

Item # 3: Scope of Work

Installation of VI Mitigation Systems

Pompton Lakes, Passaic County

Design

1. Arrange dates for design visit.
2. Complete Communication Testing and related actions (see Design Requirements, page 2).
3. Consult with homeowner about system design requirements (e.g., system suction points, piping and fan location, vent pipe material, electrical tie-ins, fan cover).
4. Record the communication test results and all related design activities in a standardized checklist.
5. Prepare a drawing of the system design.
6. Get homeowner's sign-off on final design drawings.
7. Submit design drawings to borough and obtain appropriate permits (construction/electrical). In addition, submit design drawings and supporting design information to NJDEP/USEPA for sign-off.
8. After permit approval and NJDEP/USEPA sign-off, arrange date for installation from homeowner.
9. Notify NJDEP/USEPA inspectors 2 weeks in advance of the installation.

Installation

1. Install the mitigation system consistent with the Installation Requirements (page 4) and inspection checklist (Attachment A).
2. Arrange date for system inspection by borough.
3. Notify NJDEP/USEPA when the installation is complete for final inspection.

Post-Mitigation Process & Reporting

1. Arrange dates for post-mitigation confirmation process no less than 30 days after commissioning.
2. As part of the post-mitigation confirmation process, collect indoor air and ambient air samples.
3. Prepare Remedial Mitigation Report (RMR) consistent with the Post-Mitigation Process & Reporting Requirements (page 6).
4. Submit all air analytical results with the RMR to NJDEP/USEPA for review.

Operation & Maintenance (O&M)

1. Arrange dates for quarterly (every three months) inspections of mitigation system for the first year following commissioning. Reduction to annual inspections after the first year may be appropriate (with NJDEP/USEPA approval).
2. Conduct the O & M inspection consistent with the O&M Requirements (page 8).

Design Requirements

For active subsurface depressurization (SSD) systems, a communication test is required for each structure as part of the design phase to assist in the determination of the suction point location(s) and fan size. In addition, a communication test must then be conducted at the time of installation to confirm that the installed suction point(s) is depressurizing the entire building slab. The principal design criterion is the depressurization of the entire slab.

The test involves drilling an extraction hole in the same location where the suction point is expected to be installed and applying suction (using a shop vacuum or similar device). The extent of the suction field is then determined at observation holes placed at representative locations (roughly four corners) across the slab in unobtrusive spots such as utility closets. Digital micromanometers or other types of small differential-pressure monitoring devices are utilized to quantify the suction field at the observation holes. The vacuum at the extraction point shall be recorded. The communication test shall be conducted under “worst case conditions” during which the structure is maximally depressurized (with all windows and doors closed and while running the furnace, hot water heater, dryer, fan vents, etc.).

In structures where the concrete slab is highly deteriorated with major cracks (or there is a dirt floor), actions may be required to repair the slab (or install a new slab) prior to the implementation of the communication test. Consult with the NJDEP/USEPA before installing a new slab. However, this provision is not applicable to crawl spaces with dirt floors.

Suction fields below the slab may be interrupted by existing subslab features (e.g., grade beams, footings, foundation walls) and require the installation of additional suction points. In other situations, drain pipes and sump pumps can be utilized as suction points if properly sealed and converted.

Under the maximum building depressurization, the sub-slab depressurization systems must achieve a pressure differential of at least 0.004 inches of water across the entire slab. Deviations from this value may be considered in cases where subsurface soils/fill are highly permeable and large volumes of air can be evacuated with little pressure drop. Under these parameters, air is to be drawn through the sub-slab soils, diluting the contaminants in the subsurface. Thus, sub-slab ventilation (instead of depressurization) reduces the concentration of contaminants entering the building. In these situations, a smoke test shall be employed to verify proper ventilation under the entire slab. Sub-slab ventilation (SSV) systems have been installed (full or partial) in a very limited number of houses within the Pompton Lakes plume area.

Alternative mitigation systems other than sub-slab or submembrane depressurization systems may be identified based on the results of the initial design. Any alternative mitigation system, including SSV systems, must be approved by NJDEP/USEPA in advance of installation.

Backdraft tests must be performed on all appliances and heating systems in the lowest floor that exhaust combustion gasses during their operation (e.g., heaters, clothing dryers, hot water heaters). Backdraft tests are performed during design and immediately following installation to check if a pre-existing backdraft condition exists in the home and to ensure the mitigation system does not create a backdraft condition. The backdraft test that is performed is a “simple smoke visualization test”. Chemically generated smoke (inert smoke-like fine powder) is released around the exhaust vents or intakes of the above listed appliances and the stream of smoke should move toward the opening

indicating air flow movement. This test should be performed under maximum building depressurization conditions (exterior and interior doors and windows closed, and with any exhaust systems on – kitchen fans, bathroom fans, clothing dryer and heater). This procedure is described in the USEPA document “Radon Reduction Techniques for Detached Houses” (EPA/625/R-93/011), Section 11.5.1.

For buildings with accessible crawlspaces, submembrane depressurization (SMD) systems are the most common and effective mitigation system. SMD systems employ a membrane as a substitute for the slab to permit depressurization of the soils. A proper seal must be established with the membrane and all edges of the foundation wall or footings, as well as any pipe penetrations through the membrane. SMD systems are typically used in combination with SSD systems. The Design Phase must assess the ability to utilize an SMD system for existing accessible crawlspaces.

Inaccessible crawlspaces can be mitigated using ventilation. Ventilation is provided in the crawlspace using a 1- or 2-inch pipe. The design target velocity is calculated based on the crawlspace volume, pipe size, and a target air exchange rate of 0.70 air exchanges per hour. A sample port shall be installed in the pipe to measure air velocity.

Both accessible and inaccessible crawlspaces that are isolated from the main basement area can also be mitigated by natural ventilation – either through existing vents or through the installation of additional vents. The adequacy of the ventilation shall be determined based on one square foot of opening per 150 square feet of crawlspace.

Building-specific modifications shall be implemented to the mitigation system and related components when disabilities or significant concerns of the occupants necessitate it. For example, the alarm system (required for ALL systems) shall be installed in an appropriate place on the first floor for people that have hearing problems or difficulties walking up or down stairs.

The installer shall work with all homeowners to identify the locations for the external fan, system suction points, overhead piping, and the alarm system. In addition, the homeowner can decide whether they want the fan discharge (vent) pipe made of aluminum downspout or PVC piping. Fan covers, while not technically necessary, shall be installed unless the homeowner requests otherwise.

In situations where a building already has a radon system installed, the installer is required to evaluate the effectiveness of the system to mitigate the vapor intrusion pathway using the same protocols that are applied to every other building. In addition, the NJDEP’s Bureau of Environmental Radiation has additional procedures the installer must conduct to meet the radon requirements for buildings with radon systems. If an existing radon system needs modification to meet the vapor intrusion design requirements described above, a New Jersey certified radon mitigation business must be contracted to complete the radon mitigation work, including the collection of pre- and post-modification radon samples in accordance with NJDEP requirements.

Prepare a drawing of the system design (slab floor plan and fan/stack elevation detail) with the relevant system piping, fan, system suction points, communication test points, communication test suction holes, communication test results, combustion devices tested for back-draft, and plan notes.

The installer should recognize that modifications to the design drawings may become apparent during system installation. Minor modifications are to be expected. All modifications are to be noted on the final as-built drawings and described (with technical justification) in the Remedial Measures Report.

Installation Requirements

The NJDEP has developed a Vapor Intrusion Mitigation System Inspection Checklist that identifies a series of technical design requirements for subsurface depressurization systems. The Checklist covers a variety of technical issues, including system installation and interior piping, general sealing, electrical, SMD, sump pits, monitors and labeling, system vent discharge point, fan installation, and design drawing and as-built drawing requirements. Unless specifically approved by the NJDEP/USEPA, all items contained in the Checklist shall be incorporated into the design for any subsurface depressurization system. Modifications may be required during the installation of the mitigation system due to site-specific building factors and/or preferences of the occupant/owner.

System suction points shall be constructed by drilling a hole through the slab and excavating a 10-20 inch pit with a depth of 10 inches. The pit shall be backfilled with crushed stone.



Audible alarm and system labels

The fan and vertical ventilation pipe shall be located on the exterior of the building. An accessible sampling port shall be installed on the vertical vent pipe. A bypass for condensation drainage shall be provided for the fan to prevent condensate freezing and blockage.

A pressure gauge (e.g., U-tube manometer) shall be mounted in a conspicuous place (NOT inside a crawlspace) at each system suction point to allow occupants to monitor the pressure differential. For pipes installed into inaccessible crawlspaces or submembrane depressurization systems with readings less than -

0.50 inches of water, U-tube manometers with a resolution of 0.125 inches of water shall be installed. An audible alarm shall also be installed to alert occupants in the event of a system malfunction. Labels shall be placed on system components that identify the purpose of the system, as well as the name and phone number of a contact in case there are any problems. In the electrical panel, the appropriate electrical breaker or fuse that powers the mitigation system shall be labeled.

Sealing of accessible cracks and openings in foundations walls and floor slabs is required to avoid short-circuiting of the negative pressure field and to increase the efficiency of the system. Major visible cracks and those indicating connection with the subsurface in floors and walls shall be sealed. These cracks are identified through smoke testing (when the vapor mitigation system is operating). A practical rather than exhaustive level of sealing will generally result in a more conservative design, because the design is not relying on a completely sealed building shell in order to meet performance objectives, and seals may deteriorate over time.



Proper sealing around suction point

To fill wall and slab cracks and prevent air leakage, polyurethane sealants (or similar products) shall be utilized. Sealants containing "low" or no volatile organic compounds are highly recommended.

To reduce the potential for vapors to migrate into structures, utility conduits shall be sealed at the terminus with the structure. These seals shall be constructed using insulating foam sealants (or similar inert gas-impermeable material).

Sumps may provide a preferential pathway for vapors to migrate into a structure. Mitigation designs must include measures to seal these entryways. Air tight covers should be installed over sumps that prevent vapor intrusion, allow for periodic access and still permit active dewatering.

Floor drains that are not connected to the municipal sewer shall be replaced with Dranjer-type devices that allow water to travel down the drain but do not allow vapors to migrate up the drain.

Submembrane depressurization (SMD) systems are to be installed using 60 mil ethylene propylene diene monomer (EPDM) membrane. A proper seal must be established with the membrane and all edges of the foundation wall or footings, as well as any pipe penetrations through the membrane. Each seam of the EPDM membrane (e.g., around the suction point, along the basement wall, where two pieces of membrane were connected together) shall be smoke tested to ensure there are no leaks.



Once installed, the system shall be commissioned to verify that it is functioning consistent with the mandated performance specifications and to establish an operational baseline. Depending on subsurface conditions (e.g., high moisture content), additional time may be necessary for the sub-slab area to reach equilibrium. Thus, the baseline performance measurements collected during the initial system commissioning may have to be modified during the first quarterly inspection or verification sampling event.

A communications test shall be conducted to confirm that a pressure differential of at least 0.004 inches of water have been established across the slab under maximum building depressurization. The investigator shall substantiate that back-drafting is not occurring due to the operation of the subsurface depressurization system. After the successful completion of the communication test, the static pressure at each suction point and at the fan inlet, as well as flow measurements for inaccessible areas and sub-slab ventilation systems, shall be recorded (to serve as the operating baseline).

The investigator shall describe and point out the various components of the mitigation system to the owner/occupants, the purpose of the pressure gauge and the contact information if they suspect a problem with the system. The investigator shall provide this same information in writing to the home owner/occupants in the form of a fact sheet.

Post-Mitigation Process & Reporting Requirements

After the mitigation system is operational, post-mitigation confirmation shall be conducted. One indoor air sample (from the basement or lowest floor) and one ambient (outdoor) air sample shall be collected, consistent with the NJDEP Vapor Intrusion Guidance document. The sampling event shall be conducted no less than 30 days after the mitigation system is started to verify the effectiveness of the system. Indoor air sampling events that do not occur during the winter or early spring (November 1st through March 31st) shall necessitate a second round of indoor air sampling during this timeframe. The samples shall be sent to an NJDEP-certified laboratory and analyzed for Low Level TO-15 Method (full list of volatile organic compounds). An "Indoor Air Building Survey and Sampling Form" shall be filled out for each sampling event. **Every effort shall be made to remove likely background sources of indoor air contamination from the building several days prior to the indoor air sampling.**

Site-specific Indoor Air Comparison Levels were developed using the new Low-Level Method TO-15 analytical method at the DuPont Pompton Lakes Works site. Comparison levels for the 10 contaminants of concern are available below.

Chemical	Site-Specific Indoor Air Comparison Levels ($\mu\text{g}/\text{m}^3$)
Carbon tetrachloride	1
1,1-Dichloroethane	510
1,2-Dichloroethane	0.8
1,1-Dichloroethene	220
1,2-Dichloroethene (<i>cis</i>)	36
1,2-Dichloroethene (<i>trans</i>)	73
Tetrachloroethene (PCE)	1
1,1,1-Trichloroethane	1,000
Trichloroethene (TCE)	1
Vinyl chloride	0.5

If the post-mitigation indoor air results (collected during the winter/early spring timeframe) are above the Site-specific Indoor Air Comparison Levels for the contaminants of concern, the installer shall inspect the mitigation system performance and identify indoor air background sources. Resample the indoor air and ambient air samples after system modifications and/or removal of background sources. The pressure readings at the design communication locations shall be measured and recorded to reconfirm that a pressure differential of at least 0.004 inches of water exists across the slab under maximum building depressurization. Other lines of evidence may be required by the NJDEP/USEPA based on building-specific concerns. Using the multiple lines of evidence approach, alternative data (such as the negative pressure field data, Indoor Air Building Survey and Sampling Form) can be utilized to establish that the system is operating appropriately in those situations where it is reasonable to conclude that background sources are impacting the post-mitigation indoor air results.

The one situation where the post-mitigation indoor air results are particularly important is with sub-slab ventilation (SSV) systems. The baseline minimum velocity for the SSV system suction points can only be established upon the receipt of validated sample results that show the contaminants of concern are below the site-specific indoor air comparison levels.

The results from the installation of the mitigation system shall be submitted to the NJDEP/USEPA within 90 days of the initial system commissioning. A separate Remedial Measures Report (RMR) shall be prepared for each property with a copy presented to the property owner upon approval by the NJDEP/USEPA. The RMR shall contain:

- As-built drawings showing all system components and electrical connections, as well as IA and SSSG sampling locations, extraction and observation holes, and mechanical combustion devices (hot water heater, clothes dryer, etc.) tested for backdrafting
- Design drawing prepared prior to installation (and signed by the homeowner)
- Pertinent dates of sampling events, communication testing, and commissioning
- All communication testing results (in table format)
- Static pressure readings and flow measurements upon commissioning
- Post-mitigation IA sampling results with interpretation
- Summary table of the post-mitigation sample results (indoor and ambient air)
- Post-Mitigation Chain-of-Custody Records
- Indoor Air Building Survey and Sampling forms for each sampling event
- Installation Photographs
- Any building permits required by the local municipality
- Explanation and technical justification for any modifications to the original design drawing submitted to the municipality as part of the permit application

All air analytical results shall be submitted with full laboratory data deliverables pursuant to N.J.A.C. 7:26E-2.1(a)17 & 1.18. The following three electronic items shall be included on compact disk (CD) or 3.5 inch diskette with the QA/QC laboratory package:

- Electronic Data Deliverables Format
- Method TO-15 Unit Conversion Table
- Hazsites Electronic Data Submission of Results

Operation & Maintenance Requirements

The investigator shall implement an Operation and Maintenance Program that consists of quarterly inspections of the mitigation system to verify the system's proper operation. The inspections can be reduced to annual after the first year provided the initial inspections reveal no operational deficiencies.

The static pressure of the system suction points and the fan inlet shall be measured and recorded. If the static pressure deviates by more than +/- 0.25 inches of water from its commissioned (baseline) value, then additional investigations (such as pressure field extension testing) shall be conducted to determine the effects, if any, of the change in system performance. Additionally, a minimum of 0.125 inches of water (or greater) must be achieved at system suction points for Submembrane Depressurization (SMD) systems. If the system needs to be modified, depressurization will be re-verified (communication test) and documented accordingly.

The velocity measured at the inaccessible crawlspace system suction point shall be determined and adjusted to maintain +/- 10 % of the calculated design target velocity.

For sub-slab ventilation systems, verify air movement at the designated communication test point and any other points noted during the installation. Measure the velocity at the system suction point for the ventilation system and verify that it has not dropped below the established minimum (baseline) velocity.



Inspection of SSD fan and weatherproof cover

Inspections shall also consist of a thorough examination of the system components for proper installation and operation. All walls and the slab on the lowest floor shall be inspected for cracks or other entryways (and properly sealed if necessary). SMD systems shall also be inspected for leaks (smoke check).

A Monitoring and Maintenance Report (MMR) shall be prepared and submitted on an annual basis to the DEP/EPA and the homeowner. The MMR document the results of the O&M inspections. All information/data generated from the inspections shall be reported in the MMR.

Attachment A
DuPont Pompton Lakes
Vapor Intrusion Mitigation System Inspection Checklist

Address inspected: _____ Pompton Lakes, NJ

Person(s) interviewed: _____

Date of inspection: _____

Inspector(s): _____

Make and Model of Fan _____

Date System Installed _____

System Pressures	SSP-1	SSP-2	SSP-3	FAN
Observed Vacuum Pressure				
Commissioned Vacuum Pressure				
Difference				

1.0 Systems Installation and Interior Piping Requirements **Yes**
No Unk / NA

1.1 Are all manifold and suction point piping solid, rigid pipe not less than 3 in. inside diameter? _____

1.2 Are all pipe interior joints and connections in mitigation systems sealed permanently?
 (Exceptions include installation of fans and sump covers) _____

1.3 Does the system piping avoid attachment to or support by existing pipes, ducts, conduits
 or any kind of equipment? _____

1.4 Does the system piping avoid blocking window and doors or access to installed equipment?

1.5 Are supports for system piping installed at least every six (6) feet on horizontal runs? _____

1.6 Are vertical runs secured above or below the points of penetration through floors, ceilings
 and roofs, or at least every (8) feet on runs that do not penetrate floors, ceilings or roofs? _____

1.7 Are suction point pipes supported and secured in a permanent manner
 that prevents their
 downward movement to the bottom of suction pits or sump pits, or into the soil beneath

a soil-gas-retarder membrane? _____

1.8 Are horizontal runs in system piping sloped to ensure that water from rain or condensation drains downward into the ground beneath the slab or soil-gas-retarder membrane? _____

1.9 Does the system piping pass the smoke stick check (no leaks)? _____

2.0 General Sealing Requirements

2.1 Are openings around the suction point piping penetrations of the slab properly sealed using methods and materials that are permanent \ durable and pass the smoke stick check? _____

2.2 Are accessible openings around utility penetrations of the foundation walls and slab, test holes, wells and other openings in slabs properly sealed using methods and materials that are permanent / durable and pass the smoke stick check? _____

2.3 Are openings / cracks sealed where the slab meets the foundation wall (if appropriate)? _____

2.4 At the point where vent pipe exits the building, is urethane caulk or equivalent material used, and when the joint is greater than 1/2 inch in width, is a foam backer rod or other comparable filler material inserted into the joint before the application of the sealant (principally from the outside)? _____

2.5 When installing baseboard-type suction systems, are all baseboard sealed to walls and floors with adhesives also designed and recommended for such installations? _____

2.6 Are all utility and other penetrations through a soil-gas-retarder membrane sealed? _____

2.7 Did all cracks or openings in the slab or wall pass the smoke test? If not, identify the location of failed cracks or openings in the Notes & Comments Section below. _____

3.0 Electrical Requirements

3.1 Is the plugged cord used to supply power to the fan no more than 6 feet in length? _____

3.2 Does the plugged cord avoid penetrating a wall or being sealed within a wall? _____

3.3 Is the power supply to the fan hard-wired with an electrical disconnect within line of sight and 4 feet of the fan? _____

3.4 Does the power supply have a seal to determine if access has occurred? _____

3.5 Is the electrical service panel labeled to indicate the circuit breaker powering the SSDS fan? _____

4.0 **Sub-**
Membrane Depressurization Requirements

4.1 Is a sub-membrane depressurization system part of the mitigation system? _____

4.2 If yes, did the sub-membrane depressurization system pass the smoke test? _____

5.0 **Sump Pit Requirements**

5.1 Is there a sump pit in basement? _____

If yes:

5.2 Is the sump pit installed with an impermeable cover and sealed with O-ring or silicone caulking? _____

5.3 Is the sump pit cover designed to facilitate removal for sump pit maintenance? _____

5.4 Is there a mitigation system designed to draw soil-gas from the sump pit? _____

6.0 **Monitors and Labeling Requirements**

6.1 Does each suction point have a mechanism to measure vacuum? _____

6.2 Is the mechanical mitigation system's monitor, such as manometer type pressure gauges, clearly marked to indicate the initial pressure readings? _____

6.3 Is the current vacuum reading within 0.25" water of the initial reading for low vacuum fans and within 5% of the commissioned vacuum for high vacuum fans? _____

6.4 Is a system description label placed on the mitigation system or other prominent location? _____

6.5 Is the label legible from a distance of at least three feet and does it display the following information: Purpose of the system (“Vapor Intrusion Mitigation”), name, address and phone number of the contact person. _____

6.6 Does the mitigation system prevent backdrafting of combustion products into the structure? _____

6.7 Were the vacuum readings in the system stable during the backdraft test? _____

6.8 Does the mitigation system include an audible alarm to inform occupants of a system malfunction? _____

6.9 Is the audible alarm operational? _____

7.0 System Vent Discharge Point Requirements

7.1 Is the vent pipe vertical and upward, outside the structure, at least 10 feet above ground level, and above the edge of the roof ? **(Req. A)** _____

7.2 Is the discharge of the vent pipe ten feet or more away from any window, door, or other opening into conditioned or otherwise occupiable spaces of the structure, if the vapor discharge point is not at least 2 feet above the top of such openings? **(Req. B)** _____

7.3 Is the discharge of the vent pipe ten feet or more away from any opening into the conditioned or other occupiable spaces of an adjacent building? Chimney flues shall be considered openings. **(Req. C)** _____

7.4 For vent stack pipes that penetrate the roof, is the point of discharge at least 12 in. above the surface of the roof? **(Req. D)** _____

7.5 For vent stack pipes attached to or penetrating the sides of the buildings, is the point of discharge vertical and a minimum of 12 inches above the surface of the roof. _____

7.6 Does the horizontal run of vent stack pipe penetrate the gable end walls? **(Req. E)** _____

7.7 If yes, does the piping outside the structure routed to a vertical position so that the discharge

point meets the requirements of (A), (B), (C), and (D)? _____

7.8 Do points of discharge that are not in a direct line of sight from openings into conditioned or otherwise occupiable space because of intervening objects, such as dormers, chimneys, windows around the corner, etc. meet the separation requirements of (A), (B), (C), (D) and (E)? _____

7.9 Is the outside vent piping fastened to the structure of the building with hangers, strapping or other supports that will secure it adequately (every 8 feet)? _____

7.10 Is vent stack piping's ID at least as large as the largest used in the manifold piping? Manifold piping to which two or more suction points are connected shall be at least 4 inch ID. (3x4 inch aluminum downspout is an acceptable deviation) _____

7.11 If system piping is installed on the exterior of a building, is piping sealed from the outside at point of entry to the building? _____

8.0 Fan Installation Requirements

8.1 Is the fan installed in a configuration that avoids condensation buildup in the fan housing? _____

8.2 Is the fan mounted on the exterior of buildings rated for outdoor use or installed in a weather proof protective housing? _____

8.3 Is the fan mounted and secured in a manner that minimizes transfer of vibration to the structural framing of the building? _____

8.4 Does the system operate without noise or vibration above normal conditions? _____

9.0 Design Drawing and As-Built Drawing Requirements

9.1 Was the system installed as per the design drawings submitted to the municipality? _____

10.0 Notes & Comments

11.0 Required Corrective Actions