact Sheet

- Overview for work products
- Most common active mitigation approaches:
  - Sub-Slab Depressurization (SSD)
  - Sub-Slab Venting (SSV)
  - Sub-Membrane Depressurization (SMD)
  - Crawl Space Ventilation (CSV)
  - Void Space Systems (VSS)
- References ANSI/AASRT standards

ACTIVE VAPOR INTRUSION MITIGATION SYSTEMS FACT SHEET

Active Mitigation Types

This fact sheet includes a brief description of five of the most common types of active vapor intrusion mitigation systems (VIMS). Each system is also described in a supporting technology information sheet as follows:

- Aerated Floors Void Space Systems (VSS)—see Aerated Floor Void Space Systems Technology Information Sheet
- Crawl-Space Ventilation (CSV)—see Crawl-Space Ventilation Technology Information Sheet
- Sub-Membrane Depressurization (SMD)—see Sub-Membrane Depressurization Technology Information Sheet
- Sub-Slab Depressurization (SSD)—see Sub-Slab Depressurization Technology Information Sheet
- Sub-Slab Ventilation (SSV)—see Sub-Slab Ventilation Technology Information Sheet

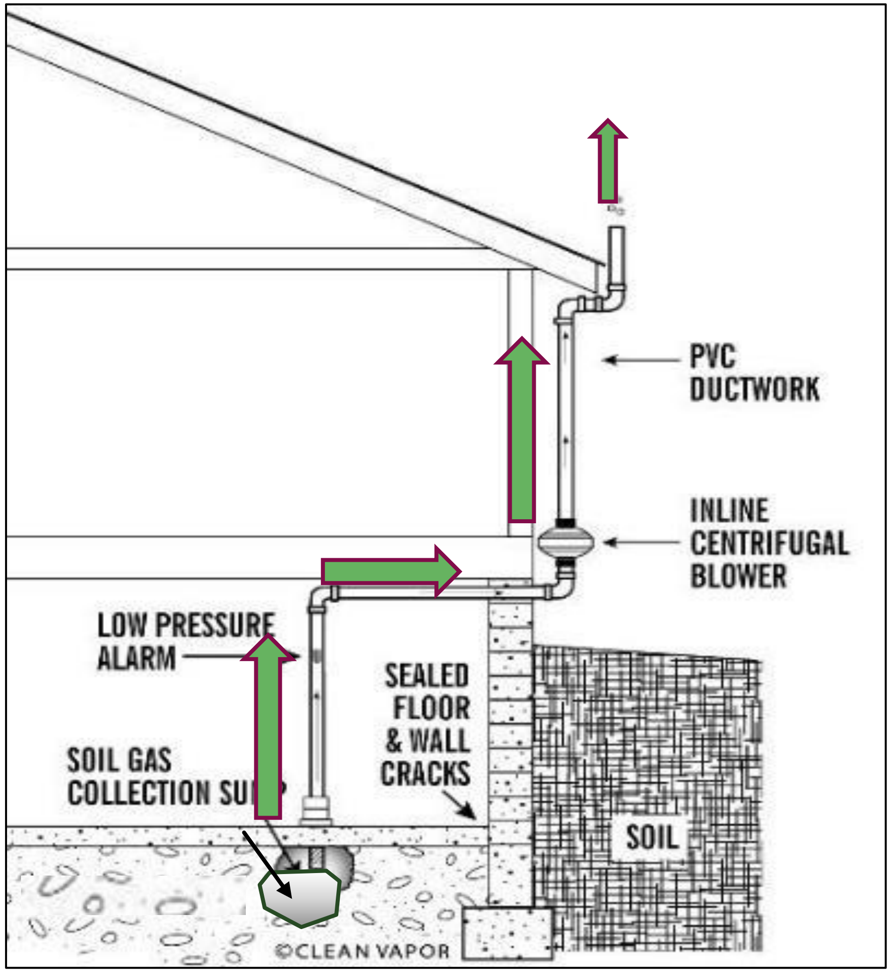
In addition to or in conjunction with the five types of active VIMS noted above, the following active VIMS approaches may be used to assist in addressing vapor intrusion (VI) risk. These methods may be used for temporary mitigation or rapid response mitigation, or in building-specific situations where the main methods (SSD, SSV, SMD, or CSV) may not be effective or may not be effective on their own. Some of these technologies are described in other technology information sheets, which are referenced below:

- Indoor air filtration—see the Indoor Air Treatment Technology Information Sheet and the U.S. Environmental Protection Agency's (USEPA's) *Adsorption-based Treatment Systems for Removing Chemical Vapors from Indoor Air* (Schumacher et al. 2017).
- Aerobic Vapor Migration Barriers (AVMB)—see the Aerobic Vapor Mitigation Barrier Technology Information Sheet.

Tech Sheet – Sub-Slab Depressurization (SSD)

- Negative pressure in sub-slab relative to indoor
- Fan pulls vapor away from the slab and out riser pipe
- Flushing of sub-slab reduces vapor concentrations

[Sub-slab Depressurization (SSD) Technology Information Sheet]

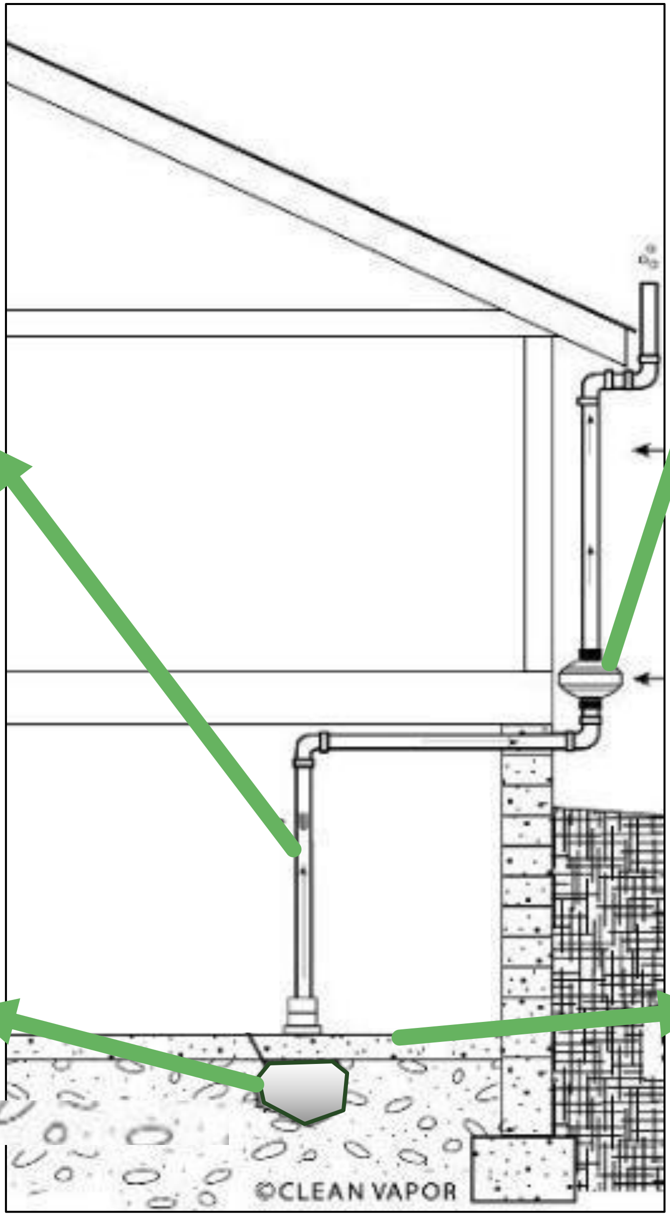


Source: Clean Vapor, LLC, adapted from USEPA (1993), used with permission.

Tech Sheet – SSD Primary Components

Suction Point Riser

Source: Arcadis



Fans/Blowers

Source: Arcadis

Source: Haley & Aldrich, 2026

Sealing cracks and sumps

Source: Haley & Aldrich, 2026

Source: Arcadis

Suction point

Source: Haley & Aldrich, 2026

Source: Arcadis

Tech Sheet – SSD Additional Components

Flow control valves, sample ports

Source: Haley & Aldrich, 2025. Used with permission

Manometers, gauges, telemetry

Source: Arcadis, 2025. Used with permission.

Sub-slab differential pressure

Source: Arcadis, 2025. Used with permission.

Larger System Equipment

- Air filter
- Makeup air
- Condensate knockout
- Condensate bypass
- Silencer
- Flowmeter
- VFD
- Emission controls
- Intrinsically safe components

Vapor Phase Carbon Units (Example)

Source: Arcadis, 2025. Used with permission.

Tech Sheet – SSD in New Construction Scenario

Advantages

- Higher subgrade material transmissivity
- Fewer riser pipes
- Can design to bridge footings
- Small fans, less electricity usage
- Vapor membranes may be less robust when not used for passive mitigation
- Optional activation of system based on post construction sub-slab data

Source: Clean Vapor, 2020.
Used with permission.

Source: Arcadis, 2025.
Used with permission.

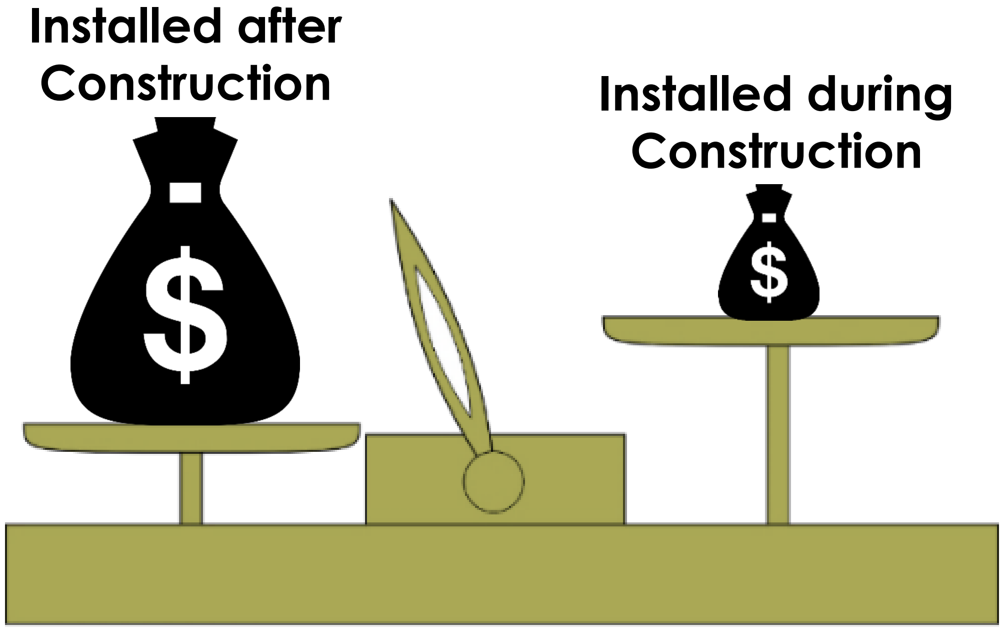
Source: Haley & Aldrich, 2025.
Used with permission.

Tech Sheet – SSD in New Construction Scenario

Positive cost impact during install and operation

- Larger blowers/more blower
- More riser pipes
- Install while facility is occupied

Source: Arcadis, 2025. Used with permission.



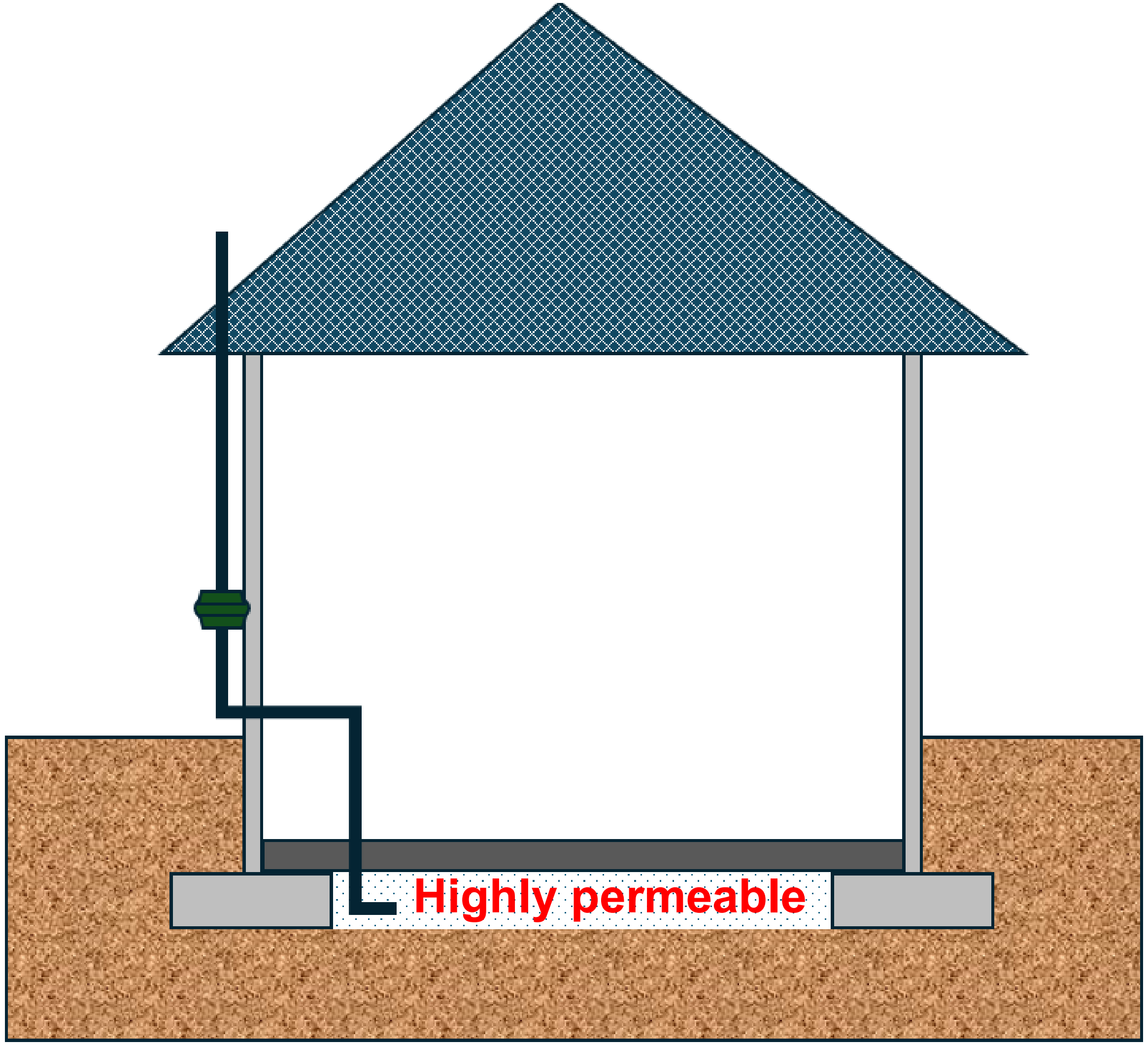
Source: Pixabay (adapted)

- In-line fans
- Fewer riser pipes
- Piping can be installed within walls

Source: Arcadis, 2025. Used with permission.

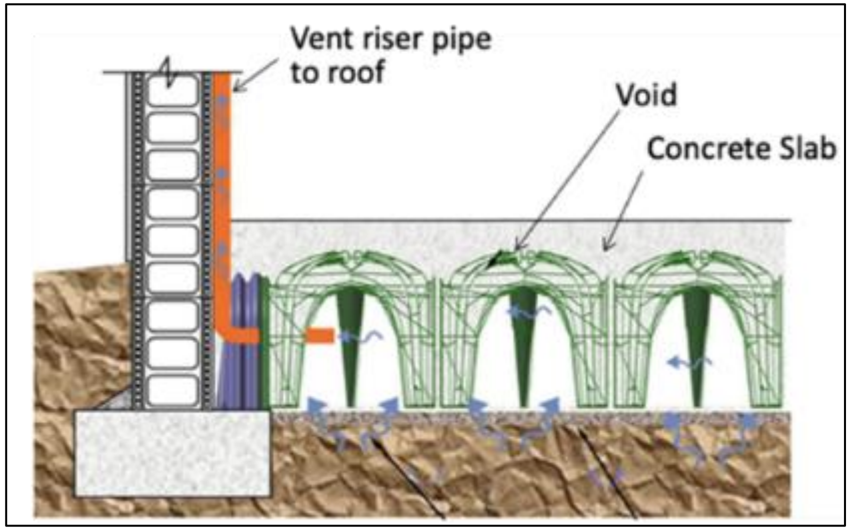
Tech Sheet – Sub-Slab Venting (SSV)

- Similar to SSD
- Air flow reduces sub-slab vapor concentrations
- Sub-slab is high-permeability materials or void spaces
- Performance measurements include
  - **Reduction in sub-slab vapor concentrations**
  - Differential pressure
  - Air flow rate
  - System vacuum
  - Mass flux



Tech Sheet – Aerated Floor/Void Space Systems (VSS)

- New construction, or can be installed over an existing slab
- A unique design component for SSD or SSV
- Continuous void space under slab
- Plastic forms on subgrade prior to concrete slab pour



Source: Cupolex Engineering Solutions, Inc., 2026. Used with permission.

Source: Clean Vapor, 2020. Used with permission.

See: Tech Sheet – Aerated Floor Void Space Systems (VSS)

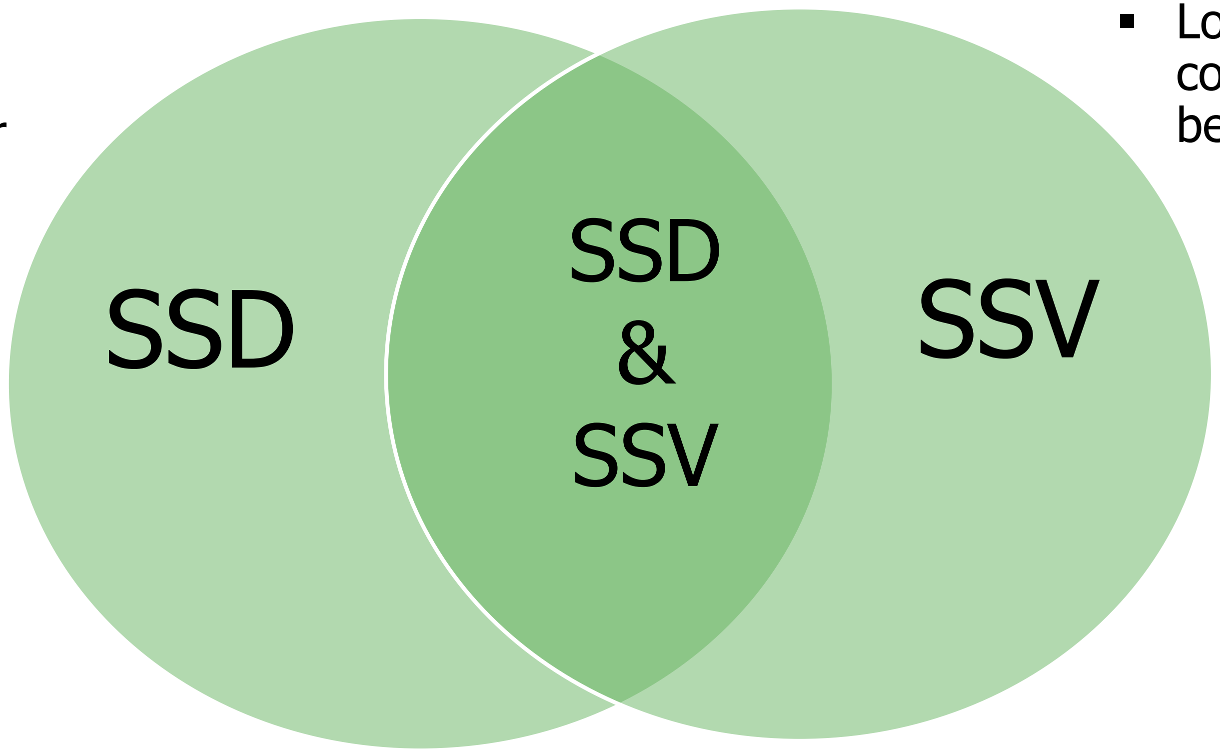
What is the difference between depressurization and venting?

SSD

- Difference in pressure between sub-slab and the indoor air
- Impacted vapors cannot enter indoor air = indoor air below risk thresholds

SSV

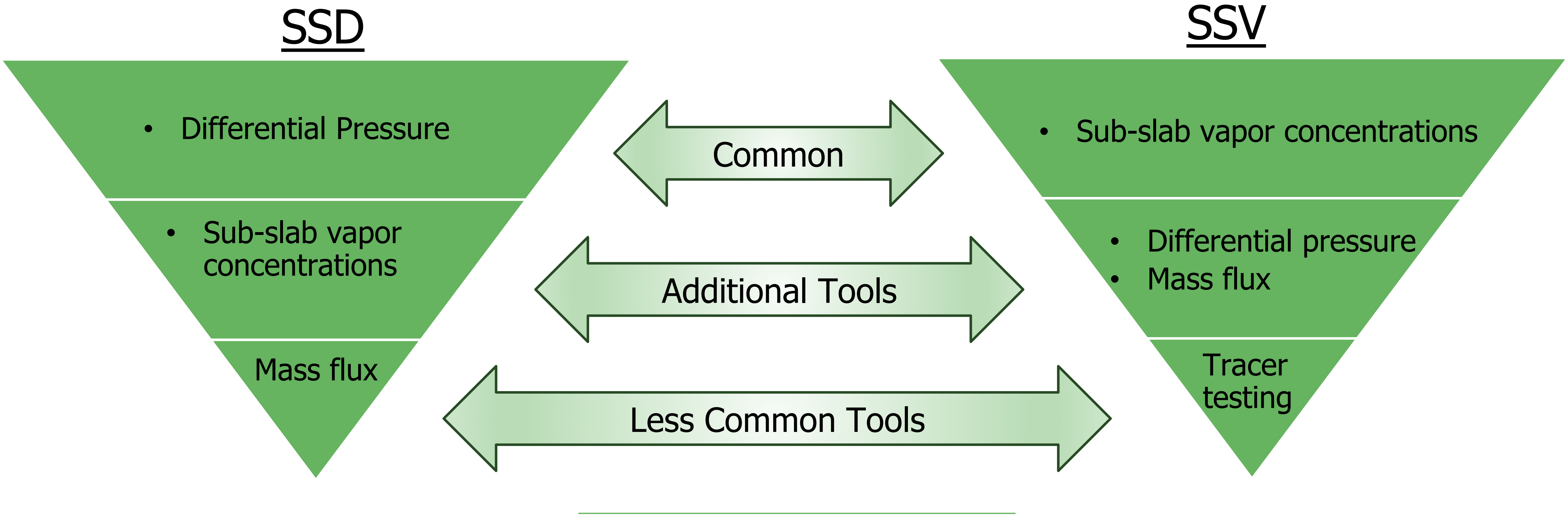
- Air movement to dilute vapor sub-slab concentrations
- Lower sub-slab vapor concentrations = indoor air below risk thresholds



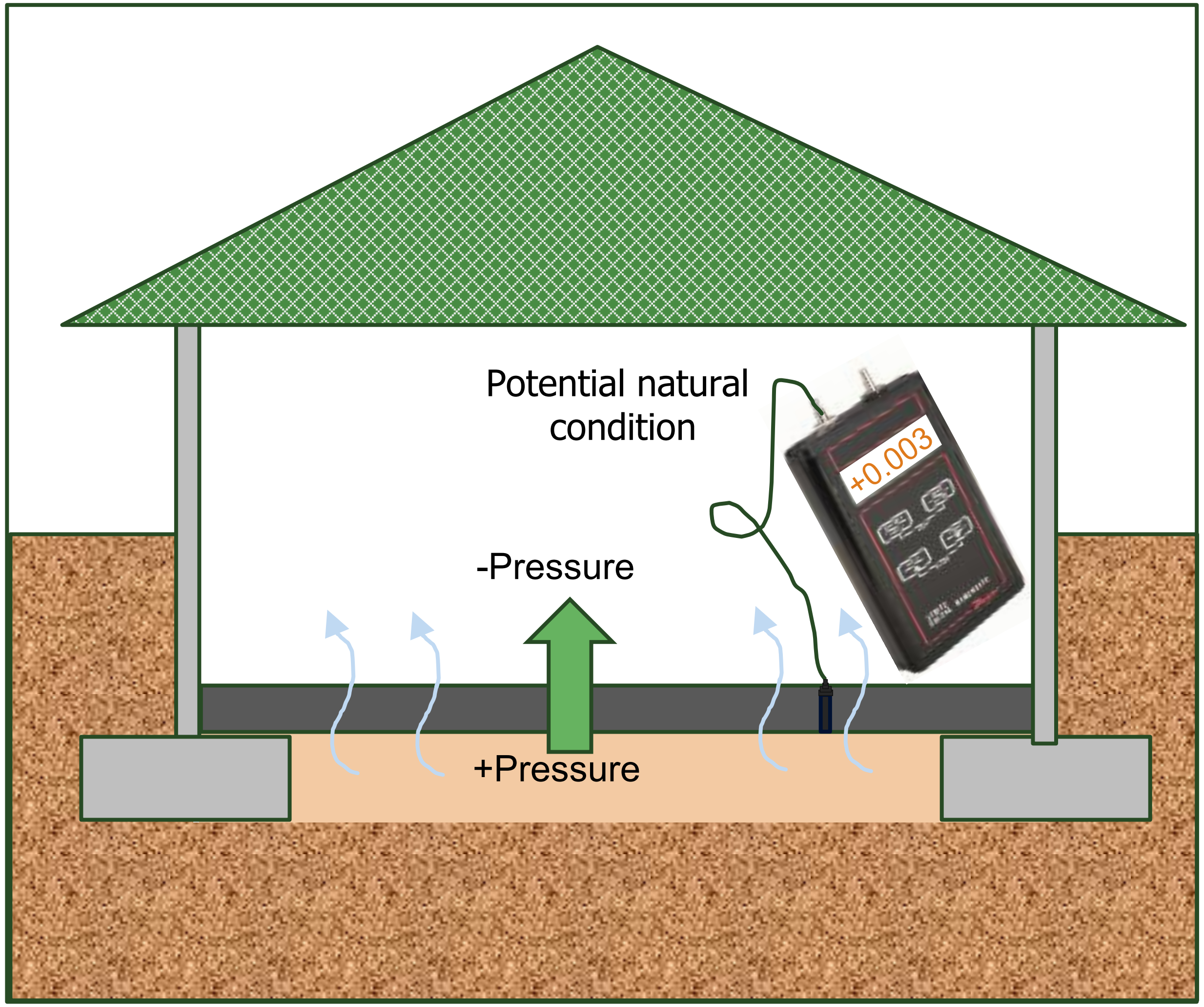
Key Point:
Active VI Mitigation Systems typically benefit from both SSD and SSV!

Performance Metrics

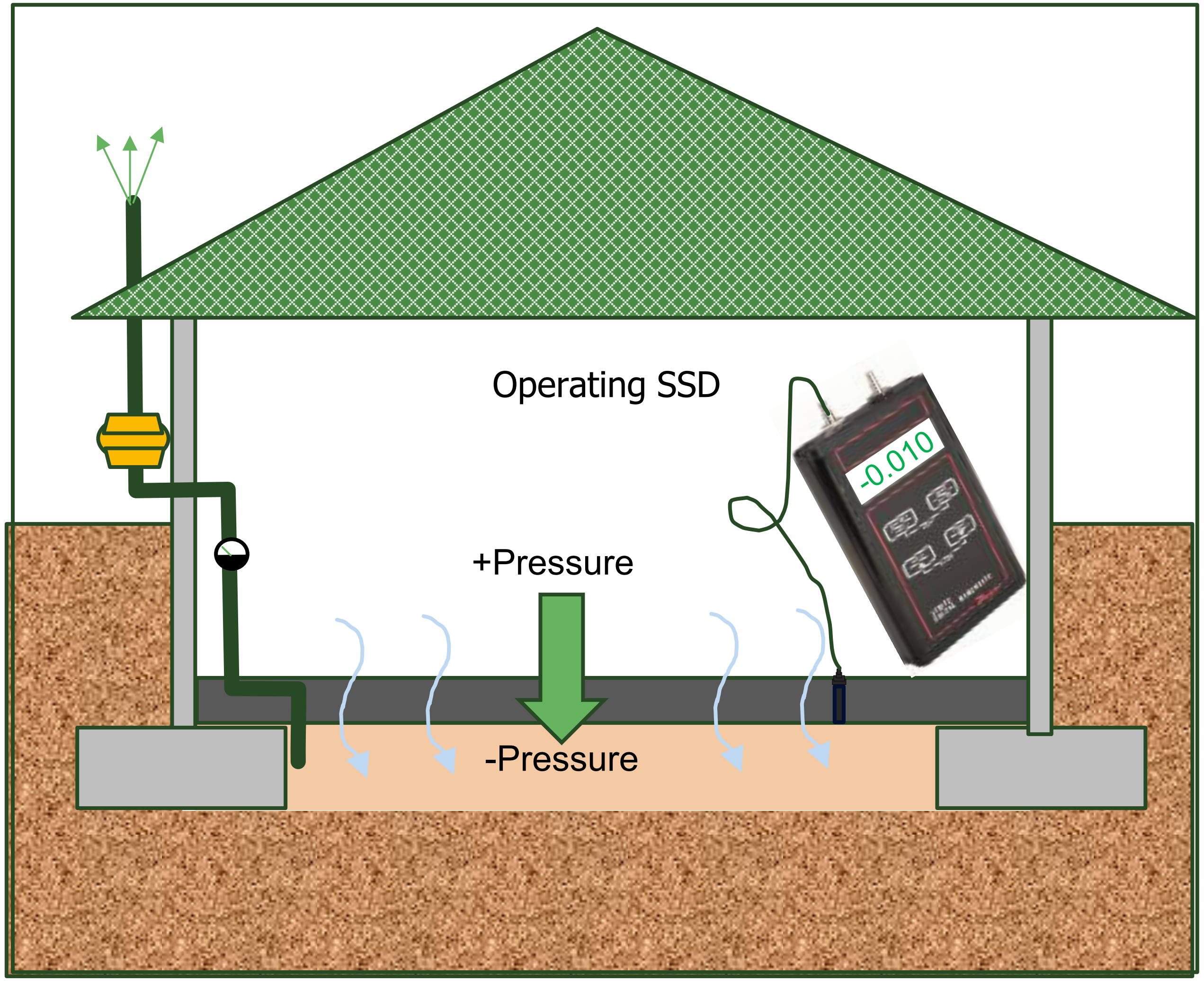
Primary performance metrics change depending on active mitigation system type



Performance Metric – Differential Pressure



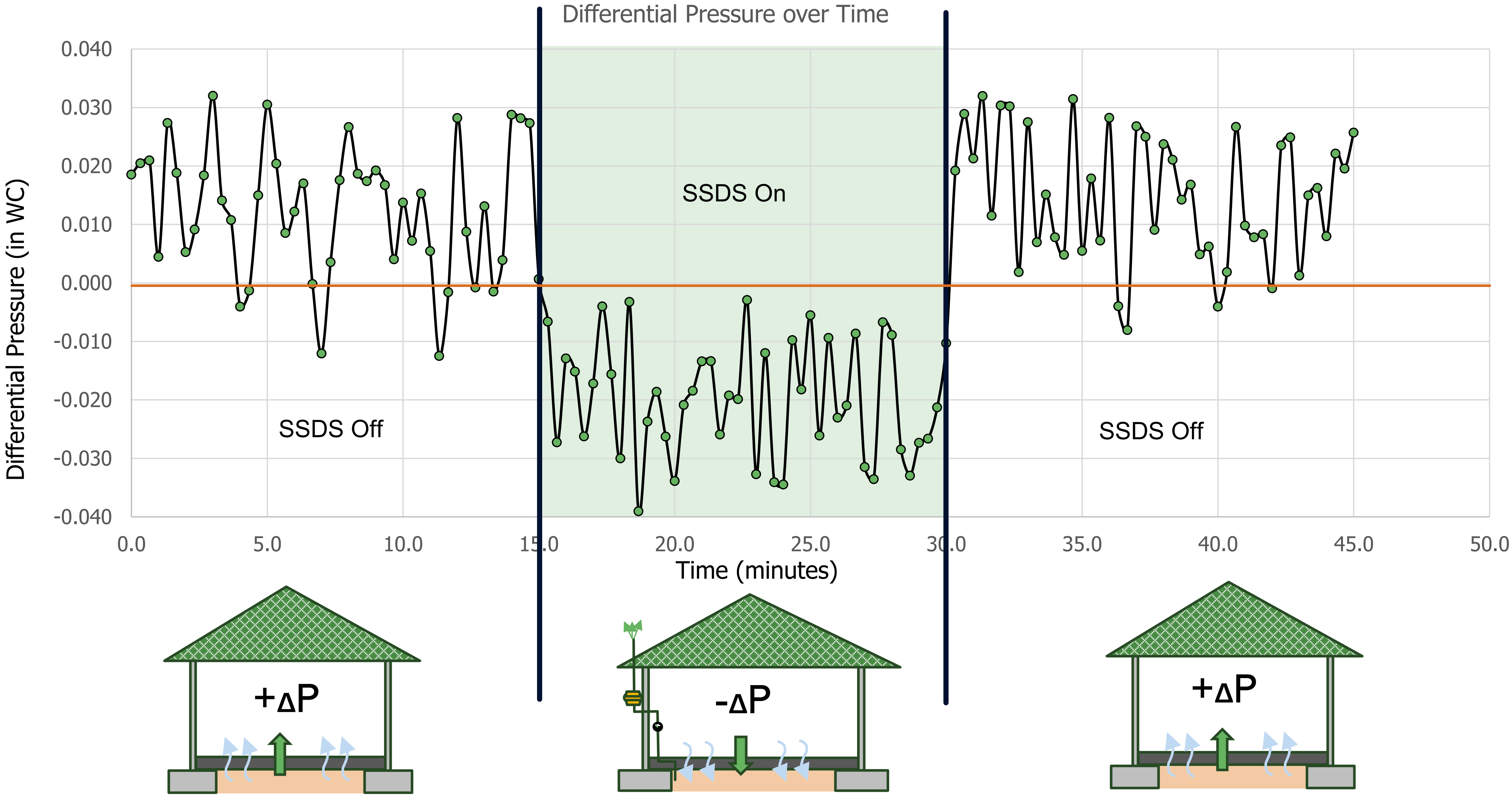
Positive differential pressure
+ΔP



Negative differential pressure
–ΔP

Source: Haley & Aldrich, 2025. used with permission

Performance Metric – Differential Pressure



How much differential pressure is enough?

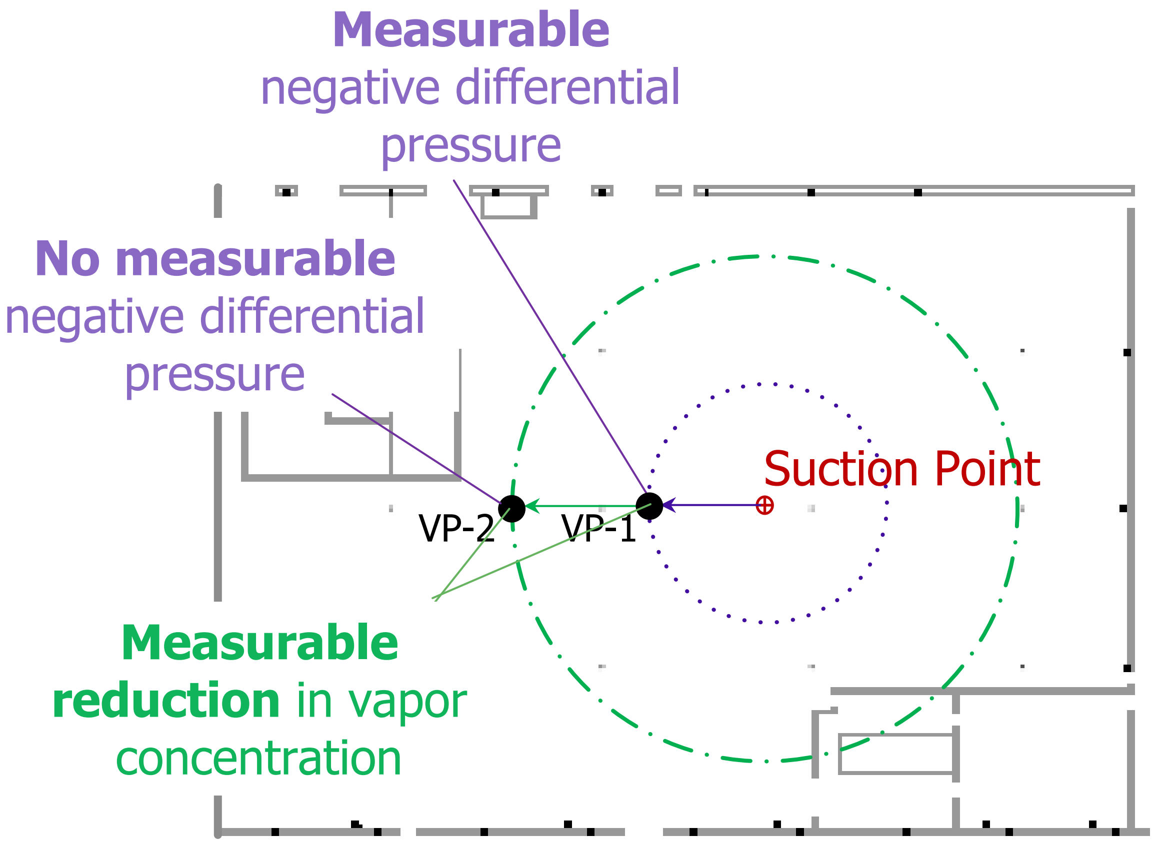
- State guidance may recommend a targeted design level
  - See ITRC's Summary of State VI Practices (Appendix A)
- Differential pressure should be maintained under reasonably anticipated building conditions
- Measured at locations that demonstrate a radius of influence (ROI)
- Most commonly measured in Pascals (Pa) or inches of water (inWC)
- 1 Pascals (Pa) = 0.004 inches of water column (in WC)
- Remember SSV may also be occurring

State	Target ΔP (in WC)	State	Target ΔP (in WC)
AK	<0	MN	-0.012 to -0.020
CA – DTSC	-0.016 to -0.040	NJ	-0.004
CA – RWQCB	-0.016	NC	-0.016
CO	-0.020	OH	-0.020
GA	-0.004	PA	-0.01 to -0.025
IL	-0.003	TN	-0.004
IN	<0	VT	-0.008
MA	-0.012 to -0.020	WI	-0.004
MI	<0		

Excerpt from Eklund et al 2023, Summary of State VI Guidance

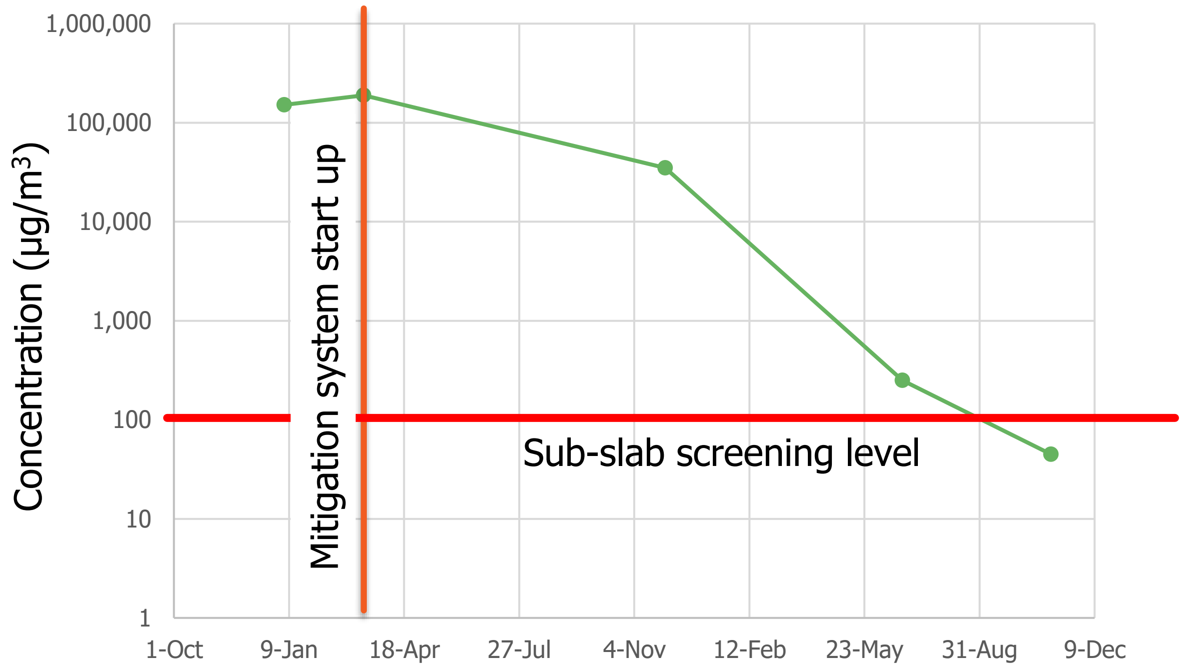
Key Point:
Effective mitigation typically means maintaining depressurization under reasonably anticipated building conditions

Performance Metric – Vapor Concentrations



Source: Haley & Aldrich, 2025. Used with permission.

Sub-slab vapor concentrations at VP-2 over time



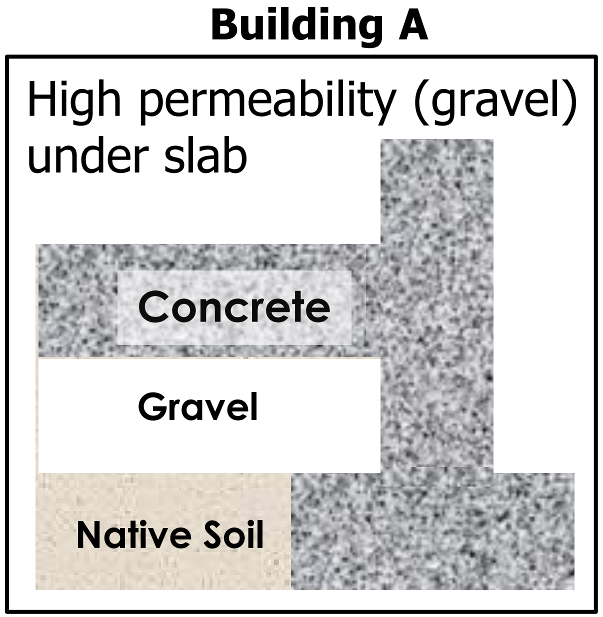
Key Points:

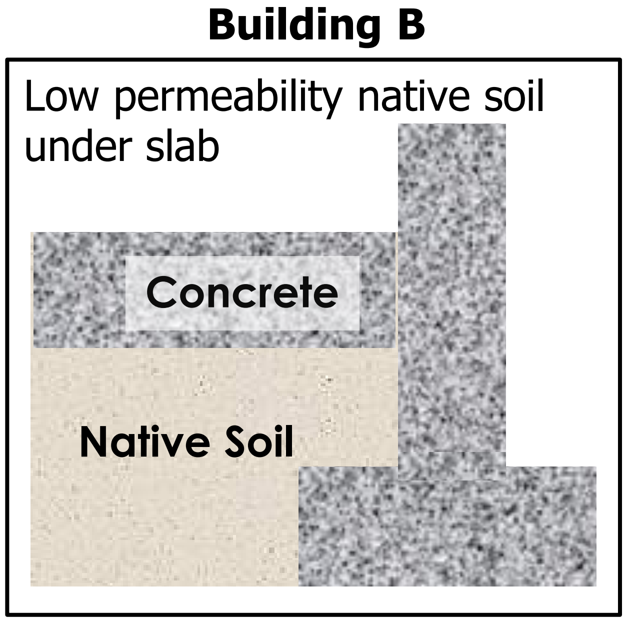
- Differential pressure alone may underestimate lateral influence of active mitigation
- Other metrics like sub-slab vapor concentrations should be considered
- Performance evaluation should use multiple lines of evidence!

Knowledge Check

Check In!

An active VIMS in which building is more likely to be evaluated for effectiveness primarily as a sub-slab venting system?





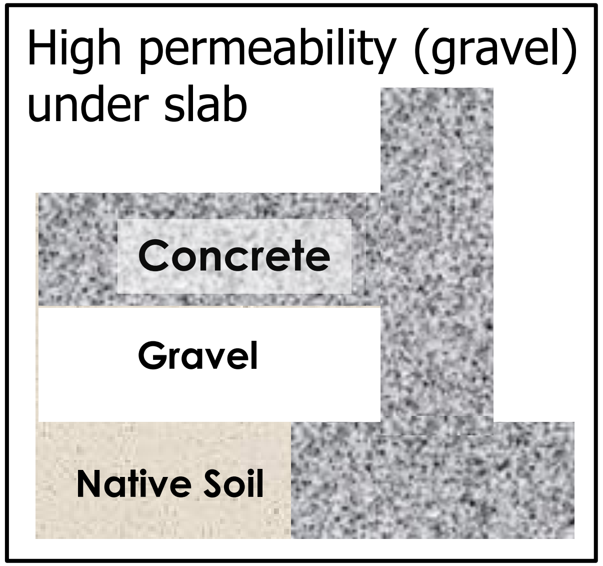
Source: ERM, 2020. Used with permission.

Knowledge Check

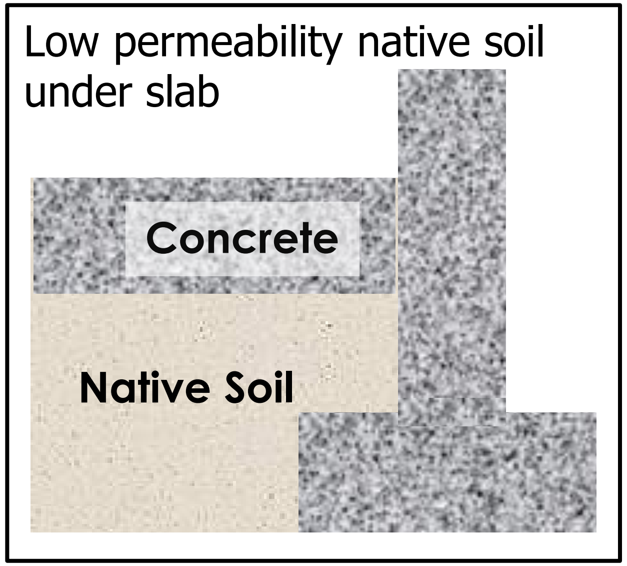
Check In!

An active VIMS in which building is more likely to be evaluated for effectiveness primarily as a sub-slab venting system?

Building A



Building B



Source: ERM, 2020. Used with permission.

Tech Sheets – Other

Sub-Membrane Depressurization (SMD)

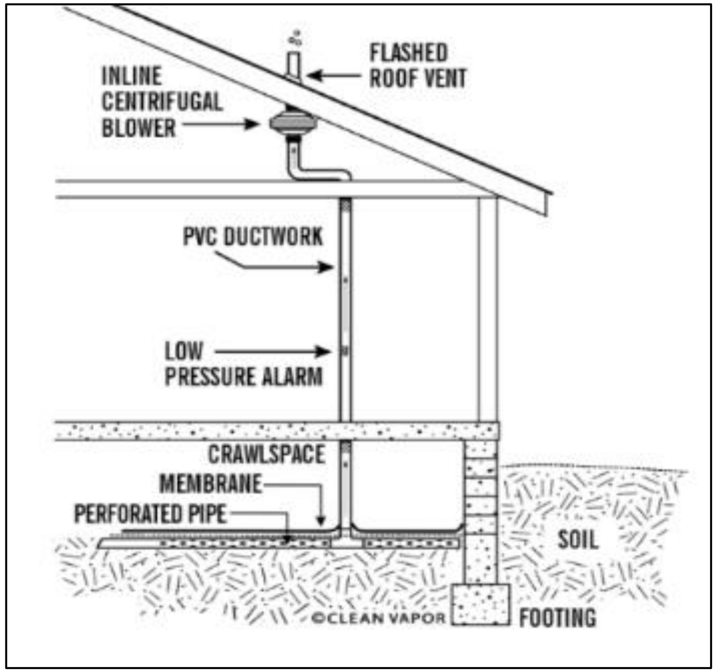


Figure 1 of the SMD Tech Sheet. Source: Clean Vapor, LLC. Used with permission.

- **Preferred** – vapors captured under a membrane
- Should be utilized if crawlspace is safely accessible
  - Sufficient working space
  - Structurally sound

Crawlspace Venting (CSV)

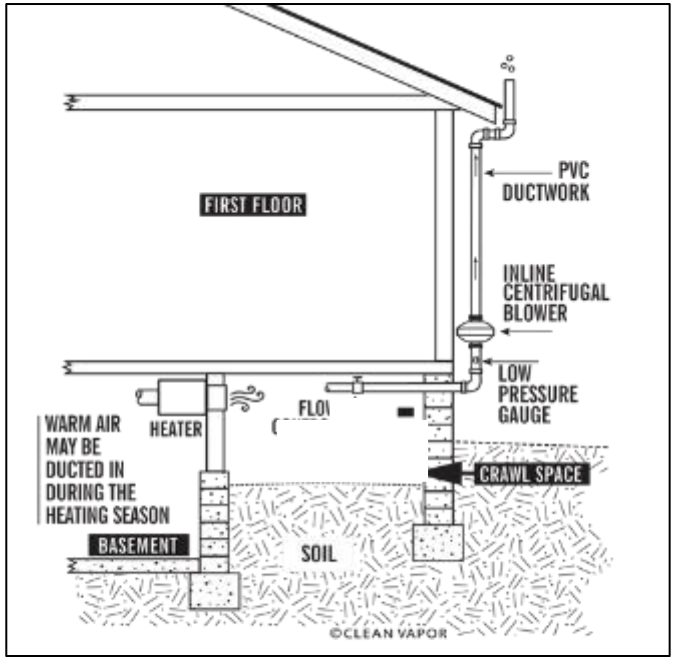


Figure 1 of the CSV Tech Sheet. Source: Clean Vapor, LLC. Used with permission.

- **Less Preferred** – utilizes the crawlspace as a plenum for vapor transport
- Should be used only when crawlspace is not accessible and
  - Combustion appliances are not present in the crawlspace
  - Water pipes are not present that could freeze

See: Tech Sheets - Sub-Membrane Depressurization (SMD) & Crawl-Space Venting (CSV)

Starting the Design Process…

Let's assume that you:

- need an active mitigation system
- know which type of active mitigation system you want

How do we start a design???

Source: Pixabay (free for use)

Design Considerations Fact Sheet

- Guide through design considerations
- Relative importance to active mitigation

Don't Forget:

- Take into account the CSM
- Plan for system verification and OM&M

Design and Implementation Considerations for Vapor Intrusion Mitigation Approaches Fact Sheet

This fact sheet describes the most common design considerations for active vapor intrusion mitigation systems (VIMS), passive VIMS, environmental remedial technologies, and rapid responses that need to be considered as part of any design process.

INTRODUCTION

Multiple factors affecting the suitability and efficacy of vapor intrusion (VI) mitigation should be considered during the design, review, and approval process, as discussed in this fact sheet. The selected technology should be based on a good understanding of the VI conceptual site model (CSM) and able to meet the remedial objectives pertaining to soil vapor conditions at the site, whether applying an active VIMS, passive VIMS, rapid response, and/or an environmental remediation technology.

The design process should begin with a consideration of the VI CSM elements applicable to mitigation and the remedial objectives; this then leads to the design basis (i.e., an explanation of how the selected approach and technologies will meet the remedial objectives at the site). In many cases, this review indicates that additional information is needed for design of a specific type of VIMS; therefore, the need for predesign investigations and/or testing should be considered. Once sufficient information is available for design, the next consideration is the design itself—the area that requires VI mitigation along with the VI mitigation components, installation details, and specifications. Other design considerations include installation and operating permitting requirements; stakeholder requirements and communications (see Chapter 3: Community Engagement); the need for construction quality control; the need to demonstrate system effectiveness and reliability; and the need for operation, maintenance, and monitoring (OM&M) plans, including a potential VIMS curtailment strategy (see the Interstate Technology and Regulatory Council [ITRC] Vapor Intrusion Mitigation System Curtailment and Shutdown Fact Sheet).

Table 1 identifies the design considerations that are discussed in more detail below and evaluates their typical importance and impact on the design of an active VIMS (see ITRC Active Vapor Intrusion Mitigation Systems Fact Sheet), passive VIMS (see the Passive Vapor Intrusion Mitigation Systems Fact Sheet), environmental remediation technology (see the Vapor Intrusion Remediation and Institutional Controls Fact Sheet), or rapid response (see ITRC Rapid Response and Ventilation for Vapor Intrusion Fact Sheet). Note that the importance of any factor can vary depending on site- and building-specific conditions and regulatory requirements.

Table 1. Summary of design considerations and impact on mitigation approach.

See: Fact Sheet - Design and Implementation Considerations

Design Considerations – New Construction

- Install low-cost infrastructure and activate as needed
- Can be combined with thinner vapor membranes than passive mitigation systems
  - Membrane thickness variable based on site conditions, plans for system activation, etc.
- Typically utilizes inline fans
- Include sub-slab ports located for sub-slab sampling and differential pressure measurements
- Review building construction drawings to identify relevant building features (foundation plans and details, architectural drawings, HVAC, etc.)

Source: Arcadis, 2025. Used with permission.

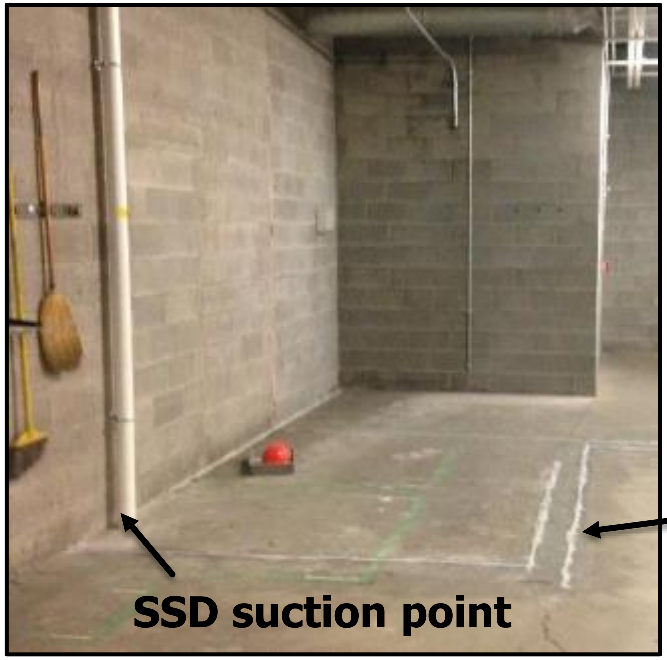
Design Considerations – Existing Buildings

<u>Factors included in design may be:</u>

- Foundation type (multiple foundations)
- Slab integrity
- VI preferential pathways (VIPPs)
- HVAC - settings, location of intakes
- Building dimensions
- Exterior façade requirements
- And many more! – see ITRC's Active Mitigation Checklist

Vent stack installation

Source: Clean Vapor, 2020. Used with permission.



SSD suction point

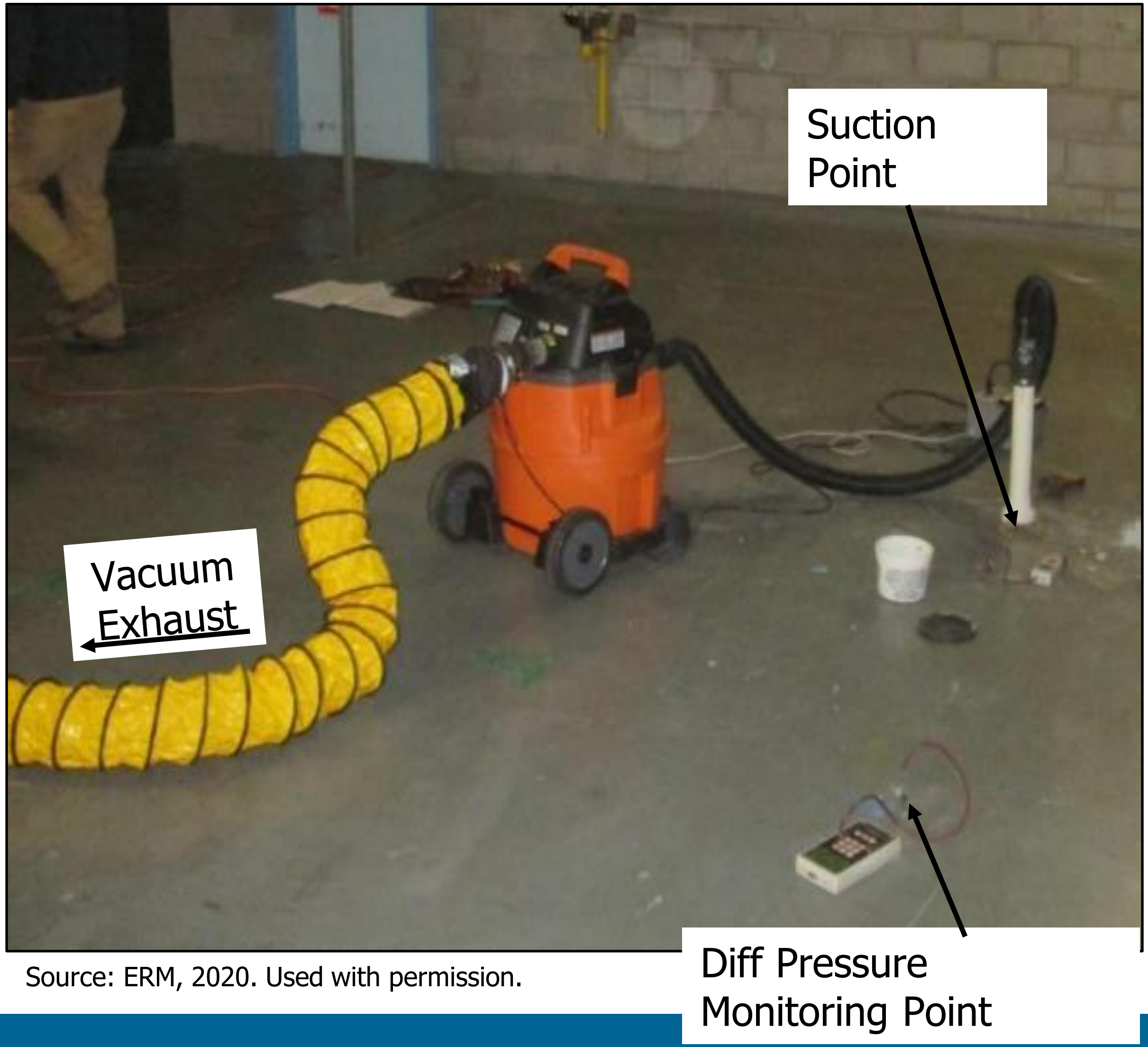
Sealed floor cracks

Source: ERM, 2020. Used with permission.

Design Considerations – Design Investigation

<u>Sub-Slab Diagnostics</u>

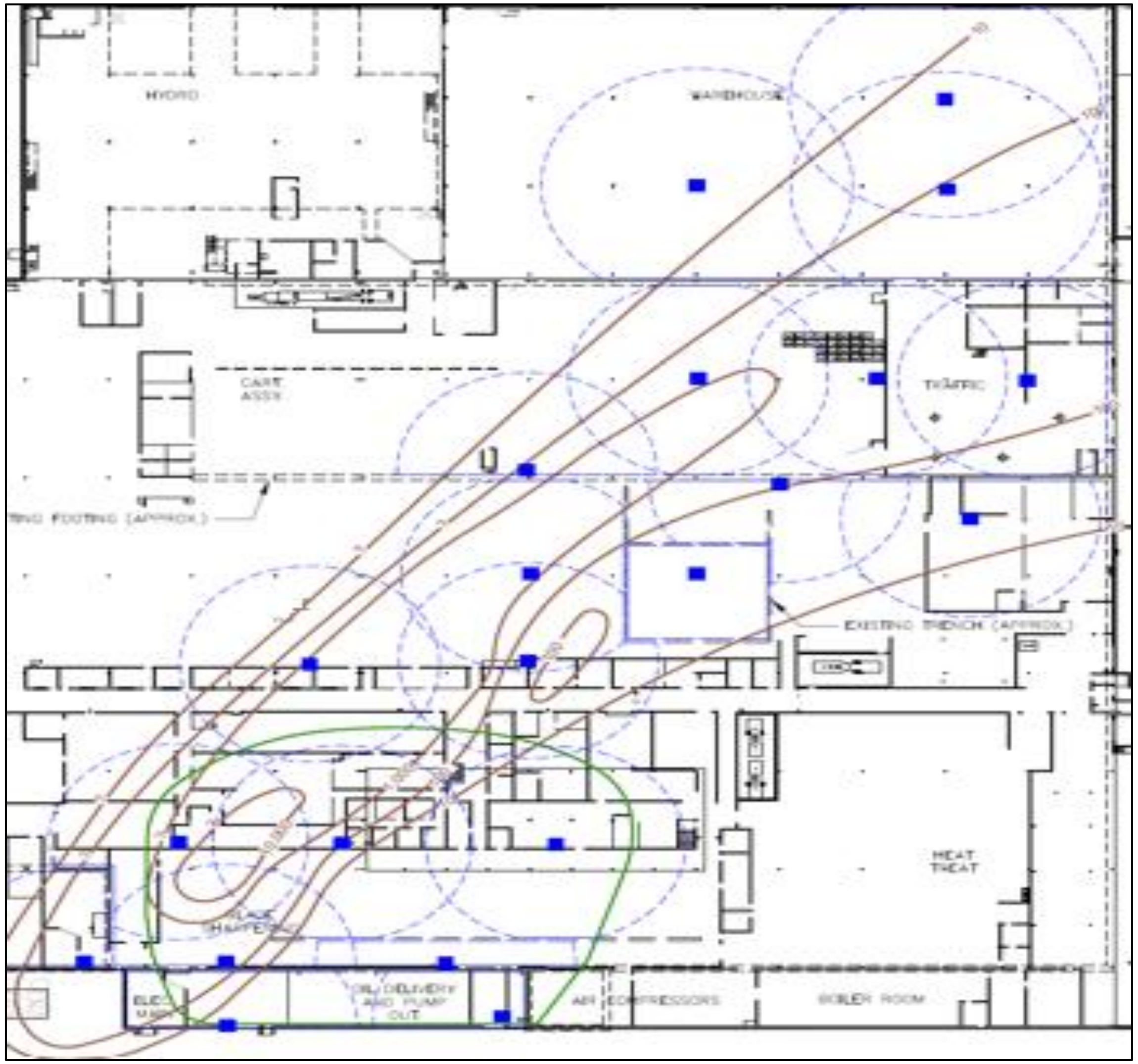
- Pressure field extension (PFE) testing
- Typical for existing buildings
- Used to determine
  - Suction point spacing
  - Number and size of fan(s)/blower(s)
- Measure
  - Applied vacuum and flowrate at suction point
  - Differential pressure at various distances from suction point
- Test at multiple applied vacuum/flow rates
- Test multiple locations in large buildings (variable sub-slab conditions, typically at building additions)
- Consider sampling extracted vapor



Source: ERM, 2020. Used with permission.

Design Considerations – Design Layout and Components

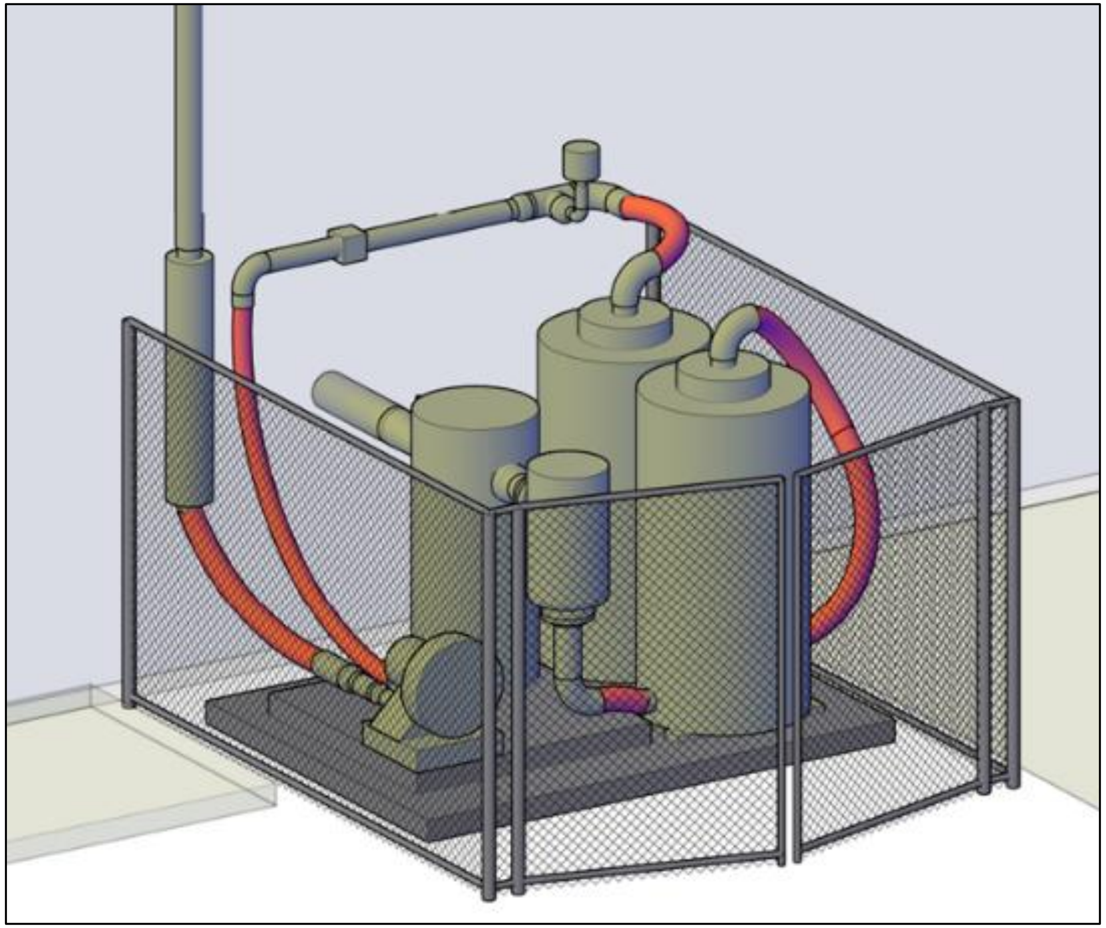
- Establish mitigation area based on sub-slab data
- Locate sub-slab monitoring points
- Telemetry considerations
- Is vapor treatment needed?



Source: Arcadis, 2025. Used with permission.

Design Documentation

- Design basis
- Design drawings
- Permitting – building permitting and air discharge permitting, if needed
- Installation instructions and specifications
- Construction quality assurance (CQA)
  - See ITRC's CQA Factsheet
- Preliminary OM&M plan
- May include stakeholder/community engagement plan



Source: Arcadis, 2025. Used with permission.

See: Fact Sheet - VIMS Construction Quality Assurance

Active Mitigation Checklist

Walks through each design consideration

Prompts user for site-specific information

Not all items may be applicable for all sites

ACTIVE MITIGATION CHECKLIST

INTERSTATE TECHNOLOGY REGULATORY COUNCIL ITRC

Details and types of active mitigation can be reviewed in the Active Vapor Intrusion Mitigation Systems Fact Sheet. The primary active technologies that are the focus of this design checklist are sub-slab depressurization, sub-slab venting, sub-membrane depressurization, and crawl-space venting, and these technologies are detailed in their respective technical information sheets. This section focuses on design checklist considerations for existing buildings where the design needs to accommodate an existing building slab. Some of the considerations in the checklist below may also apply to new construction if an active system such as a sub-slab depressurization system is being installed. This differs from mitigation of new construction that consists of a passive barrier or aerated floor. For the passive mitigation systems, see the Passive Mitigation Checklist.

Active Mitigation System Design and Documentation

- Have all the building's slab areas been fully characterized for contaminants? ☐Yes ☐No ☐N/A
- Has pressure field extension (PFE) testing been completed? ☐Yes ☐No ☐N/A
- Have emissions been calculated and compared to local discharge limits, and have any necessary permits been obtained? ☐Yes ☐No ☐N/A

Selection of System Materials and Methods

- Were total building footprint, foundation type, and under-slab compartments (created by haunches, thickened slab, or elevation changes) considered in the design process? ☐Yes ☐No ☐N/A
- Have monitoring points (i.e., sub-slab differential pressure monitoring points/embedded probes, riser vacuum, and flow monitoring points) been included in the design? ☐Yes ☐No ☐N/A
- Has depth to groundwater been considered (along with management methods as warranted, such as dewatering)? ☐Yes ☐No ☐N/A

See: Checklist - Active Mitigation

Summary

- Definition of active mitigation
- Common active mitigation approaches for new construction and existing buildings
- Important performance metrics
- Active mitigation design considerations
- Design documentation

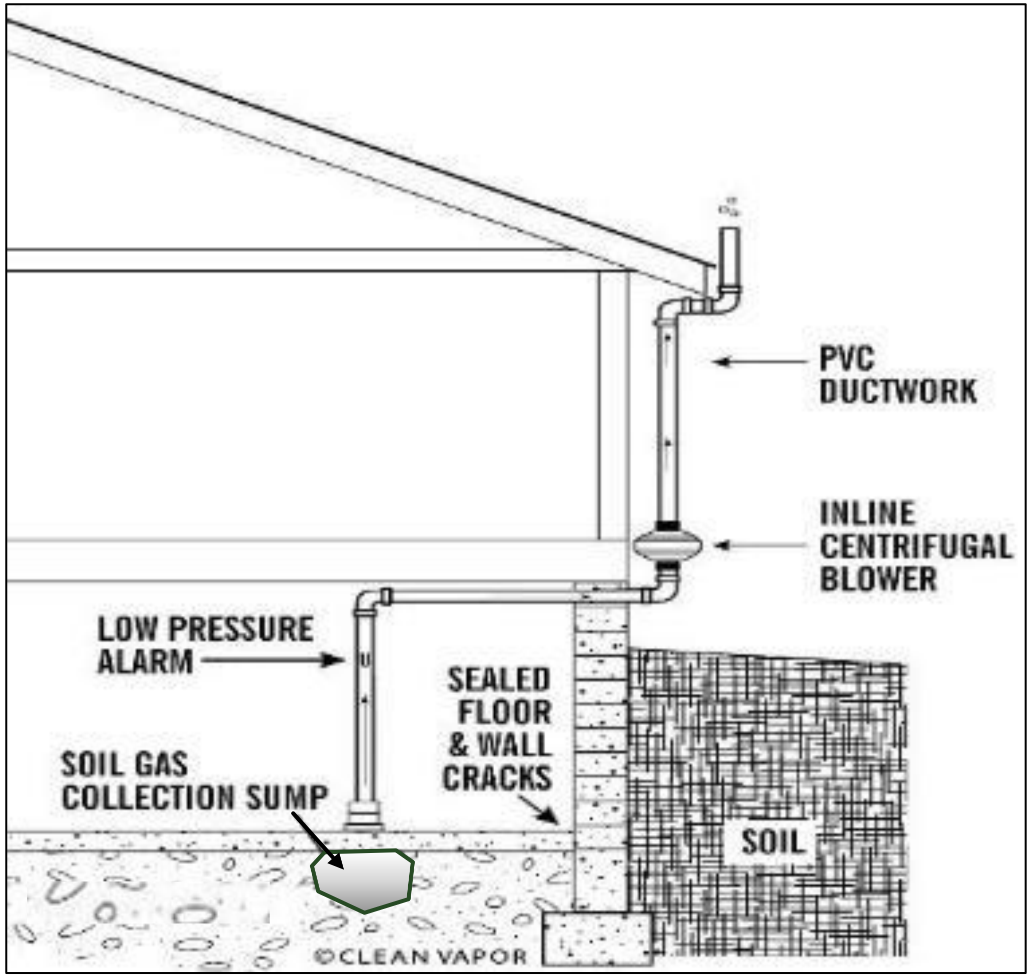


Figure 1 of Sub-slab Depressurization (SSD) Technology Information Sheet.

Next Steps

- Install the system as designed
- Verify effective installation and operation
- Conduct routine OM&M
- Monitor and plan for an exit strategy

Subsequent steps covered in other modules

Question & Answer Break

Coming Up Next…

VIM Session 1

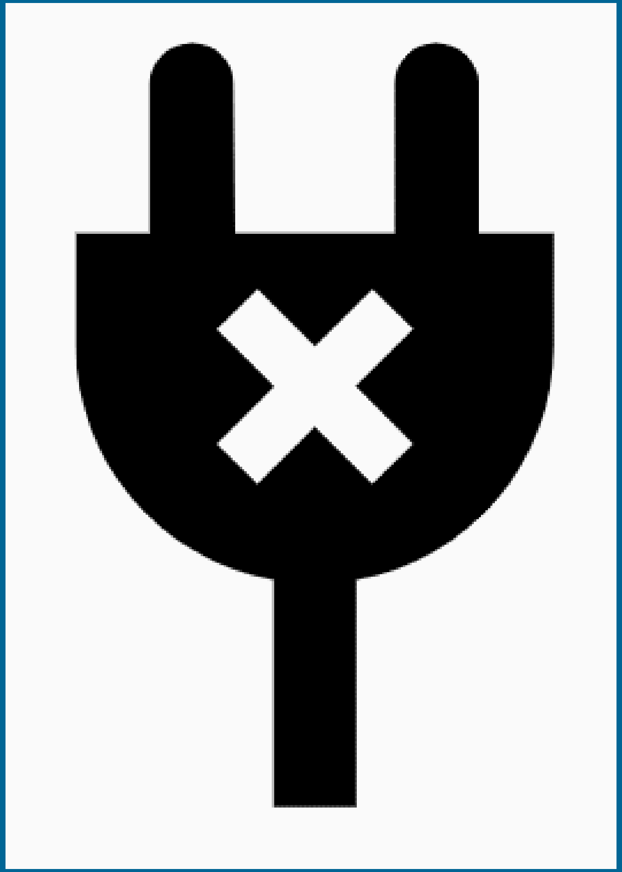
- Introduction
- Conceptual Site Model for VI Mitigation
- Community Engagement for VI Mitigation
- Rapid Response and Ventilation
- Remediation and Institutional Controls
- Active Mitigation Approaches
- **Passive Mitigation Approaches**
- System Verification, OM&M, Curtailment and Shutdown
- Closing

VIM Session 2

Q&A Session to be conducted after each module

Passive Mitigation Approaches

Passive mitigation definition
Technology overview
Design considerations
Installation planning
Construction quality assurance



Source: thenounproject.com.
Used with permission.

What is Passive Mitigation?

- Does not rely on mechanical means (e.g., fans/blowers)
- Block or divert contaminant vapors around the building
- Venting relies on natural mechanisms
  - Stack effect
  - Barometric pressure changes
  - Dilution of chemical vapor

Source: Adapted from ITRC.

Common Passive Barrier Systems

Composite Membranes (CM)

Source: EPRO Services, Inc, 2020. Used with permission.

Single Sheet Membranes (SSM)

Source: EPRO Services, Inc, 2020.
Used with permission.

Epoxy Floor Coatings (EFC)

Source: Land Science, a Division of Regenesis.
Used with permission.

Tech Sheet – Composite Membranes (CM)

General Design

- Barrier to prevent VI in new buildings
- Typically comprised of
  - Base layer
  - Continuous asphalt latex material (ALM)
  - Cap sheet
- Effective for a wide range of contaminants

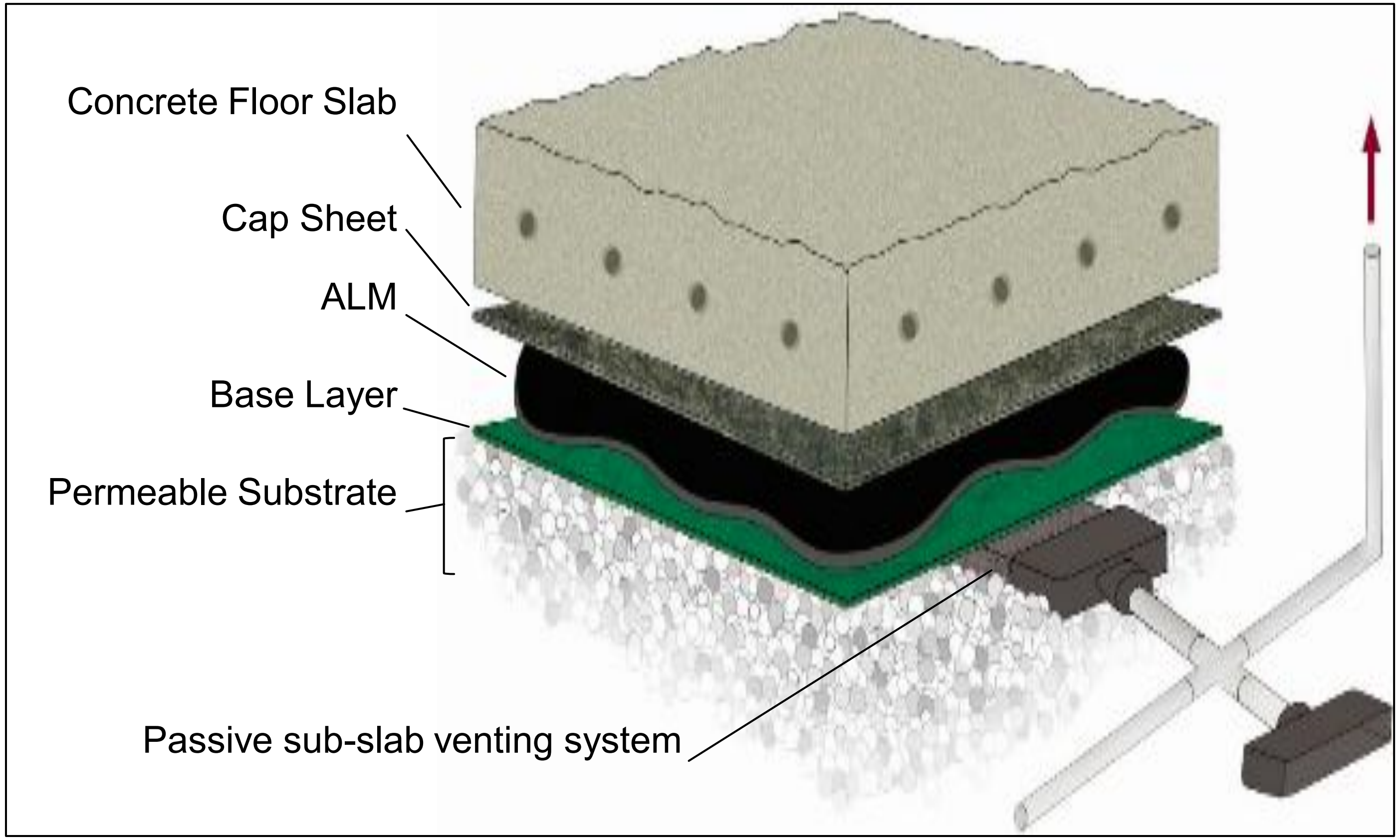


Figure 1. Composite Membranes Technology Sheet. Souce: Adapted from CETCO. Used with permission.

Tech Sheet – Composite Membranes (CM)

Installation

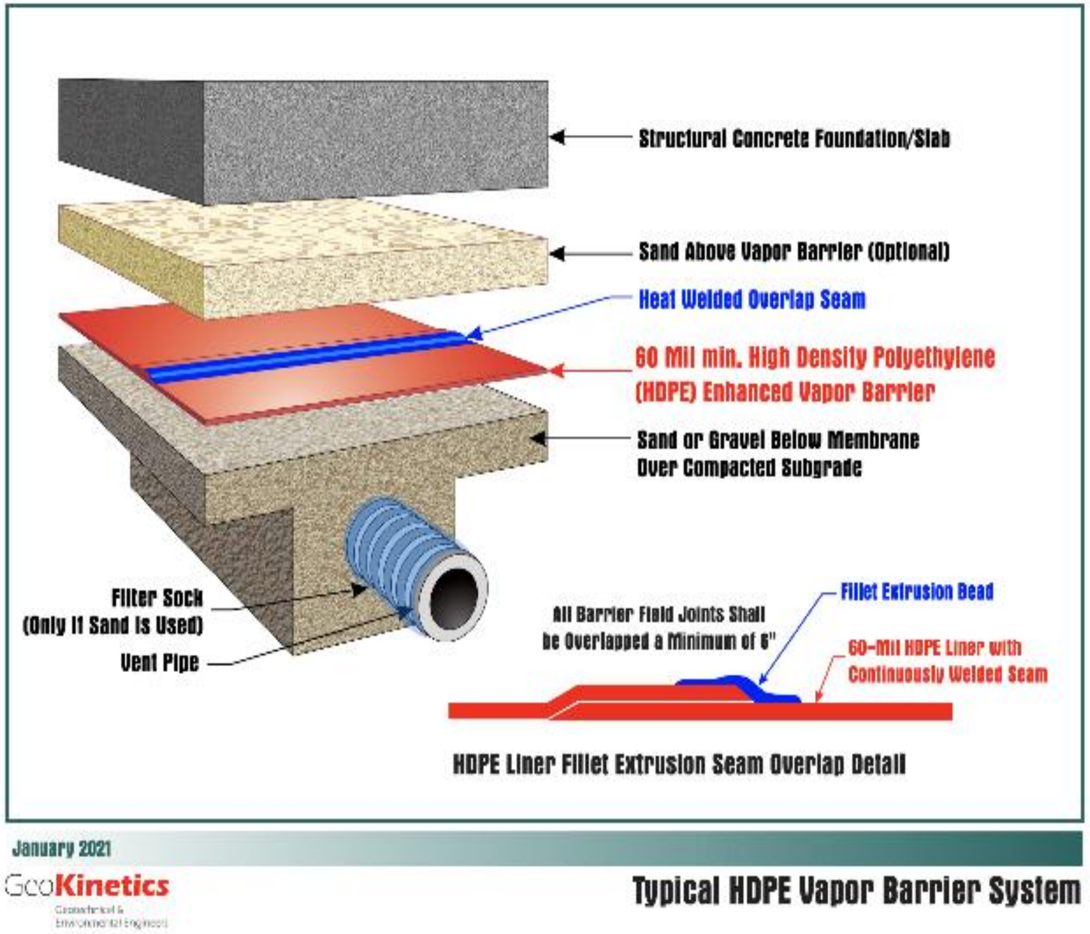
- ALM spray applied to a carrier layer
- Manufacturers provide specific installation instructions

Source: EPRO Services, Inc, 2020. Used with permission.

Tech Sheet – Single Sheet Membranes (SSM)

General Design

- Typically comprised one or more materials, such as:
  - High-density polyethylene (HDPE)
  - Linear low-density polyethylene (LLDPE)
  - Ethyl Vinyl Alcohol (EVOH)
  - Metallized films
- Effective for a wide range of contaminants



Source: Geokinetics, Inc, 2021. Used with permission.

Tech Sheet – Single Sheet Membranes (SSM)

Installation

- Seams and penetrations sealed by various methods
  - Heat welding
  - Spraying
  - Taping
- Manufacturers provide specific installation instructions

Source: EPRO Services, Inc, 2020. Used with permission.

Tech Sheet – Epoxy Floor Coatings (EFC)

- Applicable to all building types
- Most applicable to existing building floors as a passive VI barrier
- Involves concrete surface preparation prior to application
- Can protect concrete
- Requires specialty applicators
- Specially formulated to resist VFCs

Figure 1 of Epoxy Floor Coatings (EFCs). Application of EFC to concrete substrate.

Common Passive Venting Systems

Passive Sub-Slab Perforated Pipe Venting

Source: Duncklee & Dunham, P.C., 2025.
Used with Permission

Trenchless Sub-Slab Geocomposite Venting

Source: CETCO, 2025. Used with permission.

Aerated Floor Void Space Systems (VSS)

Source: Vapor Mitigation Sciences, LLC, 2020.
Used with permission.

Passive Sub-Slab Venting

- Fundamentally different from SSD
  - No power source required
  - Relies on temperature and/or pressure differences to induce airflow
- Most applicable to new construction
- Often used with passive barriers

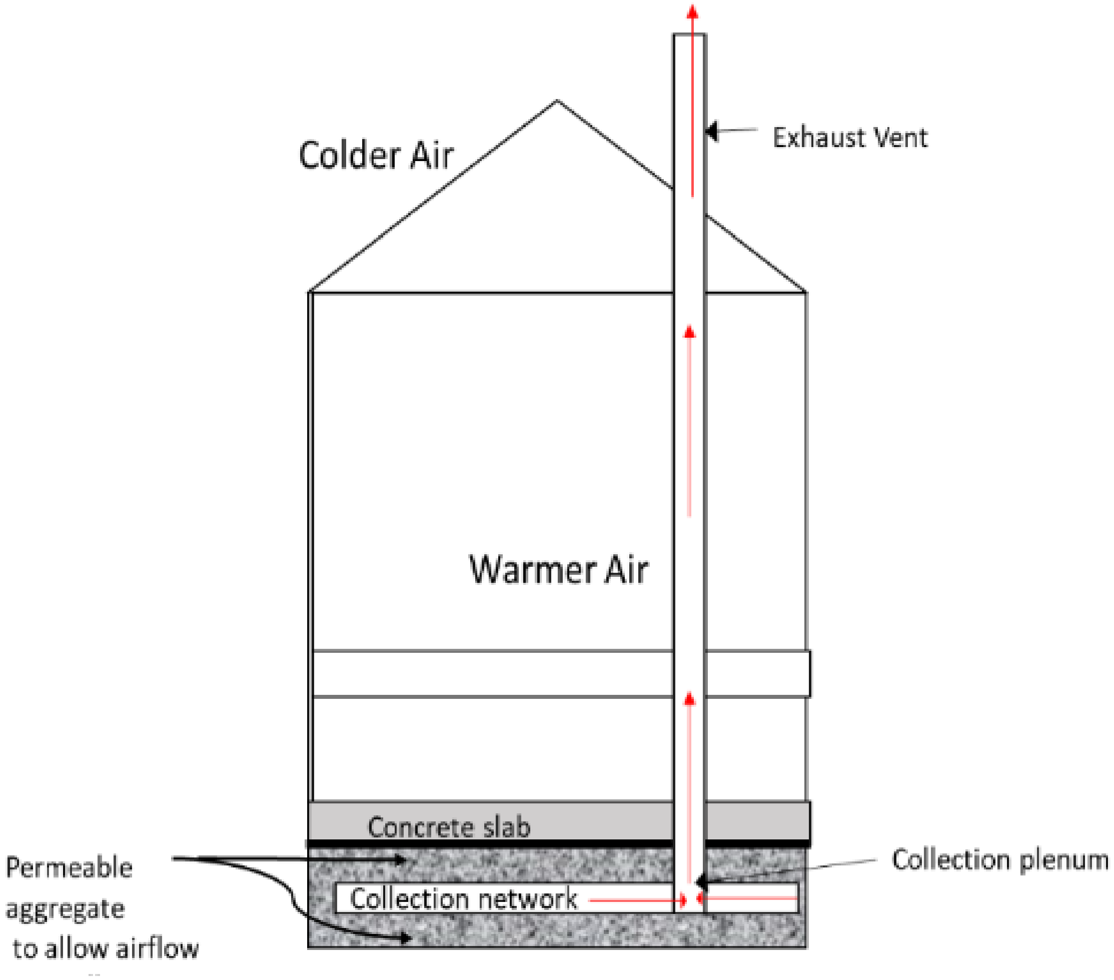


Figure 1. Passive Sub-Slab Ventilation Technology Information Sheet.
Source: S. McKinley, used with permission.

Passive Sub-Slab Venting

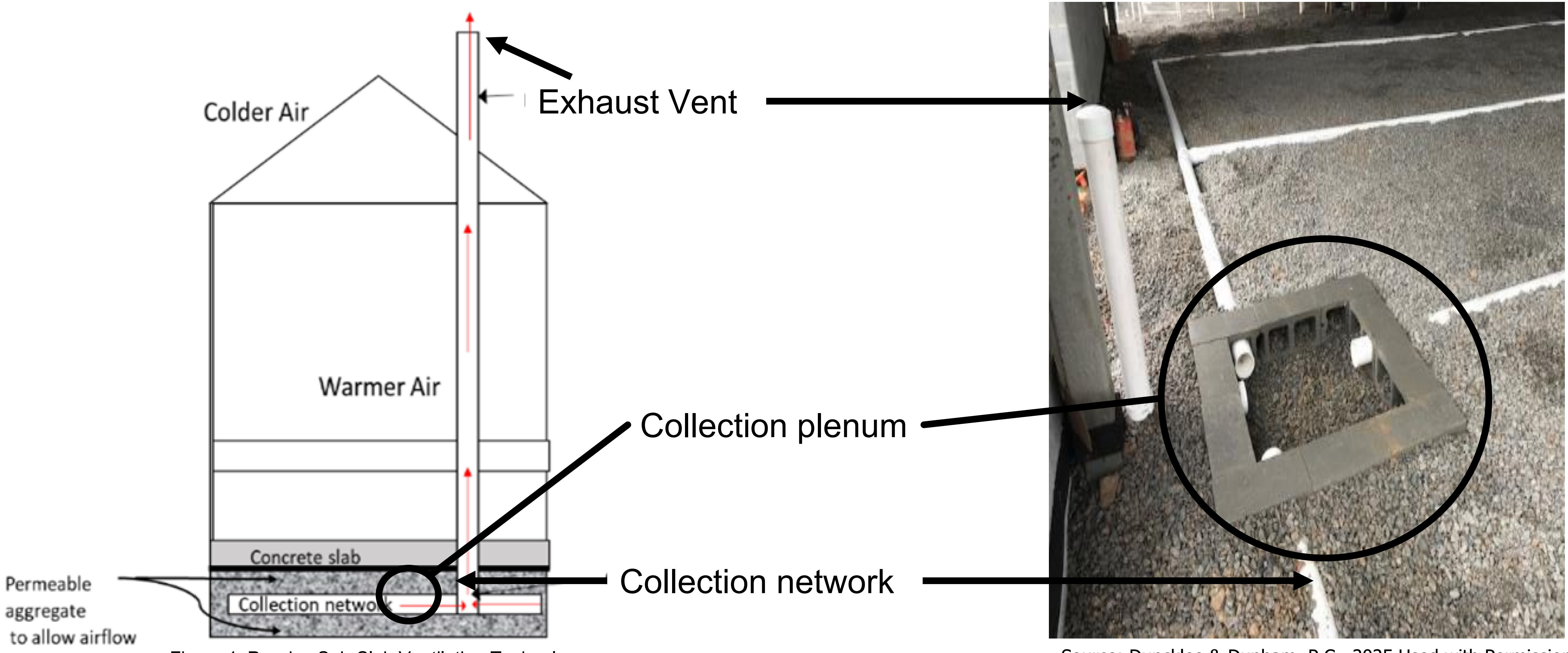
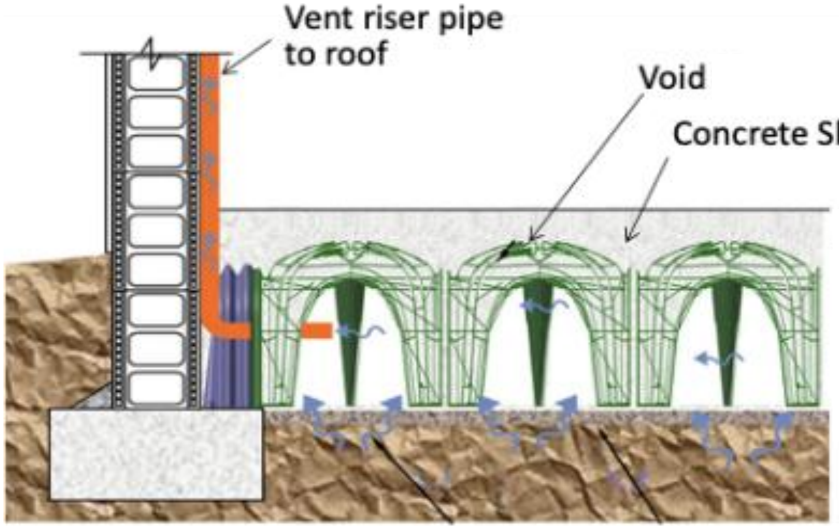


Figure 1. Passive Sub-Slab Ventilation Technology Information Sheet.
Source: S. McKinley, used with permission.

Source: Duncklee & Dunham, P.C., 2025 Used with Permission

Tech Sheet – Aerated Floor Void Space Systems (VSS)

- Create continuous void space under slab
- Low resistance to air flow, air exchange rates are high
- Most applicable to new construction
- Proprietary forms designed for all building types
- Designed for SSV or SSD



Source: Cupolex Engineering Solutions, Inc., 2026. Used with permission.

Source: Vapor Mitigation Sciences, LLC, 2020. Used with permission.

Tech Sheet – Building Design for Passive VIMS

Vented Garages

- Used where space is limited
- Separates vapor source from occupiable spaces
- Naturally or mechanically ventilated
- Ventilation rate written in building code
- Adequate ventilation rate needed to mitigate VI

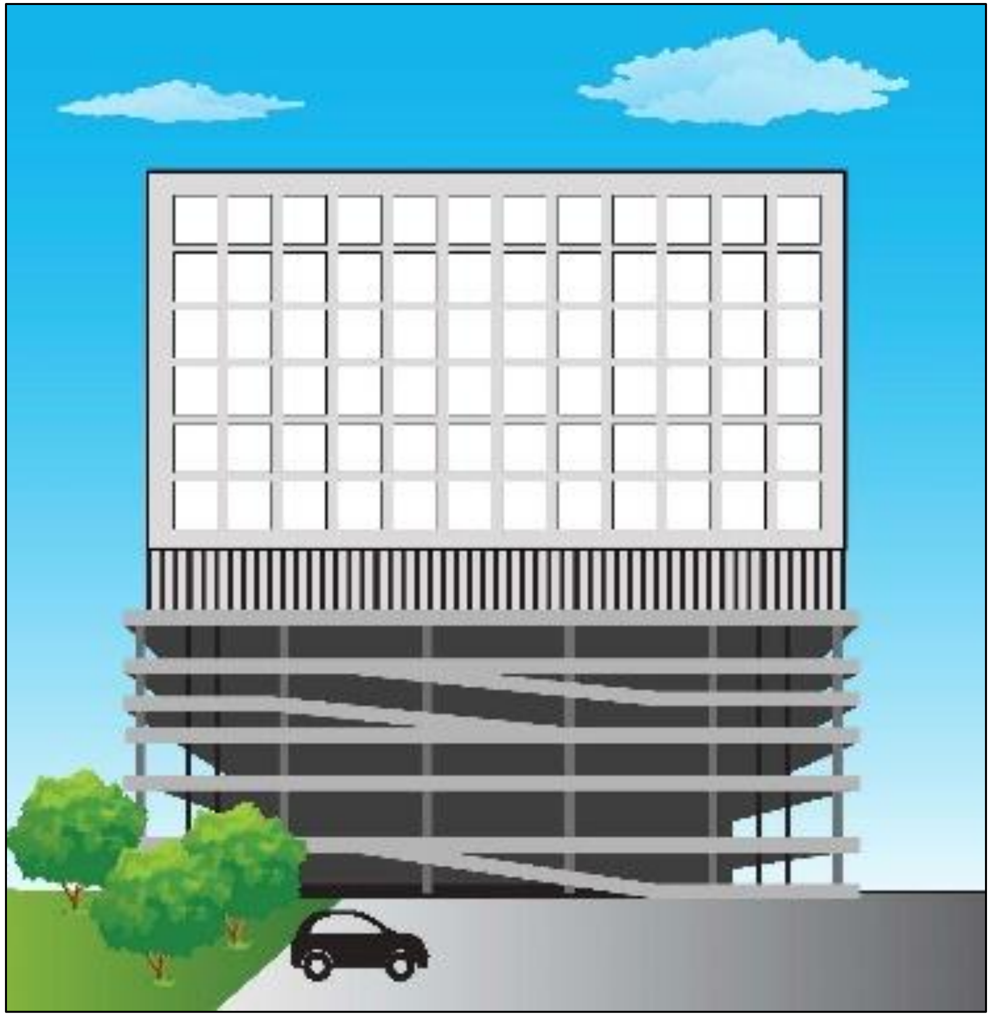


Figure 1 Building Design for Passive VIMS Technology Sheet.
Source: J. Kasunic, used with permission.

See: Tech Sheet – Building Design for Passive VI Mitigation

Tech Sheet – Building Design for Passive VIMS

Raised Foundations & Ventilated Crawl Spaces

- Typically used in regions with:
  - Temperate climates
  - High water tables/flooding
- Separates vapor source from occupiable spaces
- Naturally or mechanically ventilated
- Design or ventilation rate often specified in building codes

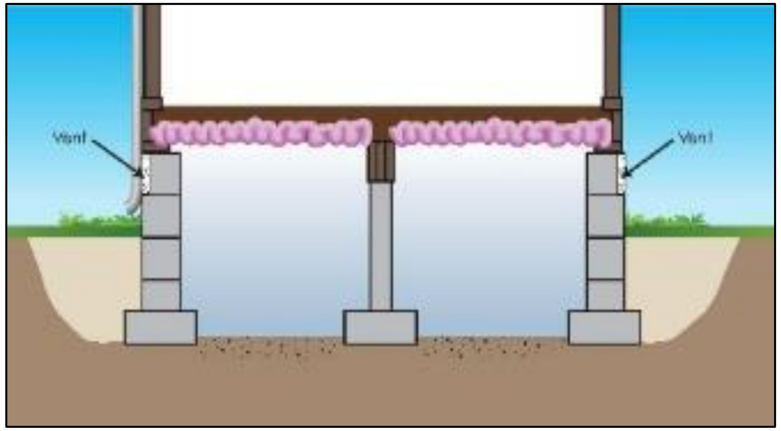


Figure 2 (top) and Figure 3 (bottom) of Building Design for Passive VIMS Technology Sheet.
Source: J. Kasunic, used with permission.

Starting the Design Process…

Now that you have seen what's out there, let's assume you have chosen

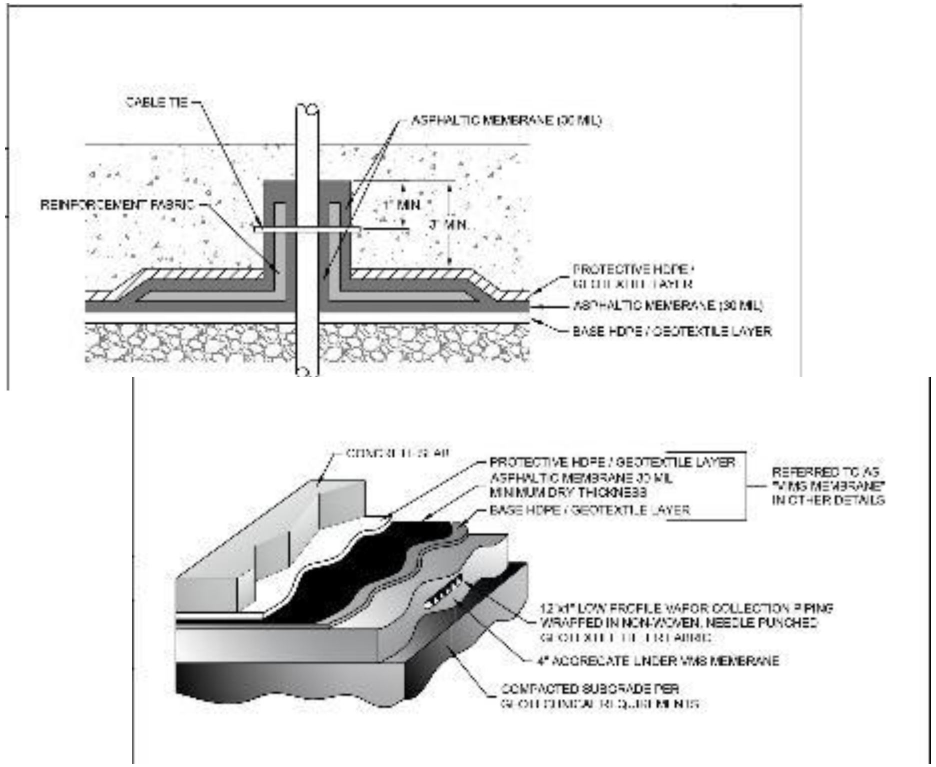
- Passive mitigation
- The specific approach to implement

Now what???

Source: Pixabay (free for use)

Design Considerations – Drawings

- Materials used
- Layout of system components, including vent, stack, and monitoring points
- Installation instructions and specifications
- Performance testing



Illustrative Images of design drawings only.

Source: Terracon Consultants, Inc, 2020. Used with permission.

System Installation Planning – Pre-Construction Meeting

- Include all persons involved with the installation
- Include ancillary trades who might impact the performance of the VIMs

Source: Pixabay (free for use)

Design Considerations – System Verification

- Incorporate quality assurance & quality control (QA/QC) into design
- QA/QC sources:
  - Manufacturer's specifications
  - Applicable regulations
  - Site-specific considerations
- System Verification
  - Smoke testing/Tracer gas testing
  - Coupon sampling (membrane thickness)
  - Oversight documentation

Smoke Testing. Source: EPRO Services, Inc, 2020. Used with permission.

Design Considerations – New Construction vs. Existing Buildings

High level of control in **New Construction**

Source: EPRO Services, Inc, 2020. Used with permission.

Must work around conditions within **Existing Buildings**

Source: Contractors Waterproofing, 2021. Used with permission.

Design Considerations – New Construction

- Building-specific customization of mitigation system
- Coordination with multiple construction trades required
- VIMS design drawings aid in successful installation
- Able to combine mitigation approaches

Source: Kelly Johnson, 2020. Used with permission.

Design Considerations – Existing Buildings

- Conditions may limit the passive technologies which can be used
- Foundation can impact system effectiveness
- Building modification may be necessary to accommodate mitigation system
- Planning and construction oversight required

Source: Land Science, 2020. Used with permission.

Why is QA/QC Important?

Source: Geosyntec, 2026. Used with permission.

Source: Geosyntec, 2026.
Used with permission.

Source: Arcadis, 2025. Used with permission.

Knowledge Check

Check In!

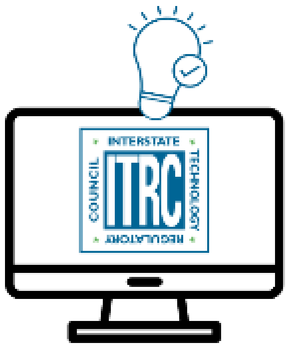
What is the most important element of good design?

A. Letting the project team know you want passive mitigation

B. Understanding basic requirements with no formal design

C. Figuring it out as you go

D. Developing a formal design & implementing proper planning



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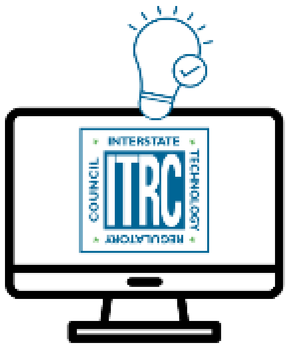
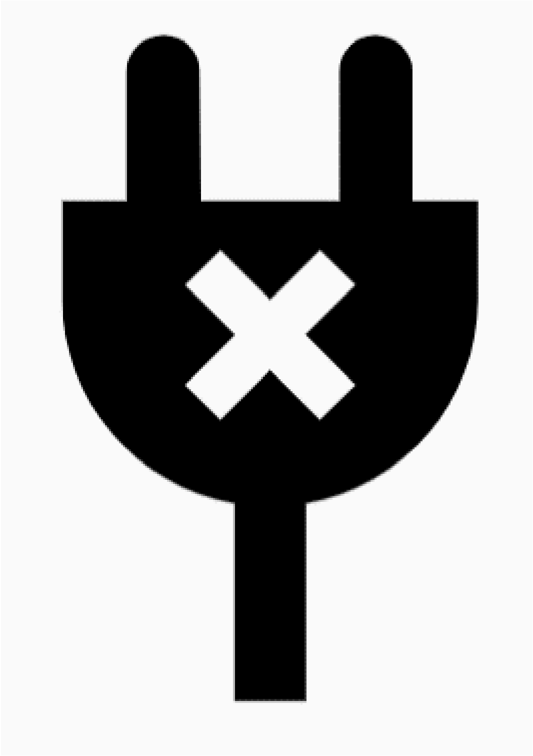


Summary

- Define passive mitigation
- Major categories of technologies
- Key elements of system design
- Importance of Quality Assurance, oversight, and documentation



Source: thenounproject.com.
Used with permission.

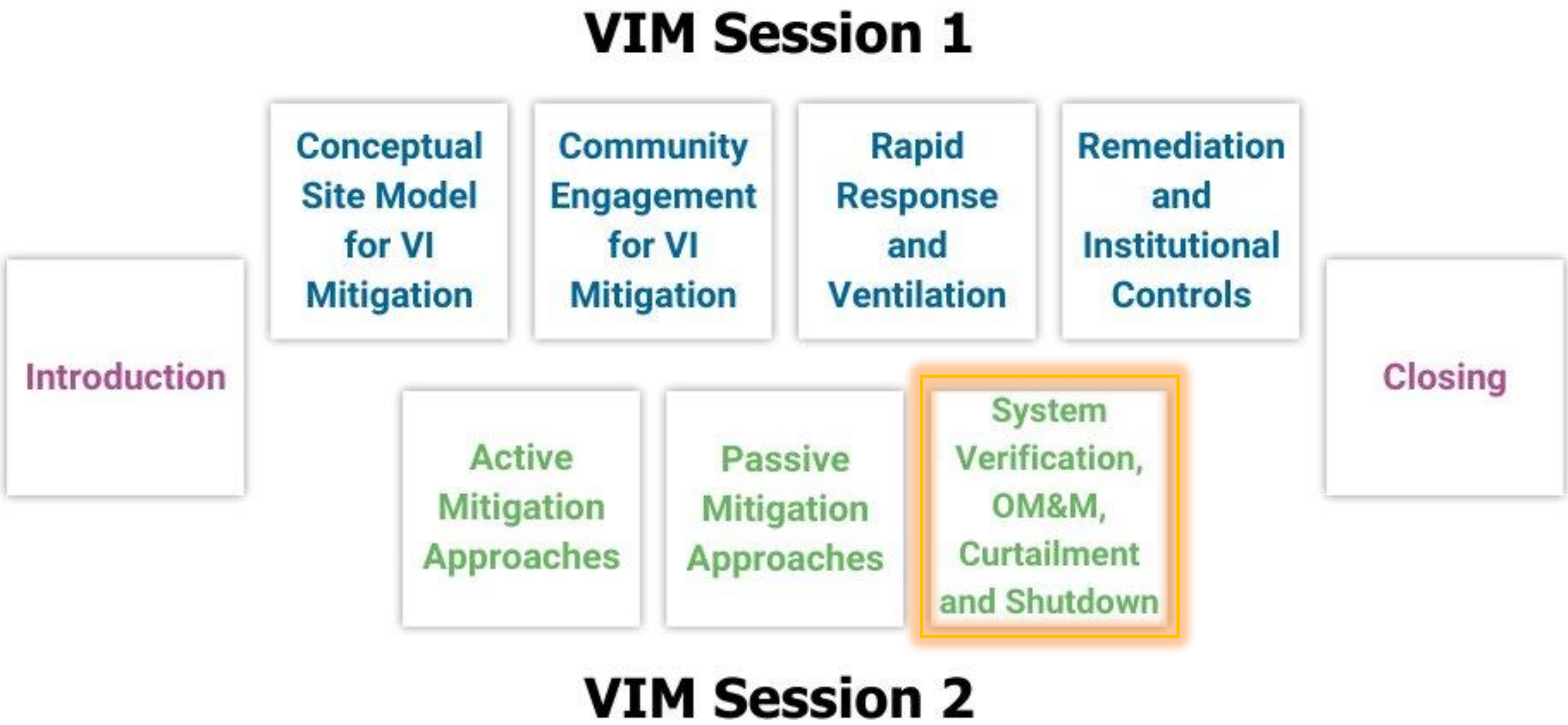
Next Steps

- Passive mitigation system verification
- Conduct routine OM&M
- Assess need for continued operation of passive mitigation system
- Consideration for these steps are covered within another module.

Subsequent steps covered in other modules

Question & Answer Break

Coming Up Next…

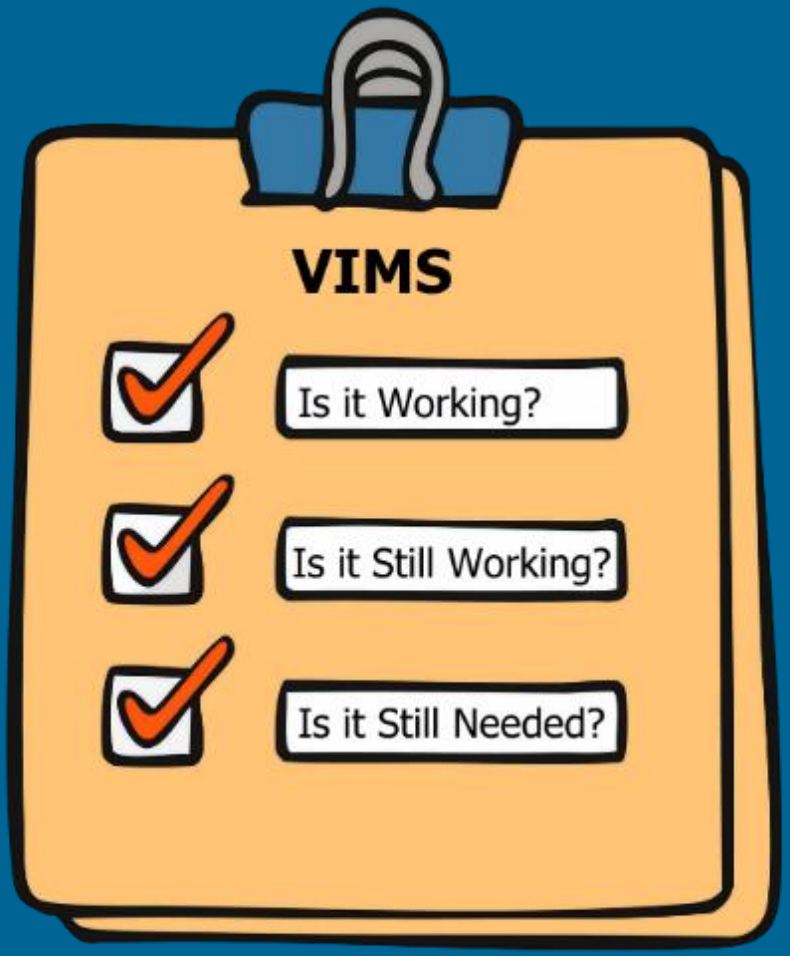


Q&A Session to be conducted after each module

System Verification; Operation, Maintenance, & Monitoring (OM&M); Curtailment and Shutdown

Approaches and Considerations for:

- Initial performance testing
- Long-term stewardship
- VIMS reduction and/or shutdown



Plan and Communicate Regularly

Short and long-term VIMS stewardship starts at the design stage

- Establish performance monitoring metrics and approaches
- Consider approaches for curtailment and/or shutdown
- Maintain active stakeholder engagement

Understanding PFOA Class at Bennington College, Vermont
Fact sheets, Bennington College example

Post-Install Verification – Is the VIMS Working?

- Confirm VIMS was installed as designed
  - Consider the observations from VIMS CQA
  - Perform a post-construction building condition survey
  - Consider system balancing during commissioning
- Performance testing to verify intended operation
- Validate or adjust vapor intrusion CSM
- Initial performance testing provides baseline for future OM&M

Source: Integral Consulting Inc, 2020.
Used with permission.

VIMS Post-Installation Fact Sheet – Relative Impact

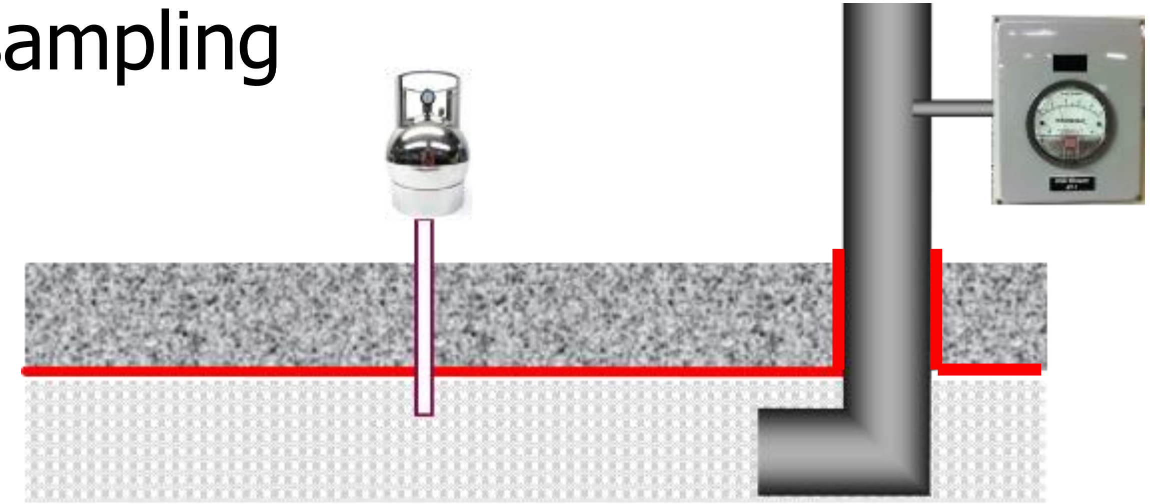
- Key considerations for VI system verification
- Multiple mitigation approaches considered
- Presents relative impact of each approach
  - Narrative component to support table

Post-installation Consideration	Active approaches	Passive approaches	Remediation	Rapid response
Confirmation testing				
Pressure field extension (PFE) confirmation	High	—	High	Low
System vacuum, air flow, and velocity	High	Medium	High	Low
Sub-slab, indoor air, outdoor ambient air sampling	High	High	High	High
Mass removal rate	High	Low	Medium	Low
Smoke and tracer gas testing	High	High	High	High
Backdraft testing	Medium	—	Low	—
Coupon testing	—	High	Low	—
Telemetry	Medium	Low	Medium	Low

Key High impact ● Medium impact ◐ Low impact ◒ Not applicable —

Example VIMS Performance Metrics

- Pressure differential across slab
- Static vacuum and air flow rate
- Indoor air and/or sub-slab vapor sampling
- Smoke or tracer gas testing



Source: Geosyntec, 2020. Used with permission.

Post-Installation Verification Checklist

Accurate record keeping is critical for short- and long-term stewardship

- Post-Installation Verification Checklist
  - Field-ready checklist – viable for multiple system types (e.g., active, passive, SSD)
  - Template – adjustable to fit state- or site-specific needs
  - Checklist includes construction quality assurance (CQA) considerations. Also refer to:
    - VIMS CQA Fact Sheet
    - Example VIMS CQA Outline Plan in Appendices

POST-INSTALLATION VAPOR INTRUSION MITIGATION SYSTEM VERIFICATION CHECKLIST

The purpose of this checklist is to provide the user with a selection of tools to verify that the appropriate system components for the vapor intrusion mitigation system (VIMS) were installed and the system is operating as designed. This information applies to the four most common active mitigation systems: sub-slab depressurization, sub-slab ventilation, sub-membrane depressurization, and crawl-space ventilation. Passive systems are described in their associated fact sheets and technology information sheets. It is recommended that the user of this checklist review the VIMS design or as-built documentation prior to completing this checklist.

This document was prepared with multiple types of VIMS in mind. Not all of the information presented below is necessary to document system operation for all types of systems on all types of buildings. The user should be able to identify which criteria below best represent effective operation for their specific VIMS and which criteria will validate the conceptual site model for which the VIMS was implemented. Timing on when to collect post-installation verification data may vary and more than one event may be reasonable. See the Vapor Intrusion Mitigation Systems Post-Installation Verification Fact Sheet for additional information on timing a post-installation verification site visit.

Instructions for Use: As-built drawings and performance criteria are needed when conducting inspections of VIMS. Major system components are grouped below for this checklist, and one or more of these groups may not apply to a particular VIMS design. Those groups can be marked as Not Applicable by selecting the 'X' box on the right side of the page.

This checklist is intended to serve as a guide for design considerations and as documentation for VIMS installation. This list can be modified for a specific project or program if needed or can be used as shown. The list should be submitted along with the final project as-builts and/or installation oversight verification documentation and reporting.

1. **SITE INFORMATION:**

Address Inspected: ____________________

City, State, ZIP: ____________________

Inspector's Name: ____________________ Date/Time Inspected: ____________

Inspector's Email: ____________________ Inspector's Phone No.: ____________

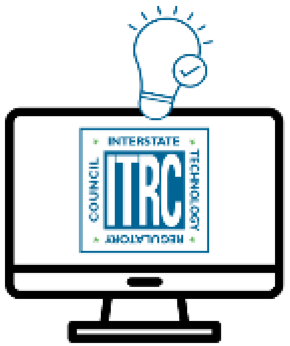
See: Checklist - Post Installation VIMS

Knowledge Check

Check In!

When is it most important to develop post-installation verification procedures?

- During VI investigation
- During mitigation design and planning
- At the time of mitigation implementation
- After construction
- Never



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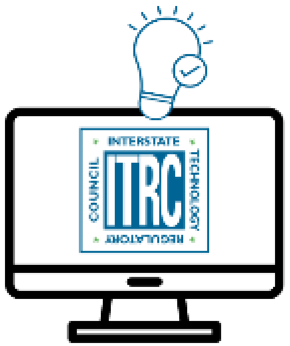


VIMS OM&M Fact Sheet

- Key considerations for long-term operations, maintenance, and performance monitoring
- Multiple mitigation approaches considered
- Presents relative impact of each approach

BONUS: VIMS OM&M Checklist

Vapor Intrusion Mitigation System Operation, Maintenance, and Monitoring Fact Sheet

INTERSTATE TECHNOLOGY REGULATORY COUNCIL ITRC

INTRODUCTION

After the mitigation system has been selected, designed, and commissioned, the operation, maintenance, and monitoring (OM&M) plan plays a key role in demonstrating the ongoing effectiveness of the vapor intrusion mitigation system (VIMS). This fact sheet describes the key considerations of OM&M. Complex mitigation strategies will typically require more complex OM&M procedures. The key to OM&M is to gather data to support maintaining the VIMS to operate as designed, with the goal that it remains effective in the short and long term until it is appropriate to implement an exit strategy, if appropriate.

Emerging technologies, such as aerobic vapor mitigation barriers, are not addressed within this fact sheet. Please see the Aerobic Vapor Mitigation Barrier Technology Information Sheet for more information.

OPERATION, MAINTENANCE, AND MONITORING PLAN

An OM&M plan provides instructions for VIMS operation and upkeep and should be prepared for each installed VIMS. Information in these sections provides details for OM&M plan content that applies to the installed VIMS in general and is not specific to just petroleum vapor intrusion (PVI). The goals of OM&M are to verify performance of the VIMS during operation as compared to performance during system commissioning and to inspect and repair any system malfunction (i.e., VIMS not operating to meet performance objectives or due to system equipment life expectancy). In cases where testing shows the VIMS is not working and no defects in the system components have been identified, reevaluating the conceptual site model (CSM) to determine the presence or contribution of additional sources of vapor-forming chemicals (VFCs) may be appropriate. For example, VFC transport via sewers or other preferential pathways may require further evaluation if this pathway had not been addressed previously.

OM&M – Is the VIMS (Still) Working?

Evaluate if VIMS continues to meet performance metrics

- Use multiple lines of evidence to evaluate performance
- Inform stakeholders as appropriate if changes are warranted
- Repair, modify, upgrade VIMS as needed
- Ongoing data review:
  - evaluate if operational or monitoring improvements or reductions are justified
  - Refer to VIMS Curtailment and Shutdown Fact Sheet

Figure 5. Sub-slab Depressurization Technology Information Sheet. Source: R Saari, Arcadis. Used with permission.

VIMS OM&M Fact Sheet Relative Impact

- Key considerations for VIMS OM&M
- Multiple mitigation approaches considered
- Presents relative importance of each approach
- Same concept as VIMS Post-Installation Verification rating table

OM&M Consideration	Active Approaches	Passive Approaches	Environmental Remedial Technology	Rapid Response
Mitigation system operation				
Purpose of installation of VIMS	●	●	●	●
Brief description of VIMS	◐	◐	●	◐
Monitoring frequency and maintenance schedule	◐	◐	●	◐

Key | High impact ● | Medium impact ◐ | Low impact ◒ |

Active Mitigation	**High Impact:** It is important to understand and continue to evaluate the purpose and objectives of an operating active VIMS, especially in terms of the occupation and use of the building in which it is installed. Understanding and periodically re-evaluating this purpose will facilitate the management of the VIMS and the decision points needed to progress to an exit strategy if appropriate.
Passive Mitigation	**High Impact:** The purpose and objectives of the VIMS and its role in protecting human life are essential to understanding the OM&M process, especially for passive mitigation where there are no mechanical components.

VIMS OM&M Checklist

- VIMS OM&M Checklist
  - <u>Field-ready checklist</u> – viable for multiple system types (e.g., active, passive, SSD)
  - <u>Template</u> – adjustable to fit state- or site-specific needs

Clickable Check Boxes

Category

Primary prompt

Conditional (secondary) prompt

3. Mitigation System Operation

3.1. Was the mitigation system functioning as designed and operating upon arrival? ☑Yes ☐No ☐N/A

If no, explain in Section 6 why the system was not operational and the steps taken to correct the problem.

If no and the cause of the system shutdown is determined, follow the start-up procedures as detailed in the system OM&M plan and complete the remainder of the checklist.

3.2. Are there/have there been any unusual noises (e.g., water sloshing, motor straining) indicating potential issues with VIMS piping, blower, and/or motor? ☐Yes ☐No ☐N/A

If yes, discuss changes and possible impacts in Section 6.

See: Checklist - VIMS OM&M

VIMS Curtailment and Shutdown Fact Sheet

- New Fact Sheet!
- Provides framework to support long-term VIMS decision making
- Flow charts, tables, and conceptual scenarios
- Example Curtailment Plan Outline

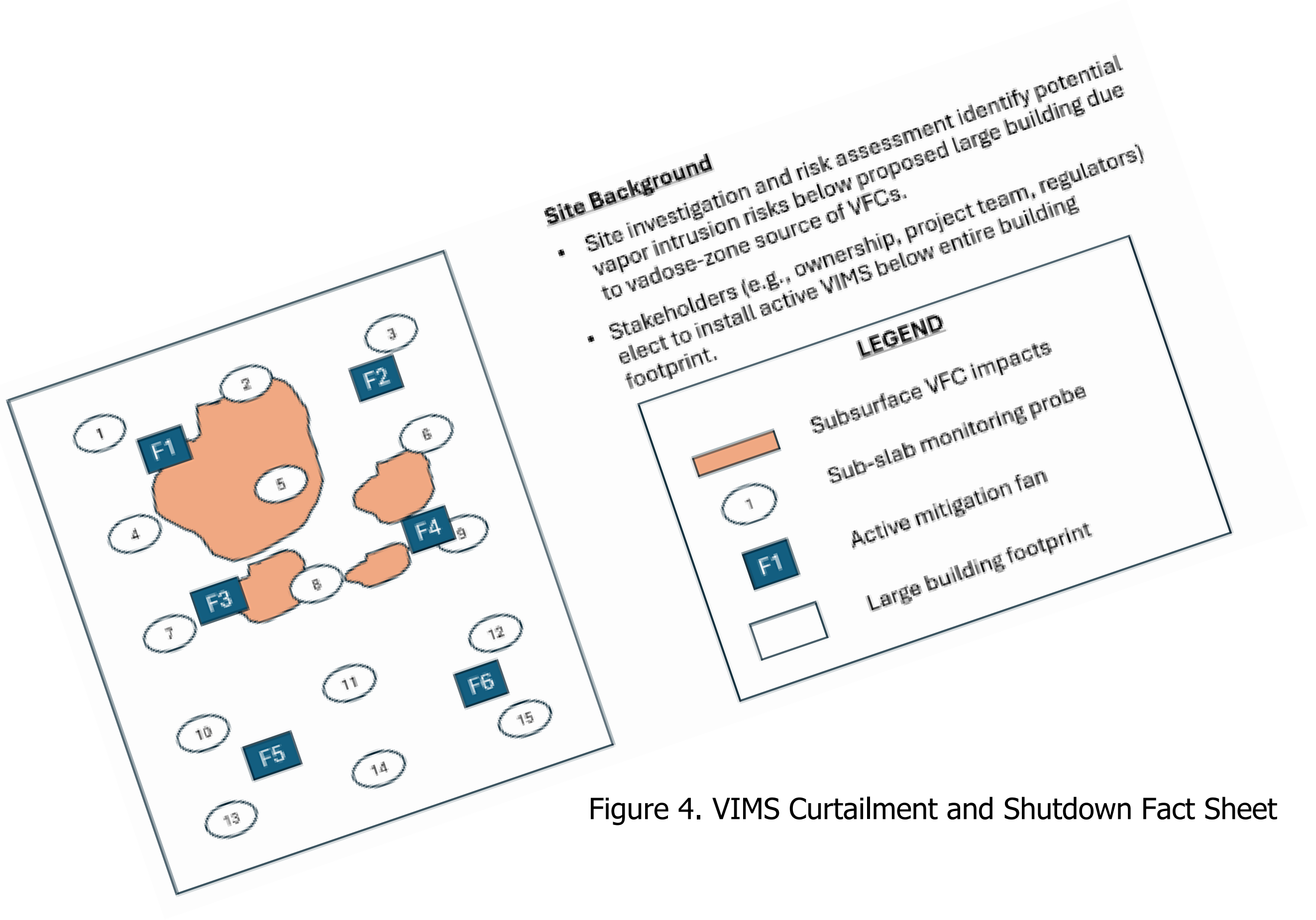
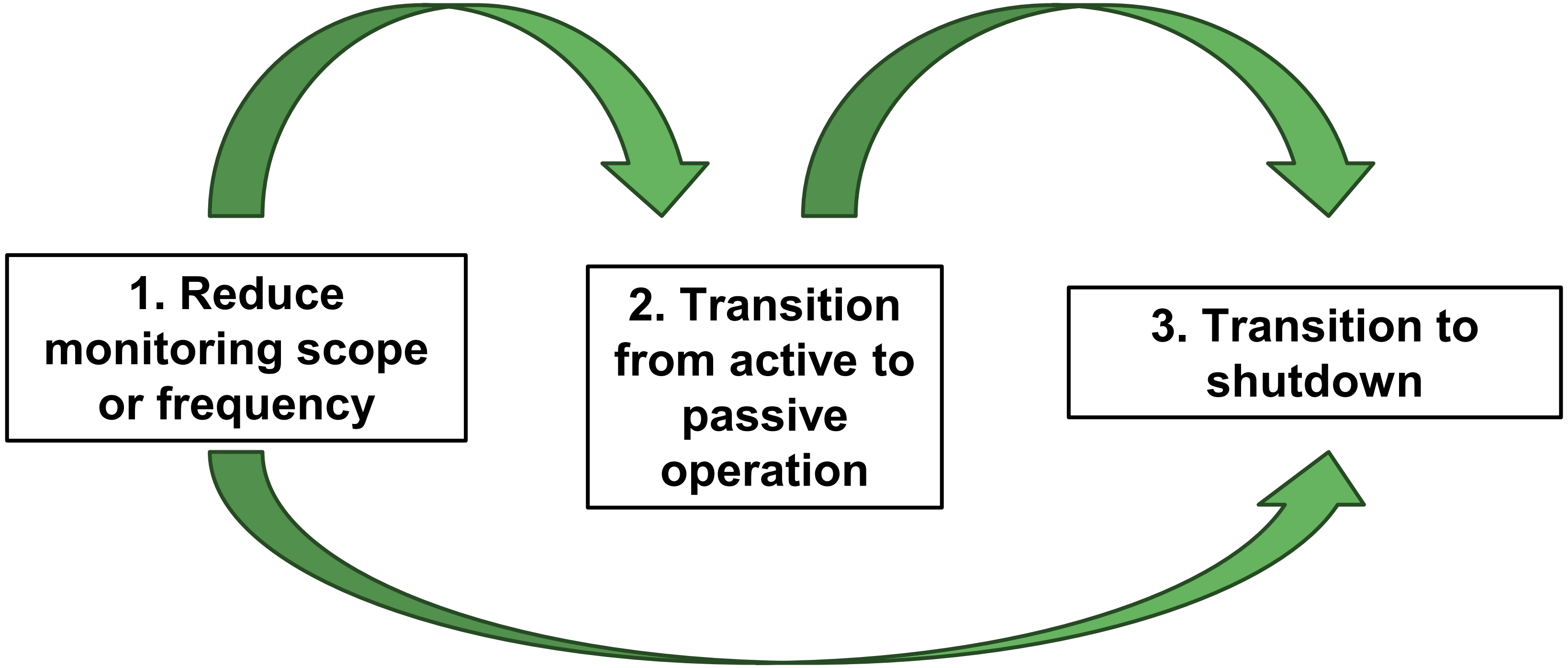


Figure 4. VIMS Curtailment and Shutdown Fact Sheet

VIMS Curtailment and Shutdown Fact Sheet



Use multiple lines of evidence

- Chemical data (SSV, IA)
- Modeling
- Building-specific AFs
- Mass flux

VIMS Curtailment and Shutdown Fact Sheet

Use multiple lines of evidence over multiple events to evaluate and justify curtailment or shutdown

- Develop and evaluate strategy early
- Evaluate performance over time
- Use multiple lines of evidence to justify changes
- Communicate and plan with pertinent stakeholders

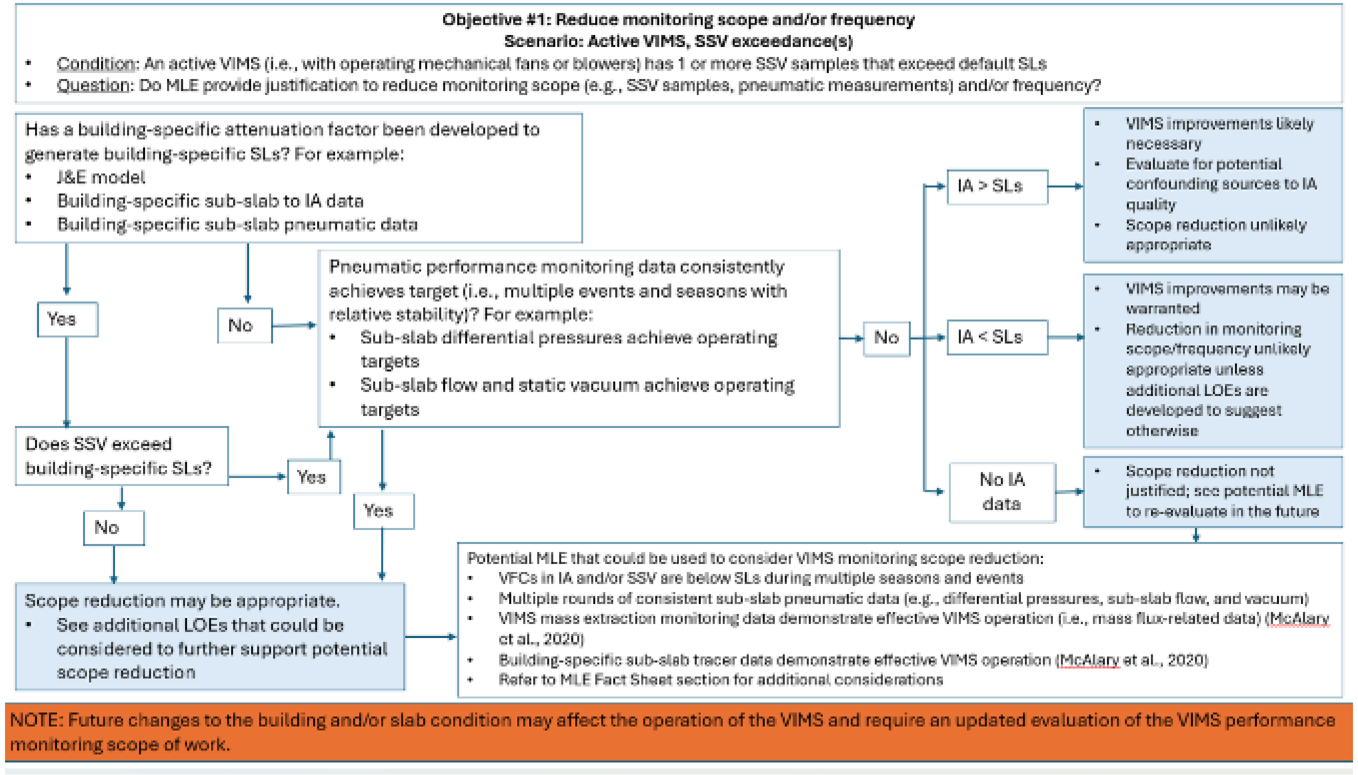


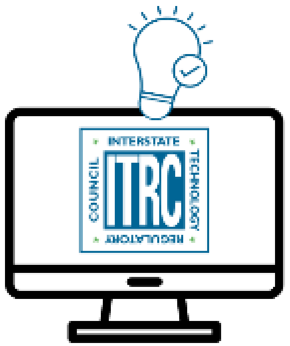
Figure 1. VIMS Curtailment and Shutdown Fact Sheet

Knowledge Check

Check In!

Which is the most important data to use to support VIMS curtailment and/or shutdown?

- The data from the first event
- The data from the last event
- Differential pressure data
- Multiple lines of evidence over multiple events



Knowledge Check

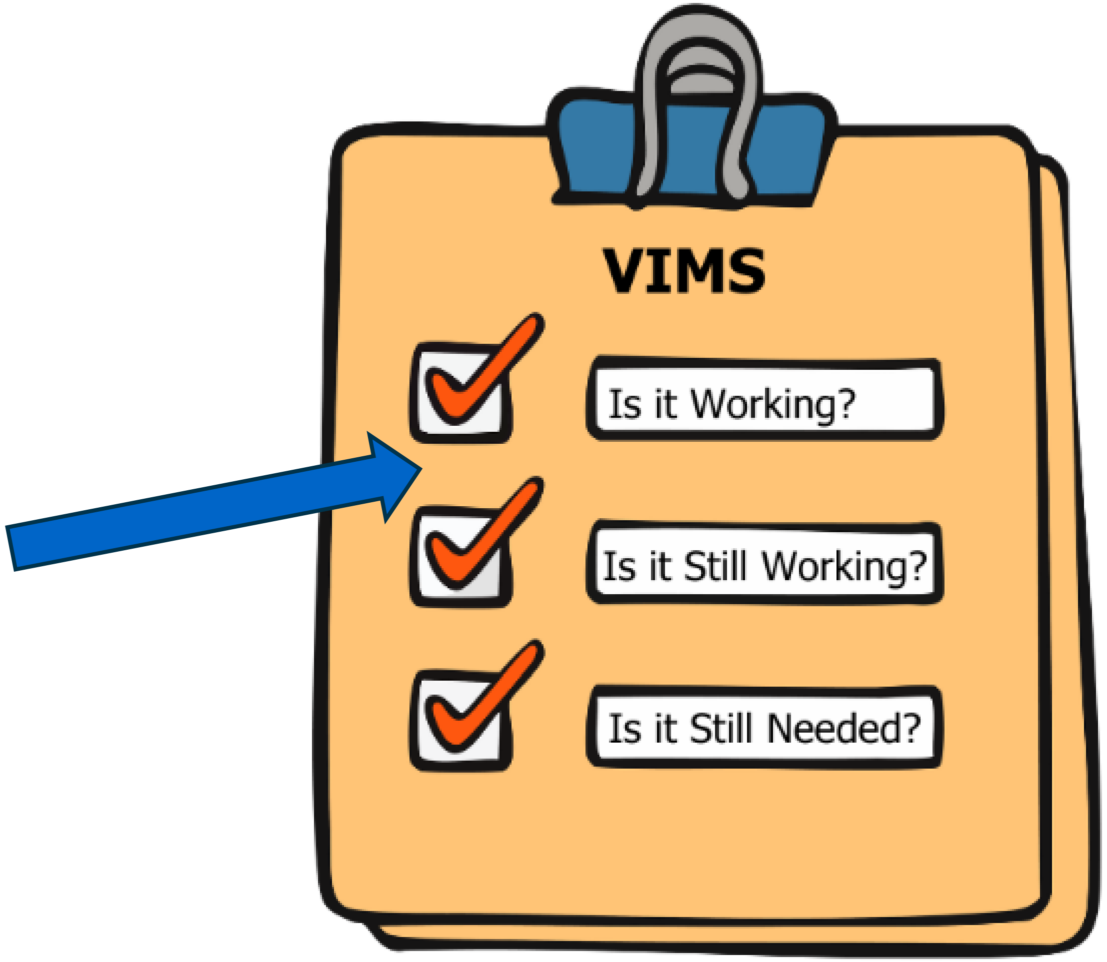
Check In!

Which is the most important data to use to support VIMS curtailment and/or shutdown?

- The data from the first event
- The data from the last event
- Differential pressure data
- Multiple lines of evidence over multiple events should be used to drive decision making

Summary

- Early planning and regular communication is critical
- Different techniques, tools, and approaches are considered for a wide range of scenarios
- ITRC provides comprehensive planning and delivery tools (fact sheets and field checklists) covering multiple technologies



Today's Training Topics

VIM Session 1

Introduction

Conceptual Site Model for VI Mitigation

Community Engagement for VI Mitigation

Rapid Response and Ventilation

Remediation and Institutional Controls

Active Mitigation Approaches

Passive Mitigation Approaches

System Verification, OM&M, Curtailment and Shutdown

Closing

VIM Session 2

2026 Vapor Intrusion Trainings

Vapor Intrusion YouTube Playlist

Understanding Vapor Intrusion: Introductory Concepts & Fundamentals: Session 2

Vapor Intrusion Mitigation: Session 2

Understanding Vapor Intrusion: Introductory Concepts & Fundamentals: Session 1

Vapor Intrusion Mitigation: Session 1

Vapor Intrusion Trainings

Thank You!

Certificate of Completion: https://www.clu-in.org/conf/itrc/vim-1/