Vapor investigation and mitigation decision best management practices

Purpose

This best management practices (BMPs) document describes the processes used to conduct vapor investigations and provides a mitigation decision framework for determining when building mitigation is necessary.

This document is applicable to the following Minnesota Pollution Control Agency (MPCA) Minnesota Environmental Response and Liability Act programs:

- Resource Conservation and Recovery Act
- Superfund
- Site assessment
- Voluntary investigation and cleanup

If you are conducting vapor investigation on a Petroleum Remediation Program site, please refer to MPCA Guidance Document 4-01a Vapor intrusion assessments performed during site investigations (https://www.pca.state.mn.us/sites/default/files/c-prp4-01a.pdf).

When is vapor investigation necessary?

Vapor investigation is necessary whenever there is a known or potential release of vapor forming chemicals. Vapor forming chemicals are defined in the June 2015, U.S. Environmental Protection Agency (EPA) "Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Source to Indoor Air" (2015 EPA Technical Guide). If a vapor forming chemical is identified as part of a release or potential release and the chemical is not on the TO15 Minnesota soil gas list (Appendix A) and/or an intrusion screening value (ISV) has not been derived, contact the MPCA project team for assistance.

Some examples of potential sources of vapor forming chemicals include:

- Known and suspected releases
- Shallow groundwater contamination
- The presence of non-aqueous phase liquids

What are the main goals of vapor investigation?

The main goals of vapor investigation are:

- Determine the extent and magnitude of soil gas impacts also referred to as the vapor intrusion (VI) area of concern (AOC)
- Evaluate VI risk to building receptors
- Determine if building mitigation is necessary

  (If building mitigation is necessary, refer to the MPCA vapor mitigation BMP (https://www.pca.state.mn.us/sites/default/files/c-rem3-06.pdf)

What are the vapor investigation steps?

There are five general vapor investigation steps summarized below. Not all of the steps may be applicable for all sites. MPCA has also developed five geographic information systems (GIS) VI map templates corresponding to each step to document the results of the work performed and to provide an effective way to readily communicate the information collected. These templates should be used to create site-specific maps and be included in the vapor investigation results submitted to MPCA. An introduction to the VI map templates can be found on the MPCA website at: https://www.pca.state.mn.us/sites/default/files/c-s4-10.pdf.

A zip folder containing the map templates and associated GIS files can be found at: https://www.pca.state.mn.us/sites/default/files/Vapor_Intrusion_Map_Templates.zip.

Step 1 – GIS Template 1 – Evaluate known and potential vapor release sources, and identify buildings and their use (i.e. residential, industrial, commercial)

Step 2 – GIS Template 2 – Conduct soil gas and/or sub-slab investigation within the immediate vicinity of known and potential VI release sources

Step 3 – GIS Template 3 – Determine VI AOC based on the soil gas and/or sub-slab sample results

Step 4 – GIS Template 4 – Make vapor mitigation decisions for buildings based on building specific investigation results and building conditions

Step 5 – GIS Template 5 – Establish vapor mitigation area based on the defined extent and magnitude of vapor impacts and building mitigation status

The following sections provide additional details on each of the VI investigation steps.

Step 1 – Evaluate vapor sources and identify nearby buildings and their use

First, review available site information to determine if there is a known and/or potential release source of vapor forming chemicals. When there is a known and/or a potential source of a vapor forming chemical(s) and a building receptor, there is potential for VI risk that must be investigated.

Next, identify building receptors and building use (residential, commercial, industrial, etc.) within 100 feet of known and/or potential release sources of vapor forming chemicals. Building receptors can include both existing habitable structures and proposed new buildings that are designed for human occupancy.

Illustrate known and/or potential release sources of vapor forming chemicals and building receptors (include usage, i.e. residential or commercial/industrial) on GIS Template 1.

Step 2 – Conduct soil gas and/or sub-slab investigation

Soil gas and/or sub-slab samples should be collected within 100 feet of known or suspected vapor sources to define extent and magnitude of soil gas impacts and develop a VI AOC. Use GIS Template 2 to assist in developing the proposed VI investigation sampling locations and illustrate the proposed sample locations.

Collect soil gas and/or sub-slab samples within a 100 feet buffer of known or suspected vapor sources [i.e. groundwater plumes, known volatile organic compounds (VOC) release sources]. If soil gas and/or sub-slab concentrations are detected above 33 times an ISV (33X ISV) a vapor source with potential VI risk is present. A list of ISVs for vapor intrusion risk evaluation and an associated technical support document for ISVs can be found at the following link: https://www.pca.state.mn.us/waste/intrusion-screening-values.

Multiple sampling events are necessary due to the temporal and seasonal variability that can be observed in soil gas and sub-slab sampling to conclude there is not a potential VI risk. EPA's 2015 Technical Guide states, "Seasonally variable conditions (e.g., soil moisture levels, depth to groundwater) can lead to seasonally variable concentrations and distributions of vapors in the vadose zone. An individual sample (or single round of sampling) would be insufficient to characterize seasonal variability, or variability at any other time scale."

The minimum sampling necessary to address seasonal temporal sampling for vapor investigation includes collecting samples at least 30 days apart and under differing seasonal conditions as follows:

- One sampling event in the heating season, which MPCA defines as November 1 thru March 31
- One sampling event in the non-heating season, which MPCA defines as April 1 thru October 31

Collect soil gas and sub-slab samples in accordance with the sampling methodologies included as Appendix B. Appendix C consists of a table with a recommended number of sub-slab samples to collect based on building size.

If the first round of samples collected indicate that a vapor screening level (i.e. 33X ISV) is exceeded, the next phase of investigation (or mitigation for sub-slab samples) can commence without collecting a second seasonal sample. If both seasonal soil gas-sampling events within 100 feet of a building are less than 33X ISVs, a building specific investigation (sub-slab sampling and VI building survey) will typically not be necessary. However, if site contaminant conditions are not stable (i.e. migrating soil gas or groundwater plumes), ongoing sentinel soil gas monitoring may be required. If soil gas concentrations within 100 feet of a building receptor are greater than ISVs, and there is reason to believe that use of the 33X ISV screening level is not valid based on building conditions, a VI building survey (Appendix D) should be conducted to determine if a building specific vapor assessment is necessary.

Historic VOC analytical data for a soil gas or sub-slab sample is generally acceptable if the sample was collected within the previous two years. However, if there is a recent known or suspected release after the historic analytical data was collected, and/or evidence of groundwater or soil gas migration, two current rounds of seasonal soil gas or sub-slab sampling are necessary.

Step 3 – Determine VI area of concern

The VI AOC defines the area where building specific investigation (VI building survey and sub-slab sampling) is necessary. However, building specific investigation can commence before, and/or concurrent with, defining the VI AOC. The VI AOC can be delineated through:

- Soil gas sampling
- Sub-slab sampling
- A combination of soil gas and sub-slab sampling concurrently

The VI AOC is defined by the area where sub-slab and/or soil gas concentrations are detected above the applicable vapor screening level (33X ISVs or ISVs if attenuation factor is not valid). If the VI AOC extent is not defined (e.g. perimeter soil-gas concentrations > 33X ISV or ISV if attenuation factor is not valid) in all directions, continue collecting soil gas and/or sub-slab samples outward in all undefined directions until the vapor impacts are defined. For non-responsible parties conducting VI investigation on their property, the VI AOC should be defined to the property boundaries and all buildings on the property within the VI AOC should be evaluated for potential VI risk.

Two sub-slab or soil gas-sampling events are the minimum requirement to document that there is not a VI AOC. This consists of two seasonal (described in Step 2 above) soil gas or sub-slab sampling events within 100 feet of known or potential vapor sources.

Document the VI AOC on GIS Template 3. The original VI AOC will likely be updated and revised as the vapor investigation progresses and additional sampling data is obtained.

Step 4 – Make vapor mitigation decisions

The following sections provide guidance on making mitigation decisions. There are two mitigation decision frameworks based on the type of building use. The two building use categories are:

1. Residential
2. Commercial and/or industrial

The residential building use category includes the following; single family homes, multi-family housing (apartments, townhomes, condominiums, etc.), long-term care facilities, correctional housing, childcare centers, and schools. Buildings in the residential building use category should be evaluated using the residential framework.

Residential building mitigation decision framework

The decision to mitigate residential buildings is based on **potential VI risk to the building**. Potential VI risk is determined by collecting sub-slab samples from beneath the building and evaluating building conditions to determine if it is valid to use the 33X ISV screening level to evaluate the sub-slab sampling results. All references to ISVs in this section correspond to the **residential ISVs**.

Steps for evaluating potential VI risk to a residential building and determining if building mitigation is necessary are provided below. Mitigation decisions based on sub-slab sampling results and building conditions are also summarized in Table 1 below.

1. Property owners have the responsibility of notifying building occupants of the vapor intrusion investigation. The Minnesota Department of Health (MDH) fact sheet titled *Your Health and Vapor Intrusion* (https://www.health.state.mn.us/communities/environment/hazardous/docs/spresidential.pdf), provides information about the potential risks to sensitive individuals from vapor intrusion. This fact sheet provides MDH contact information and describes a process for sensitive individuals to notify MDH. Provide the MDH fact sheet to the property owner, and all building occupants when property access is requested at the start of a vapor investigation.
2. Conduct two sub-slab sampling events (one sampling event in heating season and one in non-heating season) to evaluate soil gas concentrations beneath the floor slab. Sub-slab samples should be collected in accordance with the sub-slab sampling methodology found in Appendix B.
3. The number of sub-slab samples to be collected from a building is dependent upon the size (area) of the building foundation and the building construction. Appendix C includes a summary table with a recommended number of sub-slab samples to be collected based on building size.
4. Measure and record pressure differential readings between the indoor building air and the air beneath the building at each sub-slab sampling point with a micro-manometer during each sampling event.
5. Complete a VI building survey (Appendix D) to determine if building conditions warrant the use of 33X ISV when evaluating sub-slab sample results. Per the 2015 EPA Technical Guide, specific building factors that may result in 33X ISV not being valid for a specific building and make the building more susceptible to soil gas entry include:
    - Significant openings to the subsurface that facilitate soil gas entry into the building (e.g., sumps, unlined crawl spaces, earthen floors) other than typical utility penetrations.
    - Buildings with deteriorating basements or dirt floors, which generally provide poor barriers to vapor (soil gas) entry.
6. For buildings where use of the 33X ISV screening level is valid based on building conditions, compare sub-slab soil gas concentrations to 33X ISVs. If sub-slab concentrations for either sampling event (heating season or non-heating season) exceed 33X ISVs, building mitigation is necessary.
7. For buildings where the use of the 33X ISV screening level is not valid based on building conditions, collect soil gas samples from a depth of three feet below the building floor level in accordance with the recommended number of samples per building foundation area in Appendix C. If collection of soil gas samples from a depth of three feet is not feasible due to shallow groundwater or bedrock, collect paired 24-hour indoor air and outdoor air samples to evaluate VI risk to the building. Compare the soil gas or indoor air samples concentrations directly to the appropriate ISVs to determine the need for mitigation. **Building mitigation is necessary** if any soil gas or indoor air sample concentrations for either seasonal sampling event exceed the ISVs, and the presence and concentration of the chemical of concern (COC) cannot be attributed to an indoor or outdoor ambient source.

8. When vapor mitigation is necessary for a residential building, an active vapor mitigation system should be installed and verified. Additional details regarding active mitigation system installation and verification testing can be found in the MPCA's vapor mitigation best management practices (MPCA form c-rem3-06 dated March 2020).
9. Section 6.3.3 of the 2015 EPA Technical Guidance also recommends that appropriate lines of evidence be evaluated to assess building susceptibility to soil gas entry (e.g. concurrently monitoring indoor air samples for presence of radon and finding radon in indoor air at levels greater than in ambient air). In addition to the sampling, investigation and building specific assessment in this BMP, appropriate lines of evidence may also be evaluated on a site-specific basis to assist in determining a building's susceptibility to VI. Contact the MPCA Project Team to discuss site-specific appropriate lines of evidence.
10. An additional important part of the mitigation decision process is determining if expedited actions are needed to protect human health. Expedited action decisions are discussed after Table 2 under the section titled "**When should expedited action be evaluated**?"
11. Illustrate the vapor mitigation decision for each building on GIS Template 4.

Table 1 – Residential mitigation decision – based on sub-slab sampling

	Mitigation decision	
Sub-slab concentrations	**33X ISV is valid[1]**	**33X ISV is NOT valid[1]**
SS[2] < ISV	Active mitigation is not necessary Additional sampling not required unless Site or building conditions change[3]	Active mitigation is not necessary. Additional sampling not required unless Site or building conditions change[3]
SS[2] > ISV and < 33X ISV	Active mitigation is not necessary Additional sampling not necessary unless Site or building conditions change[3]	Active mitigation is necessary[4] OR Sample paired sub-slab (or soil-gas below building), indoor and outdoor air and report results to MPCA immediately to determine mitigation action[4] OR Address building conditions so 33X ISV screening level is valid, then repeat seasonal sub-slab sampling to determine mitigation[4]
SS[2] > 33X ISV and <33X EISV	Active mitigation is necessary[4]	Active mitigation is necessary Determine the need for expedited[5] action
SS[2] > 33X EISV	Active mitigation is necessary[4] Determine the need for expedited[5] action	Active mitigation is necessary[4] Determine the need for expedited[5] action

Notes: **SS** = Sub-slab; **ISV** = Intrusion screening value; **EISV** = Expedited intrusion screening value

Active Mitigation Necessary | Expedited Action Evaluation

[1] The validity of using 33X ISV for attenuation of sub-slab vapors is based on the building conditions, which are evaluated as part of the VI building survey.

[2] Requires two seasonal samples to make determination that mitigation is not necessary. If initial sample concentrations exceed 33X ISV, the decision to progress to mitigation of the building can be made with one sample

[3] Examples of changed site conditions can include but are not limited to; migration of a soil gas and/or groundwater plume, changed building conditions (i.e. cracks in floor, building additions, HVAC changes)

[4] If Trichloroethylene (TCE) is present in the sub-slab or soil gas below the building above the ISV, and the attenuation factor is **not** valid and a woman who is pregnant or may become pregnant is present, expedited action is necessary. If the TCE sub-slab is >33X ISV, and the attenuation factor is valid and a woman who is pregnant or may become pregnant is present, contact MPCA to determine if expedited action is necessary.

[5] Expedited action = paired sub-slab, indoor air and outdoor air sampling or system installation work shall begin as soon as possible and no longer than 30 days after receiving laboratory analytical results.

Commercial and industrial building mitigation decision framework

The decision to mitigate commercial and industrial buildings is also based on **potential VI risk to the building.** All references to ISVs in this section correspond to the **commercial/industrial ISVs**.

Steps for evaluating VI risk to a commercial and/or industrial building and determining if building mitigation is necessary are provided below. Mitigation decisions based on sampling results are also summarized on Table 2.

1. Property owners have the responsibility of notifying building occupants of the vapor intrusion investigation. The MDH fact sheet titled *Your Health and Vapor Intrusion* (https://www.health.state.mn.us/communities/environment/hazardous/docs/vihlthcommercial.pdf), provides information about the potential risks to sensitive individuals from vapor intrusion. This fact sheet provides MDH contact information and describes a process for sensitive individuals to notify MDH. Provide the MDH fact sheet to the property owner, and all building occupants when property access is requested at the start of a vapor investigation.
2. Conduct two sub-slab sampling events (one sampling event in heating season and one in non-heating season) to evaluate soil gas concentrations beneath the floor slab. Sub-slab samples should be collected in accordance with the sub-slab sampling methodology found in Appendix B.
3. The number of sub-slab samples to be collected from a building is dependent upon the size (area) of the building foundation, the building construction and areas of known or suspected contamination. Appendix C includes a summary table with a recommended number of sub-slab samples to be collected based on building size. Additional samples may be necessary to define vapor impacts beneath a building within known or suspected contamination.
4. Measure and record pressure differential readings between the indoor building air and the air beneath the building at each sub-slab sampling point with a micro-manometer during each sampling event.
5. Complete a VI building survey (Appendix D) to document building conditions to determine if conditions warrant the use of 33X ISV when evaluating sub-slab sample results. Per the 2015 EPA Technical Guide, specific building factors that may result in 33X ISV not being valid for a specific building and make the building more susceptible to soil gas entry include:
    - Significant openings to the subsurface that facilitate soil gas entry into the building (e.g., sumps, unlined crawl spaces, earthen floors) other than typical utility penetrations.
    - Buildings with deteriorating basements or dirt floors, which generally provide poor barriers to vapor (soil gas) entry
6. For buildings where the use of the 33X ISV screening level is valid (based on building conditions), compare the sub-slab soil gas concentrations to 33X ISVs and 33X EISVs.
    - If sub-slab concentrations for any sampling event exceed 33X ISVs, **building mitigation is necessary** (refer to Mitigation BMP, https://www.pca.state.mn.us/sites/default/files/c-rem3-06.pdf).
    - If sub-slab concentrations exceed 33X EISVs, **building mitigation is necessary** and contact the MPCA project team to determine the need for expedited action (see "When should expedited action be evaluated" section below).
7. For buildings where the use of the 33X ISV screening level is not valid based on building conditions, collect soil gas samples from a depth of 3 feet below the building floor level in accordance with the recommended number of samples per building foundation area in Appendix C. If collection of soil gas samples from a depth of 3 feet is not feasible due to shallow groundwater or bedrock, collect paired 24-hour indoor air and outdoor air samples to evaluate VI risk to the building. Compare the soil gas or indoor air samples concentrations directly to the appropriate ISVs to determine the need for mitigation. **Building mitigation is necessary** (refer to Mitigation BMP, insert Link) if any soil gas or indoor air sample concentrations for either seasonal sampling event exceed the ISVs, and the presence and concentration of the COC cannot be attributed to an indoor or outdoor ambient source.

8. An additional important part of the mitigation decision process is determining if expedited actions are needed to protect human health. Expedited action decisions are discussed below after Table 2 under the section titled "**When should expedited action be evaluated**?"

9. Illustrate vapor mitigation decisions for buildings on GIS Template 4.

Table 2 – Commercial/Industrial mitigation decision – Based on sub-slab sampling

Sub-slab concentrations	Mitigation decision	
	33X ISV is valid[1]	**33X ISV is NOT valid[1]**
SS[2] < ISV	Active mitigation not necessary Indoor air sampling not necessary Additional sampling not necessary unless Site conditions change[3]	
SS[2] > ISV and < 33X ISV	No further investigation or mitigation is necessary unless site conditions change[3]	Active mitigation is necessary[4] OR Sample paired sub-slab (or soil-gas below building), indoor and outdoor air and report results to MPCA immediately to determine mitigation[4] OR Address building conditions so 33X ISV screening level is valid, then repeat seasonal sub-slab sampling to determine mitigation[4]
SS[2] > 33X ISV and <33X EISV	Active mitigation is necessary[4]	Active mitigation is necessary[4] Determine the need for expedited[5] action
SS[2] > 33X EISV	Active mitigation is necessary[4] Determine the need for expedited[5] action	Active mitigation is necessary[4] Determine the need for expedited[5] action

Notes: EISV – Expedited ISV; **ISV** – Intrusion screening value; **SS** – sub-slab

Active Mitigation | Expedited Action Evaluation

[1] The validity of using 33X ISV for attenuation of sub-slab vapors is based on the building conditions, which are evaluated as part of the VI building survey.

[2] Requires two seasonal sub-slab sample events to make determination not to mitigate. If the initial sub-slab sample concentration exceeds 33X ISV, mitigation or indoor air sampling can commence

[3] Examples of changed site conditions can include but are not limited to; migration of an unstable soil gas and/or groundwater plume, changed building conditions (i.e. cracks in floor, building additions, HVAC changes)

[4] If Trichloroethylene (TCE) is present in the sub-slab or soil gas below the building above the ISV, and the attenuation factor is **not** valid and a woman who is pregnant or may become pregnant is present, expedited action is necessary. If the TCE sub-slab is >33X ISV, and the attenuation factor is valid and a woman who is pregnant or may become pregnant is present, contact MPCA to determine if expedited action is necessary.

[5] Expedited action = paired sub-slab, indoor air and outdoor air sampling or system installation work shall begin as soon as possible and no longer than 30 days after receiving laboratory analytical results.

Expedited action evaluation

The following expedited action evaluation discussion applies to residential, commercial and industrial buildings.

The need for expedited action is determined based on the following information:

- Sub-slab sampling results compared to 33X ISVs and 33X EISVs or soil-gas/sub-slab samples compared to ISVs if the building attenuation factor is not valid.
- Building conditions, use, and occupancy, captured on the Building Survey Form (Appendix D).
  - Building occupancy where there may be a **greater potential for exposure** includes when individuals rarely leave the building or spend a significant amount of time in the lowest level of a building.

- Presence of a sensitive person/population, including those that self-identify after receiving the MDH information sheets titled *Your Health and Vapor Intrusion*.
    - Examples of people who may be sensitive include women who are pregnant or may become pregnant, infants/young children, elderly people, and people who are living with a chronic disease or compromised immune system.

Expedited action options include:

- Expedited mitigation – mitigation system installation work shall begin as soon as possible and no longer than 30 days from receipt of laboratory analytical data (standard mitigation installation timeframe is generally 60 to 90 days).
- Expedited paired sub-slab, indoor air and outdoor air sampling and pressure differential measurements at the sub-slab sampling points to determine if vapor intrusion is occurring or likely to occur (expedited sampling timeframe is sample as soon as possible, rush (three-day turn around) laboratory analysis and report results to MPCA immediately upon receipt).

Expedited action for TCE.

Expedited action **is necessary** for both of the following scenarios when TCE is present.

- Indoor air TCE > ISV, and a woman who is pregnant or may become pregnant is present.
- Sub-slab or soil-gas from beneath the building TCE > ISV, and a woman who is pregnant or may become pregnant is present and the 33X attenuation factor is not valid.

Expedited action **may be necessary** for any of the following scenarios when TCE is present. For these situations, contact the MPCA Project Team.

- Sub-slab TCE > 33X ISV, and a woman who is pregnant or may become pregnant is present and 33X attenuation factor is valid.
- Indoor air TCE > ISV, and a **sensitive individual** (described above) is present with **greater potential for exposure** (described above).

Expedited action for other VOCs.

Expedited action **may be necessary** for any of the following scenarios when VOCs other than TCE are present. For these situations, contact the MPCA Project Team.

- Indoor air > ISV, and a sensitive individual is present with greater potential for exposure.
- Indoor air > EISV.
- Sub-slab > 33X EISV.

Partial building investigation

All buildings within the VI AOC need sub-slab sampling as part of a building specific investigation. The best practice is to investigate the entire building footprint, collecting the density of samples as summarized in Appendix C. However, for larger buildings on the outer boundary of a VI AOC, or larger buildings with a vapor source and/or a recognized environmental condition (REC) in an isolated portion of the building, a partial building investigation (PBI) may be considered to determine the presence and/or extent of the VI AOC beneath the building.

Conditions when PBI is appropriate:

- Building footprint is larger than 30,000 square feet. If the building footprint is less than 30,000 square feet, conduct the building VI investigation in accordance with the appropriate (residential or commercial/industrial) building mitigation decision framework listed above.
- All known vapor sources and RECs within the building footprint must be investigated for VI.
    - Example 1 - If a shallow VOC groundwater plume is present beneath the entire building, VI evaluation for the entire building is necessary.

- Example 2 - If there are other vapor sources and/or RECs in areas of the building that are not within the proposed PBI area, these vapor sources and RECs will also need to be evaluated regardless of where they are located relative to any proposed PBI areas within the building.

- There are no preferential vapor migration pathways beneath the building beyond the PBI area (see preferential vapor migration pathways description/examples below).

Preferential vapor migration pathways

Preferential vapor migration pathways are sub-surface conditions that allow for significant lateral transport of vapors beneath a building. For vapor migration to occur via a preferential pathway, subsurface conditions must allow vapors to reach the preferential pathway – either by direct contact with a vapor source (e.g. vapor plume, contaminated soil/groundwater) or by vapor migration to/along the pathway.

Examples of preferential vapor migration pathways beneath a building include:

- Utility corridors (sanitary sewer, drain tile, HVAC ducts)
- Tunnels
- Permeable fill zones (i.e. utility backfill)
- Soil voids beneath the floor slab
- Geologic features (bedrock fractures, karst terrain, joints, bedding planes, buried streambeds)

Steps for partial building investigation

- Collect sub-slab samples in alternating seasons (heating & non-heating) within a minimum of 30,000 square feet of the building that is within, or closest to, the VI AOC and/or at vapor sources and RECs at the sample density provided in Appendix C.
- Compare the sub-slab sampling results to the appropriate 33X ISV (or ISV if attenuation factor is not valid) based on building occupancy (residential or commercial/industrial) to determine the boundaries of the VI AOC beneath the building, or confirm the absence of a VI AOC beneath the building.
- If there are any vapor sources or RECs within or beneath the building, these areas need to be fully investigated (including sub-slab sampling) regardless of location and proximity to a VI AOC or other areas of PBI within the building.
- Any areas that are preferential vapor migration pathways which lead from the PBI area to other areas of the building that are not being investigated will also require investigation (including sub-slab sampling).
- If the results of the PBI indicate that the VI AOC extends beyond the initial 30,000 square foot PBI area, additional investigation (sub-slab sampling) will be necessary to further define the VI AOC and determine the building mitigation extents.

Partial building mitigation is discussed in the vapor mitigation BMP starting on page 2.

Step 5 – Establish the vapor mitigation area

The vapor mitigation area defines the area where active mitigation is required for building receptors. At this stage of the investigation the extent and magnitude of vapor impacts should be mostly defined and building receptors should be evaluated and mitigated (if required).

- If the extent and magnitude of soil gas impacts are defined and soil gas and groundwater plumes are demonstrably stable: prepare a mitigation area map using GIS Template 5.
- If the extent and magnitude of soil gas impacts are not defined, and/or all sources and potential sources have not been evaluated, conduct additional investigation to evaluate soil, groundwater, and soil-vapor. Repeat vapor investigation steps as necessary to identify additional properties that need building specific investigation. Continue vapor investigation until extent of soil gas and groundwater impacts are defined and stable and building receptors are evaluated and mitigated.

- If the soil gas plume and/or groundwater plumes are not stable, install and sample sentinel groundwater and soil gas monitoring points quarterly to monitor plume stability and evaluate the potential VI risk to buildings outside the vapor mitigation area. The sentinel network sampling frequency should be reviewed annually and may be reduced depending on site conditions.

Brownfield redevelopment

What if my need is only to demonstrate an identified release (IR) of vapor for a brownfield assurance letter?

An IR can be demonstrated with one sampling event. However, to make risk based decisions regarding VI, additional sampling events may be necessary. In addition to soil gas and/or sub-slab sampling, soil and groundwater investigation are necessary to evaluate an IR. Soil gas only investigations are not acceptable to demonstrate an IR and receive assurance letters from the MPCA Brownfield program.

If I am a non-responsible party implementing a Brownfield redevelopment project, do I have to conduct vapor investigation work beyond the property boundary?

Typically, the answer is no. However, the non-responsible party will need to define the VI AOC on their property and conduct building specific investigations and mitigation as necessary, for all habitable structures and proposed buildings within the VI AOC on the property. It is typically not necessary for a non-responsible party to investigate the VI AOC beyond the property boundary unless the party is seeking an off-site source determination assurance letter or a no action/no further action letter and the contamination is migrating off the property. If the VI AOC extends beyond the property boundaries, the IR may be referred to the MPCA Site Assessment program for further investigation. Non-responsible parties are responsible for assuring and documenting that VI does not pose a risk to proposed and existing buildings that are part of the redevelopment.

How can I resolve the VI pathway for proposed building receptors?

Collect soil gas samples at any known or suspected release areas and collect a sufficient number of soil gas samples to define the vapor AOC on the property including within the proposed building footprint (see Appendix C for appropriate sampling depths based on construction and sampling frequency).

If soil gas concentrations (or sub-slab concentrations in an existing building) within the proposed building footprint exceed 33X ISVs (or ISVs if attenuation factor is not valid), there are two options:

1. Mitigate the building based on the pre-construction action level exceedances and conduct post-construction, post-mitigation verification testing (diagnostic testing and analytical sampling) in accordance with the MPCA vapor mitigation BMP.
2. If corrective actions (i.e. contaminated soil removal) that may address vapor sources are proposed as part of a redevelopment plan, contact the MPCA project team to discuss appropriate VI risk assessment for the proposed building based on the proposed corrective actions. Proposed VI risk assessment should be included in the Response Action Plan submittal for MPCA review and approval.

What assurances are available from the MPCA's Brownfields program for vapor releases?

Please note that the Brownfield Program will not issue any soil vapor closure letters based on "vapor-only" investigations. Soil vapor data for the site must be accompanied by meaningful soil and/or groundwater data, based on potential sources of contamination.

The "Completion of Soil Vapor Assessment" and "Completion of Vapor Mitigation Response Actions" letters are technical assistance letters that are available to non-responsible parties who are enrolled in the VIC program. These letters are provided in lieu of a No Action/No Further Action letter when soil vapor impacts identified at the VIC site may pose a potential risk to off-site receptors. To qualify for the technical assistance letters, which pertain only to the on-site soil vapor impacts, the extent and magnitude of the soil vapor release must be defined to the VIC site boundaries and on-site vapor intrusion mitigation activities must be completed, if necessary. It is important to note that in order to fully define a potential vapor intrusion AOC at the site, exterior soil vapor sampling is often necessary, in addition to sub-slab soil vapor sampling. Building-only investigations are often too limited in scope and may lead to an MPCA request for additional soil vapor data, which can cause a delay in site closure.

The “Petroleum No Action” letter is a technical assistance letter available to applicants enrolled in the Petroleum Brownfields Program. This letter is provided when the MPCA has concluded that the extent and magnitude of petroleum impacts to all media, including soil vapor, have been defined, do not pose a risk to human health or the environment, and no additional action is required with regard to the petroleum release.

Detailed descriptions of available services and assurances can be found in the MPCA’s Brownfield Program Services document. For more information regarding available assurances and necessary sampling at a specific site, please contact the MPCA Brownfields staff assigned to your project.

Acronym list

AOC	Area of concern
BMP	Best management practices
COC	Chemical of concern
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information Systems
HVAC	Heating ventilation and air conditioning
IR	Identified release
ISVs	Intrusion Screening Values
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
PBI	Partial Building Investigation
REC	Recognized environmental condition
VI	Vapor intrusion
VOCs	Volatile organic compound

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