MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

Attachment B.5

Passive Vapor Mitigation Systems

Table of Contents for Submittals

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Attachment B.5-1 – Design of a Passive Vapor Mitigation System

The design of a Passive Vapor Mitigation System (PVMS) submittal to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) should include information necessary to ensure the proposed system has a reasonable likelihood of effectively mitigating unacceptable exposures for the volatilization to the indoor air pathway (VIAP). This Table of Contents (TOC) may contain information not necessarily critical for the review and approval of the mitigation strategy; however, it is included in the design to ensure that the necessary information is available if approval of the installed system is required in the future.

The obligation of ensuring the designed system is effectively mitigating the unacceptable exposures for the VIAP ***is that of the person proposing the plan***. EGLE's approval of the design of a PVMS does not guarantee that it will be effective in mitigating the unacceptable exposure, nor that additional response activities or corrective actions are not warranted. The PVMS design submittal should provide key design elements, but focus on identifying performance metrics, how and where they are measured, why they are appropriate for the design, and the construction quality assurance and quality control (QA/QC) plan.

Coversheet

The cover sheet for the system design submittal should contain the following information:

- Site – Site address with regulatory identifiers (Facility or Site name and ID#).
- Owner – Entity, address, contact information.
- System Designer and/or Environmental Consultant – Entity, address, contact information.
- Building Engineer and/or Architect (if applicable) – Entity, address, contact information.
- Submittal Date

1.0 Introduction and Conceptual Site Model (CSM)

1.1 Introduction and Overview

This section should briefly describe the submittal.

1.2 Site Setting and Description of Structure(s)

This section should describe the site setting including the location, current and planned use, and current and future structures with proposed vapor mitigation. Include a description of the height, size, and general construction characteristics.

For an existing building, a building survey should have been conducted. See Appendix 1 for an example of a building survey. The results of a building survey should identify specific building characteristics, features, and configurations that may affect the design, installation,

and effectiveness of the PVMS. If the planned building is not yet constructed, this information should be evaluated from design plans, and discussions with the site development team.

NOTE: Many buildings (particularly larger commercial or industrial buildings) have multiple foundation types due to building additions over time; slab and sub-slab conditions often vary between building areas, and foundation walls or changes in floor elevation may prevent airflow from one slab area to another. Other foundation features such as elevators, pits, sumps, floor drains, utilities, utility tunnels, and other structures located below the slab or floor level should be considered for their potential effect on PVMS designs.

Key Supporting Information

- Topographic Site Location Map (from USGS or site plans as available)
- General Site Feature Map that includes existing and proposed structures to scale with any property lines, right-of-way (ROW), and major utilities.
- Figure(s) in the plan view of the structure to be mitigated, including the room divisions, footings known and estimated, and other key features such as the location of pits, sumps, vents, basements
- Cross-sectional view figures and drawings may be helpful for depicting other key features relative to the proposed mitigation system.
- Appendix with Building survey that includes a photo log (see Appendix 1).

1.3 Site History

This section should describe the current and past site use, operational history as well as the type of hazardous or regulated substances currently and previously used at the property.

NOTE: Describing the site use and history aids in identifying the presence or likely presence of hazardous substances or petroleum products in, on, or at a property due to any release to the environment or conditions indicative of a release to the environment and may provide some general information on the concentrations of hazardous substances that could be expected to be encountered.

Key Supporting Information

- Table (optional depending on the complexity of the site) that provides a list of known activities or operational history that may have led to a release of hazardous substances into the environment.

Figure that identifies the locations of current and past activities and operations that may have or are known to have led to a release of a hazardous substance into the environment. These areas are typically referred to as recognized environmental conditions (RECs).

1.4 Geology/Hydrogeology

This section should describe the site geology and hydrogeology. Information should include a description of soil type(s) and depth to groundwater. Supporting data, including boring logs, should be provided. Soils may be described using either the USCS, USDA, or other soil classification system such as AASHTO/MDOT, but the classification system should be identified. The potential for known or estimated seasonal variations in groundwater should be described. The lithology and presence or absence of groundwater, including seasonal groundwater, should be evaluated to at least 5' below the lowest part of the structure. The lowest part of the structure includes the maximum depth of any footings, sumps, drains, pits, and elevator shafts, etc.

A cross section of the structure that is being mitigated should be provided with the site geology and hydrogeology information shown. Structures that have various footing depths, such as basements, elevators, tunnels, or pits and that are larger than 5,000 square feet may require more than one cross-section to clearly depict these features to aid in the review.

Soil that will be brought on-site beneath the structure, or as a component of the mitigation system, should also be identified and described including information on the type, characteristics, and where it will be placed.

Key Supporting Information

- Figure identifying boring locations used to classify geological and hydrogeological information.
- Boring logs.
- Cross-section(s) depicting the current or proposed structure, below grade site features (foundations, utilities, etc.) and geological and hydrogeological information.
- Tables, as necessary, identifying any monitoring wells installed, depth of the wells, and the elevation of the groundwater.

1.5 Detailed Building Information

1.5.1 Below Grade Building Features and Foundations

This section should describe the foundation type (i.e., footings, pier, columns, cast pilings, etc.) and building portions that are below grade (basements, crawlspaces, elevator sumps, pits, utilities, tunnels, etc.) that are in contact with the soil. If there are any foundations that are unknown, they should be discussed here and addressed in Section 2.2.

Key Supporting Information

- Figure(s) – plan view identifying all below grade building features and foundations.
- Figure(s) – cross section(s) of subsurface features in Section 1.4.

1.5.2 Heating, Ventilation, and Air Conditioning (HVAC)

This section should describe the current or proposed HVAC system, including any of the location of air intakes and exhaust that are required for its operation.

Key Supporting Information

- Figure(s) – should depict the location of any air intakes, vents, and discharge points including components on the roof or side of the structure.

1.5.3 Floor Slab and Condition

For an existing building, this section should describe and document the current condition of the floor. It should identify cracks with a width greater than 1/2-inch that may impact the operation of the PVMS, areas where concrete is not present, or areas where the concrete needs repair or replacement. For new or proposed floor slabs, this section only needs to identify the type and thickness of the floors that will be installed as part of the development.

Key Supporting Information

- Figure(s) – identify the location, type and condition of the floor slabs including cracks with a width greater than 1/2-inch, areas that concrete is not present, or areas that the concrete is likely to need repair or replacement based on the information collected during the building survey.
- Appendix – if applicable, with building survey and photolog with representative photos, especially in areas that repairs to the slab or building may be warranted.

1.5.4 Utility Penetrations and Man-Made Preferential Pathways

This section should describe and document the location of penetrations and sumps in which soil gas may enter and directly vent into the structure and utilities that directly come into contact with a vapor source. This evaluation is limited to those utilities that are in direct contact with a vapor source. For new construction, this section should identify any penetrations that are known or expected to occur.

Key Supporting Information

- Figure(s) and cross-section(s) – identify the location of penetrations, sumps, and preferential pathways.

1.5.5 Historic Buildings (if applicable)

This section should describe any limitations to the system design or layout that may need to be considered and are imposed on the structure due to a historic designation.

1.6 Source Areas and Contaminant

1.6.1 Applicable Criterion

This section should identify the applicable criteria used to demonstrate that the response activity or corrective action is necessary to protect the public health, safety, welfare, or the environment, and identify the assumptions used in their development including any previous approvals and the evaluation for the use of the site-specific criteria.

- **Generic Criteria or Risked Based Screening Levels (RBSLs)**: If the use of the generic criteria is appropriate, supporting information should be described and presented.
- **Site Specific Volatilization to Indoor Air Criteria (SSVIAC) or Site-Specific Target Levels (SSTLs)**: Supporting documentation should be provided demonstrating the criteria are appropriate for use and the values should be identified.

Key Supporting Information

- Table – identifying the applicable criteria.
- Appendix – provide supporting documentation for use of the VIAP Criteria, including any previous approvals and the evaluation for the use of the site-specific criteria.

1.6.2 Vapor Source

This section should identify the concentrations of the volatile regulated or hazardous substances that pose an unacceptable risk to the structures(s). The text should include a discussion of how the sample data aligns with the site history (Section 1.3). Representative soil, groundwater, and soil gas concentrations should include any samples collected above and near the vapor source where vapors may enter structure. Soil, gas, and vapor samples should be collected when site conditions allow, to confirm that mitigation is necessary.

Data that supports the design of the PVMS must be provided, including a demonstration that mitigation is warranted. Sample data must also support delineation of soil gas impacts in any areas where an PVMS is not proposed (i.e., outside of the planned mitigation footprint).

Key Supporting Information

- Table(s) – provide representative soil, groundwater, and vapor data compared to the applicable criteria.
- Figure – identifying where the data was collected, including the sampled media and location of samples depicted on a scaled figure relative to the structure(s).
- Figure – depicting detections above applicable criteria from representative samples relative to the structure.
- Figure(s) – cross-sections that include below grade features with analytical data depicted.
- Appendix should include all analytical data sheets and reports.

1.7 Man-Made Preferential Pathway Evaluation (if applicable)

This section should include an analysis of Section 1.5.4 above and if there is a need to design or propose a mitigation strategy for man-made preferential pathways or other preferential pathways that may not be addressed through the operation of the PVMS.

Key Supporting Information (As Warranted)

- Text should reference the Figures identified in Section 1.6.2, as necessary, to identify preferential pathways that may pose an unacceptable risk due to their location within a source of vapors.

2.0 PVMS Design and Plans

2.1 Overview of PVMS

This section should include a design basis that explains how vapors are entering, or may enter, the structure and how the PVMS will prevent soil vapors from entering the structure. It should include an overview of the type and function of the proposed mitigation system (e.g., vapor barrier, epoxy coating, passive sub-slab venting system, etc.).

NOTE: EGLE generally does not allow the individual use of a vapor barrier, epoxy coating, or venting system as a stand-alone mitigation approach. If the PVMS relies upon a vapor barrier or epoxy coating, a venting system should be incorporated into the overall PVMS design.

2.2 Passive Vapor Barrier Selection

This section should briefly discuss why the vapor barrier or epoxy coating material(s) selected were determined to be appropriate for the intended application based on the results of chemical and physical testing data available for the material(s) and the information provided in Sections 2.2.1 through 2.2.4.

2.2.1 Diffusion Coefficients

This section should indicate whether the vapor barrier or epoxy coating material(s) can provide an adequate level of protection for the building(s) proposed to be mitigated. Briefly discuss any diffusion coefficients established for those materials, which hazardous substances they address, and whether they are capable of preventing unacceptable soil gas concentrations from the vapor source(s) identified in Section 1.6.2 from entering the building(s). This section should contain an affirmative statement made by a professional engineer and liner manufacturer that attests to the liner's ability to prevent advective and diffusive transport of the contaminants present into the structure and meet the testing requirements identified by EGLE. It should ***NOT*** be a generic statement and must be specific to the structure and the site contaminants.

NOTE: It is the responsibility of the person proposing the plan to ensure the PVMS is protective of public health. RRD's approval is based on the design firm and design engineers' evaluation and confirmation that the liner used will be successful in reducing the subslab concentrations to below acceptable indoor air values.

Key Supporting Information

- Figure(s) – cross section that shows the vapor barrier or epoxy coating and the sampling locations.
- Appendix – manufacturer's product documentation that identifies established diffusion coefficients for the vapor barrier or epoxy coating material(s) used as part of the PVMS design.

2.2.2 Puncture Resistance

The manufacturer of the vapor barrier product(s) should provide results of puncture resistance testing similar to ASTM D1709. This information should be assessed to determine the need to implement any precautions during the installation process, such as restricting specific types of work, and/or use of certain types of equipment on the installed vapor barrier.

Key Supporting Information

- Appendix – manufacturer's product documentation that includes results of puncture resistance testing conducted for vapor barrier material(s).

NOTE: PVMS liners come in a wide range of puncture resistance. The easier a product can be punctured, the more oversight and QA/QC needs to be implemented, including the need to perform additional smoke testing at different phases of the installation process to ensure the integrity of the liner. The design engineer should evaluate the puncture resistance and assess how that relates to on-site building and construction activities so that it can be properly reflected in the installation process of the liner.

2.2.3 Tensile Strength

The manufacturer of the vapor barrier or epoxy coating material(s) should provide results of tensile strength testing similar to ASTM D882. This information should be used to assess the potential for a vapor barrier to resist settling of the structure during and after the installation process.

Key Supporting Information

- Appendix – Manufacturer's product documentation that includes results of tensile strength testing for vapor barrier or epoxy coating material(s).

NOTE: PVMS liners come in a wide range of tensile strengths that may impact the effectiveness of a liner if exceeded during the installation process. The design engineer should evaluate the tensile strength and assess how that relates to on-site building and construction activities so that it can be properly reflected in the installation of the liner.

2.2.4 Other Material Characteristics and Tests

This section should briefly identify any other material testing data that the PVMS designer assessed as part of the vapor barrier or epoxy coating material(s) selection process and why the material(s) selected is appropriate for the intended application.

Key Supporting Information

- Appendix – Manufacturer's product documentation that includes results of any other relevant material testing data.

2.3 Plan of Proposed PVMS

This section should include the preliminary design that depicts the PVMS. It should include a description of the system, and the specific components and elements described in Sections 2.3.1 through Section 2.3.12 below. Figures identified below may be combined when appropriate.

2.3.1 Liner

This section should include a general description of the preliminary design of the liner and a figure that depicts the PVMS.

Key Supporting Information

- Figure(s) – cross-section(s) depicting the liner portion of the PVMS.
- Figure – depicting the PVMS location, if a PVMS is to be installed in only a portion of the structure.

2.3.2 Terminations and Penetrations

This section should include a depiction of how the liner will be terminated against vertical surfaces and where there are vertical features such as pipes or other penetrations and how they will be completed.

Key Supporting Information

- Figure(s) – cross-section(s) or callouts that depict the termination of the liner against vertical surfaces.
- Figure(s) – cross-section(s) or callouts that depict how piping or other penetrations will be completed.

2.3.3 Liner Overlap, Joining, and Seaming (if necessary)

If the liner, as provided from the manufacturer, will need to be joined or seamed to allow for coverage of the entire floor space, this section should include a description of how that occurs, how it is verified to be successful, and how it will be documented to be completed appropriately.

Key Supporting Information

- Figure(s) – cross-section(s) or callouts that depict how two liners will be joined or seamed.

2.3.4 Permeable sub-slab layer

A venting system should be incorporated into the overall design of a PVMS that utilizes a vapor barrier or coating. This section should provide a brief description of the materials used to create, maintain, or document the permeable sub-slab layer. The information for the permeable sub-slab layer (i.e., gravel or sand) should include the material, the thickness of the permeable sub-slab layer, and specify the material(s) (i.e., perforated piping or vent matting) installed within the permeable sub-slab layer to collect vapors.

Key Supporting Information

- Figure(s) – cross-section(s) that show the type of permeable sub-slab layer material(s), the thickness of the layer, and any vapor collection piping installed within the permeable sub-slab layer.

2.3.5 Horizontal Conveyance Piping (if installed or proposed)

This section should include a general description of the horizontal conveyance piping used to direct the vapors through the structure or beneath the subsurface. In addition, any slopes that need to be maintained should be described.

Key Supporting Information

- Figure that depicts horizontal conveyance piping layout of the PVMS.

2.3.6 Vertical Vent Risers

This section should include a general description including any limitations that must be addressed when routing the vertical piping through the building and above the roof (see Sections 1.5.2 and 1.5.5).

Key Supporting Information

- Figure(s) – cross-section of structure that details the vertical piping runs.

2.3.7 Exhaust Vents

This section should include a general description of the proposed PVMS exhaust point location(s). This section should identify any distance(s) that must be achieved between each exhaust point location and building features including height above structure or roof, other air intake(s), window(s), structure access point(s) such as a door or patio, and HVAC components based on AARST SGM-SF-2017 (with 12/20 revisions).

NOTE: All distances should be measured between the closest point of the exhaust opening and the closest point of all location requirements specified.

Key Supporting Information

- Figure(s) – plan view that depicts the piping roofing locations and any other vents or air intakes that influences the location of the exhaust.
- Figure(s) – cross-section of structure that details the exhaust vents height above the structure.

2.3.8 Materials and Other Specifications

2.3.8.1 Component Labeling

This section should include the proposed labeling, example wording, and locations consistent with standards similar to AARST SGM-SF-2017. Alternatively, a person may use the statement: “Labels for the system will be developed and utilized as identified in AARST standards such as SGM SF 2017.”

Key Supporting Information

- Figure(s) – depicting example labels and wording.
- Figure(s) – identifying the proposed physical location of each label.

2.3.8.2 Other Specifications (if necessary)

Additional information can be provided in this section if the design firm believes that the information is critical to the success of the PVMS design and has not been included elsewhere in this document.

Key Supporting Information

- Figures, tables, or appendix may be provided as appropriate.

2.3.9 Preferential Pathways and Other Unique Features (if necessary)

This section should describe the mitigation strategy for any preferential pathways identified in Section 1.7 that need mitigation or additional considerations.

Key Supporting Information

- Figure(s) – detailing each unique mitigation strategy for preferential pathways.

2.3.10 Elevators and Below Grade Pits or Tunnels (if necessary)

This section should describe the mitigation strategy and how it will be effective for each elevator shaft, pit, sump, or tunnel that are part of the structure.

Key Supporting Information

- Figure(s) – detailing each unique mitigation strategy for any elevator shafts, pits, or tunnels.

2.3.11 Vertical/Sidewalls Below Grade (if necessary)

This section should describe the mitigation strategy for any vertical sidewall below grade where mitigation is necessary.

Key Supporting Information

- Figure(s) – detailing the mitigation strategy for the vertical wall(s) below grade.
- Appendix – if necessary, to provide additional supporting information.

2.3.12 Groundwater in Contact (if necessary)

If groundwater is in contact or may come into contact with the structure (see Section 1.4), this section should describe how the shallow groundwater will be addressed to allow for the proper function of the PVMS. If the PVMS will not include any mechanism to address groundwater that may come into contact with the lowest part of the structure (e.g. slab or basement floor), and there is not sufficient data from a nearby monitoring well to confirm that groundwater will not come into contact with the structure, then the monitoring that will be performed to confirm that the PVMS will remain effective should be described.

Key Supporting Information

- Figure(s) – detailing the mitigation strategy for shallow groundwater.
- Appendix – providing additional supporting information.

2.4 Monitoring Points and Test Ports

Monitoring points, sometimes referred to as vapor pins, vapor monitoring points, or test ports, can be used to assess numerous aspects of a PVMS such as the integrity of a barrier or coating, breakthrough of contaminant vapors or tracer gases (if necessary), and communication between two points within the venting system. This section should describe the intended purpose(s) and location of all monitoring or test points used for any of the purposes described above.

Key Supporting Information

- Figure(s) – plan view depicting the location of each monitoring point in relation to any subsurface PVMS venting system components.
- Figure(s) – depicting how each type of monitoring or test point will be installed.

2.5 Installation Weather and Temperature Limitations

Product manufacturers may specify conditions necessary to allow for the proper installation of their products. This includes a range of temperatures and/or weather conditions necessary during product application or installation. The design firm should identify any conditions that would prevent proper installation and determine what measures are necessary to ensure the vapor barrier or epoxy coating is installed in accordance with all manufacturer instructions and recommendations.

Key Supporting Information

- Appendix – Manufacturer's product installation instructions, recommendations, and/or requirements.

2.6 Building Codes and Permits

This section should clearly state that other permits necessary for the installation of the PVMS that are not regulated by RRD shall be obtained, met, and complied with (e.g., building codes) through an affirmative statement similar to: "The system will be installed and operated in accordance with all local, state, and federal laws and rules."

3.0 Proposed Construction Quality Assurance and System Installation Oversight

3.1 Construction Quality Assurance

This section should discuss construction quality assurance measures that will be implemented to ensure proper installation of the PVMS. A description of common construction quality assurance measures is provided below and should be included, as appropriate. Each PVMS should be installed in accordance with the manufacturer's requirements.

Inspections with recordkeeping are necessary during installation to document that the VMS components were properly installed, meet the design specifications, were not damaged during construction, and remain leak free so that sub-slab vapors do not enter the building envelope. The inspections must account for construction phases and conditions that may affect the integrity and performance of the VMS and are detailed in Section 5.0.

3.1.1 Surface Preparation

This section should identify any measures specified or required by the product manufacturer for the preparation of any surface where a vapor barrier or epoxy coating will be installed. This includes, but is not limited to:

For vapor barriers:

- Compaction requirements for subsurface base materials.
- Area will be clean, dry, and free of any debris and sharp objects that could puncture the vapor barrier.
- Any protective layer(s) required beneath the vapor barrier, such as non-woven geotextile fabric.

For epoxy coatings:

- Relative humidity of the concrete surface will be measured to ensure moisture content is acceptable prior to coating application.
- Manufacturers recommended surface preparation of the concrete surface will be completed prior to the application.
- Surface of the concrete will be clean, dry, and free of cracks, chips, and greases or compounds that may prevent adhesion.

This section should also describe and identify how the installation and site conditions will be documented to have been met and when inspections and oversight will occur. It is recommended that the documentation include written logs, observations, and photographs that confirm the inspection of the material prior to the installation of the liner.

3.1.2 Surface Restrictions

If a vapor barrier that consists of a liner will be installed, this section should discuss how any necessary precautions identified in Section 2 will be implemented and confirmed throughout the installation process to help ensure that the liner will not be punctured or damaged.

If an epoxy coating is applied, this section should describe how surface restrictions (i.e., traffic control) will be implemented to allow the coating to fully cure.

NOTE: Daily field logs, oversight, and photographs are highly recommended when the liner is exposed without a protective cap or until the epoxy floor covering has set to confirm that any restrictions are complied with, or when not, what measures will be undertaken to confirm the integrity of the liner material.

3.1.3 Smoke Testing and Tracer Gas Testing

Smoke Testing and Tracer Gas Testing is used to identify the location of any breaches within a vapor barrier during the installation process. This type of testing involves injecting non-toxic smoke beneath a vapor barrier through a passive vent riser, test port, or through a small hole cut into the vapor barrier and checking for any visual sign of smoke penetrating the vapor barrier. Any breaches, such as imperfections in a vapor barrier or utility penetrations that have not been properly sealed should be identified and repaired. When repaired, that portion of the vapor barrier should be retested to confirm no smoke is able to pass through the vapor

barrier. The area of coverage for smoke testing is highly variable depending on several key factors; therefore, in addition to referencing manufacturer recommendations, this section should identify how the area of each smoke test will be verified and documented in the field, how the results are documented, and how each repair will be verified to be effective.

Testing must provide sufficient coverage to assess every penetration, seam, and termination of the vapor barrier. Smoke testing should also be performed when field oversight identifies activities that, based on the specifications identified in Section 2.2, are likely to have punctured the liner. When field inspections and oversight indicate that the liner may have torn or been perforated, additional smoke testing is necessary.

3.1.4 Thickness Requirements and Verification

Spray-applied vapor barriers and epoxy coatings have minimum thickness requirements for proper installation which are specified by the product manufacturer. This information should be provided in this section.

There are two main methods used to confirm and verify the thickness of an applied material (see Section 3.1.4.1 and 3.1.4.2). The design firm should identify the method(s) used to confirm the thickness of an applied material(s), briefly describe the process, identify how the sampling locations will be documented, how often a sample will be collected, and discuss how the resulting information will be used for thickness verification. If thickness is measured and determined to be too thin, then additional spray-applied vapor barrier material should be added to the area. That process should also be described in this section.

3.1.4.1 Coupon Testing

If spray-applied vapor barriers are installed as a component of the PVMS, coupon testing is performed to confirm that the thickness of the spray-applied vapor barrier meets the manufacturer's design specifications and installation requirements. Coupon testing is performed by collecting a small sample of the liner (i.e., a coupon) and measuring its thickness with a caliper. When performing coupon testing, it is important to document the location where each coupon sample was obtained from and the thickness of each coupon sample.

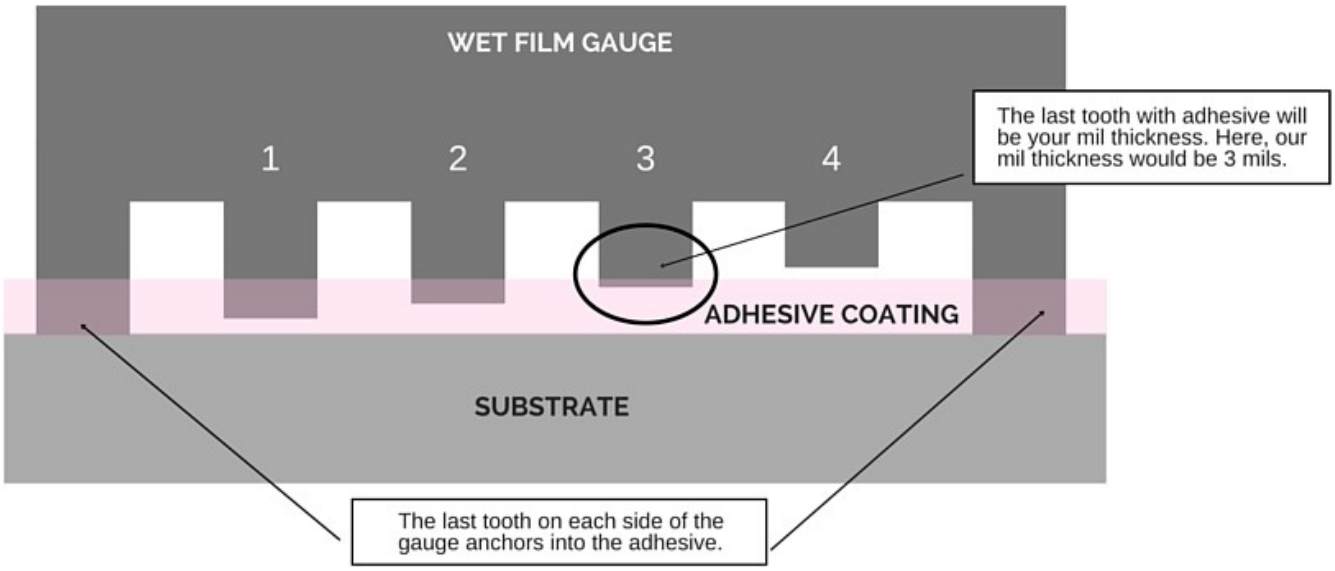
NOTE: The number of coupon samples that are necessary to adequately verify vapor barrier thickness should be based on the following:

- One coupon sample for every 500 square feet of applied surface area unless any of the following occur which then requires the collection of additional coupon samples:
- A change in spray pattern or break from the applicator due to a change in equipment or period of rest.
- Each wall or vertical surface greater than 64 square feet; and
- Each drum or vat if the area of coverage is less than 500 sq ft.

3.1.4.2 Wet Film Gauge Testing

A wet film gauge is a tool used to measure the thickness of a coating after it has been applied and is typically used with the application of surface epoxies. The gauging tool measures thickness in units of mils, which is equal to one thousandth of an inch. The location and thickness of each location where the application is gauged should be carefully documented.

How to Determine Mil Thickness



NOTE: The number of measurements that are necessary to adequately verify thickness should be based on the following:

- Every per 150 square feet unless any of the following occur which then requires the collection of additional gauging locations:
- A change pattern or break from the applicator due to a change in equipment or period of rest.
- Each wall or surface greater than 64 square feet; and
- Each drum or vat or container if the area of coverage is less than 150 square feet.

3.1.5 Material Estimation Verification

This section should provide an engineer's estimate of the estimated quantities that will be used to meet the established requirements. The estimated quantities should be provided so that during the installation process a comparison may be made to the actual quantities used.

3.2 Oversight and Documentation of PVMS Installation

Inspection of the PVMS system components should be performed during the installation process. Oversight performed and the resulting documentation are essential to demonstrate that a PVMS was installed appropriately and meets the design specifications established in Section 2. This section should include a description of the planned oversight that will be performed and the construction quality assurance measures that will be incorporated and documented throughout the installation process. Justification of the level of oversight must be included.

Obtaining photo documentation of specific features during the PVMS installation process is an efficient way to document observations made during the installation process. Photos should be obtained for key features of interest. Photographs help to document the quality of work completed during the PVMS installation process. Specific attention should be paid to details such as adequate sealing around utility penetrations, areas where repairs were performed, wall terminations, and seams or welds. Once the installation process is complete, it may not be possible to document this information.

NOTE: Providing oversight to confirm site conditions are consistent with those specified in PVMS design will increase the likelihood that the PVMS will be installed in accordance with the design plan.

Recording details such as those listed below can be used as documentation to support future submittals.

- Date
- Weather Conditions
- Materials Quantiles of Products
- QA/QC Measures Performed
- Measurements and Readings Locations and Results
- Necessary Repairs and Correction Documentation
- Samples Collected (when warranted)
- Photographs

Key Supporting Information

- It is not anticipated that any figure is warranted, though an example of a daily field log, photographic logs, or other specific documentation may be appropriate as an attachment.

4.0 Performance Objectives

This section should identify the proposed performance documentation and verification procedures that will be achieved or are able to be implemented upon completion of the installation of the PVMS and why they are appropriate to demonstrate the efficacy of the PVMS. Because the PVMS is not readily accessible or visible, and there are no measurements or readings based on a mechanical process that can speak to a system operating effectively, the performance documentation and verification procedures discussed should aid in confirming the operation of the installed system by identifying lines of evidence that indirectly indicate that the system is performing. Though they are not typical performance metrics like those used for mechanical systems, they function very similarly.

Also, because PMVSs do not contain mechanical parts nor are they expected to have consistent flow or applied vacuum through the system, performance factors are typically limited, unless the liner or coating has been breached, to the following:

- Confirming flow or connectivity from all portions of the floor to the vertical vent risers,
- Confirming flow up through the vertical vent risers,
- Confirming the barrier prevents advective and diffusive flow into the structure via smoke testing, tracer gas, or indoor air sampling,
- Confirming the operation of any meter or alarms (typically limited to methane), and
- Ensuring that the building has not undergone any settlement or modifications that may have impacted the integrity of the PVMS.

NOTE: System Performance Documentation and Verification Procedures are discussed in the design document only to ensure that a person understands different mechanisms that can document that a PVMS is functioning and to incorporate those features into the design.

5.0 System Commissioning

5.1 System Documentation

Inspections with recordkeeping are necessary during installation to document that the VMS components were properly installed, meet the design specifications, were not damaged during construction, and remain leak free so that sub-slab soil gas does not enter the building envelope. The inspections must account for construction phases and conditions that may affect the integrity and performance of the PVMS:

- Vapor collection zone and sub-barrier vapor collection system piping installation;
- Sub-slab vapor barrier installation, thickness, termination, and sealing prior to installation of building floor slab;

- Post building floor slab installation (above vapor barrier);
- Surface coating thickness and sealing (for surface-coating-based systems);
- Passive ventilation system/piping installation (above-slab/above roof).

The matrix in Appendix 2 was developed to assist design professionals with developing design-specific quality assurance/inspection plans for use during PVMS construction and obtain the necessary documentation. The matrix identifies key components where oversight may be necessary. PVMSs are specific to the conditions and location where they were installed; therefore, not all elements in Appendix 2 will be applicable to every system; however, justification should be available why oversight of specific elements are not required (i.e., such as an element is not part of the design). Some PVMS designs/applications may require quality assurance elements or protocols that are not included.

Documentation that the quality assurance/inspection plans where followed should be completed by an oversight party that most PVMS have identified as a neutral third party. Documentation that each task was completed should include photographic confirmation as well as daily fiend logs provided by the on-site oversight person. Any changes to the design should be approved through the design engineering firm.

5.2 System Commissioning

For passive mitigation, a PVMS is considered to be fully commissioned once the PVMS has been documented to be properly installed, including any protective barriers that are required, and a demonstration has been made that the PVMS is capable of meeting the performance metrics specified for the PVMS, including flow or connectivity through the system and out of the exhaust ports. That demonstration may include a combination of the product manufacturer's documentation, such as chemical and physical testing, documentation of proper system installation in accordance with all of the product manufacturer's requirements, that necessary site and installation conditions were complied with, that any identified areas where leaks or tears were identified have been appropriately corrected or fixed, and measurements demonstrating proper function of the PVMS as designed.

Key Supporting Information

- Documentation such as figures and tables may vary greatly from one PVMS design to another but should be used to support that appropriate materials and installation processes as well as functions of the PVMS meet the performance metrics specified in Section 2.

5.3 Operation, Maintenance and Monitoring (OM&M)

An OM&M Plan is developed during the commissioning phase after the installation has taken place. The design submittal **should not** include the specific details of the OM&M plan. This section is included in the design submittal only as a reminder for the design firm to consider how and where the PVMS will be monitored so that the monitoring points and components will be installed during the installation process. This section should identify that one will be developed based on the information obtained during the commissioning process so that the installed PVMS, the maintenance requirements of the equipment utilized, and the final operating parameters are accounted for in the OM&M Plan.

If specific details are provided, EGLE will review the proposed OM&M as if the PVMS was installed, which may result in unnecessary complications during the review. The approval for this type of review will contain language that modification to the OM&M Plan may be warranted depending on the final installed system.

6.0 State Funded Active PVMS Design (for EGLE Contracted PVMS Only)

Section 6.0, and its associated subsections, is **limited to those designs** for a PVMS that EGLE has contracted and is funded by public money or dollars. An owner/operator is not required to and should not include this section for a submittal to EGLE for official review. The information in this section is based on the State Occupation Code, Act 299, Article 20 Section 339.2011 which requires any public works in excess of $15,000 to be prepared, reviewed, and overseen by a licensed professional engineer (PE). However, 339.2012 exempts single family home construction of less than 3,500 square feet. Therefore, if the estimated cost of the installed PVMS (based on design, installation, and commissioning) is expected to be greater than $15,000 the additional information identified in this section must be provided.

6.1 PVMS Design Professional Engineer and License Number

6.2 Engineers Estimated Cost of the PVMS considering Design, Installation, and Commissioning

In order for EGLE to complete its review the following information must be included in the identified subsections (even if it otherwise appears):

6.3 Design Flow

6.4 Pipe Sizing

6.5 Pipe layout schematic with any valving

6.6 Sampling locations

6.7 Failsafe devices

Information provided in Section 6.3 through 6.8 should be based on the Pre-Design Sub-Slab Testing that was completed in Section 2. Typically, EGLE will not contract for a presumptive mitigation system without a building and know or potential unacceptable exposures; however, if pre-design sub-slab testing cannot be completed due to a structure not being present, the submitter should contact EGLE regarding how to provide sufficient information to complete the requirements of this section. Each section identified above must provide the necessary supporting documentation, calculations, and figures as required to support the conclusions being drawn.

Appendix 1 – Building Survey

NOTE: This building survey is intended to be used only as an example in developing a building survey that is specific to the site with the appropriate information for the structure in which a vapor mitigation system has been proposed or installed. This form may not contain all of the information necessary to design a vapor mitigation system for a particular structure. The development and use of this form is fundamentally important to document site conditions during future inspections to confirm if any modifications to the structure have been made, and whether a more detailed assessment is warranted. It should be updated on an annual basis.

Survey performed by:

Date:

Address:

1. OCCUPANT

Owner Occupied: ☐ Yes ☐ No

2. OWNER OR LANDLORD

Name:

Address:

City and State:

County:

Home Phone

Office Phone:

3. BUILDING CHARACTERISTICS

General description of property use and construction:

☐ Residential ☐ Multi-family Residential ☐ Office

☐ Strip Mall ☐ Commercial ☐ Industrial

☐ School ☐ Restaurant ☐ Other: _____

Building Description:

Building Footprint: _____ ft^2

Year Constructed:

Number of floors at or above grade:

Number of floors below grade:

General Description of structure(s) below grade:

☐ Basement ☐ Crawl space ☐ Slab on grade ☐ Not Applicable
☐ Other: _____

Any structures (besides footings) below grade:

Depth of structure below grade: _____ ft
Footprint: _____ ft^2

If residential use, which of the following describes the property?

☐ Ranch ☐ Multi-family ☐ Two-story single family
☐ Duplex ☐ Split Leve ☐ Mobile Home
☐ Apartment ☐ Townhouses/Condos ☐ Modular
☐ Log Home ☐ Other: _____

If commercial use:

Business type(s):
Does it include residences (i.e., multi-use)? ☐ Yes ☐ No
If yes, how many units?

If industrial use:

Type:

Level	**General Use** (e.g., family room, bedroom, laundry, workshop, storage)
Basement:	
1st Floor:	
2nd Floor:	
3rd Floor:	
4th Floor:	

Use additional page(s) as necessary.

3. CONSTRUCTION CHARACTERISTICS

General description of above grade construction

☐ Wood frame ☐ Concrete/Cement ☐ Stone ☐ Brick ☐ Other: _____

General Description of structure(s) below grade structures

☐ Basement ☐ Crawl space ☐ Slab on grade ☐ Not Applicable
☐ Foundation/Footings ☐ Other: _____

General Description of below grade construction

☐ Wood frame ☐ Concrete/Cement ☐ Stone ☐ Brick ☐ Other:

General Description of Basement Type

☐ Full ☐ Crawlspace ☐ Slab ☐ Other:

General Description of Lowest level flooring

☐ Concrete ☐ Dirt ☐ Stone ☐ Other: _____

General Description of foundation walls:

☐ Block ☐ Stone ☐ Poured concrete/cement ☐ Other:

Is there an attached garage? ☐ Yes ☐ No
If yes, does it have a separate heating unit? ☐ Yes ☐ No

Sump's present? ☐ Yes ☐ No

If yes, how many?

Sumps sealed: ☐ Yes ☐ No ☐ Not Applicable

Water in Sump: ☐ Yes ☐ No ☐ Not Applicable

General description of location of each sump:

Type of ground cover outside of building:

☐ Grass ☐ Concrete ☐ Asphalt ☐ Other: _____

4. HEATING, VENTING, and AIR CONDITIONING

General Description of heating system(s) used in this building:

☐ Hot Air Circulation ☐ Heat Pump ☐ Hot Water Baseboard
☐ Space Heaters ☐ Steam Radiation ☐ Radiant Floor
☐ Electric Baseboard ☐ Wood Stove ☐ Outdoor Wood Boiler
☐ Other:

General Description primary fuel type used:

☐ Natural Gas ☐ Fuel Oil ☐ Kerosene ☐ Electric
☐ Propane ☐ Solar ☐ Wood ☐ Coal

General location of boiler/furnace:

☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other

General location of hot water heater:

☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other:

Type of venting for HVAC components and hot water heater:

☐ Direct-vent ☐ Power-vent

Air Conditioning present? ☐ Yes ☐ No

Whole house or attic fan? ☐ Yes ☐ No

5. UTILITIES

Identify all utilities that enter below grade into the structure:

☐ Electric ☐ Gas ☐ Sewer ☐ Cable ☐ Communications
☐ Other:

6. DOCUMENTATION

Pictures that document items 3-6 above and the conditions at the time of the survey

Pictures attached: ☐ Yes ☐ No

Scaled drawings of the building floor plan and configuration at the time of the survey

Figures attached: ☐ Yes ☐ No

Appendix 2 – System Documentation

NOTE: Inspections with recordkeeping are necessary during installation to document that the PVMS components were properly installed, meet the design specifications, were not damaged during construction, and remain leak free so that sub-slab soil gas does not enter the building envelope. The inspections must account for construction phases and conditions that may affect the integrity and performance of the PVMS. Failure to provide actual field documentation may limit the ability to demonstrate the effectiveness of the installed liner system.

Passive Vapor Barrier Mitigation System Installation Quality Assurance Elements

1	**Materials**
	Specifications for materials delivered to the site associated with the passive vapor barrier system are consistent with the design specifications (i.e., piping, tubing, aggregate, barrier material, mastics/tapes, etc.).
	Batch numbers/source identifiers for materials delivered to the site have been recorded with those records maintained.

Vapor Collection Zone Quality Assurance

2	**Subgrade Preparation: Underlying Soil Beneath Aggregate Vapor Collection Zone**
	Soil is uniformly compacted with no irregular surfaces and meets specifications of building/structural engineer.
	Horizontal and vertical surfaces are free puncture hazards (e.g. protrusions/debris).

3	**Utilities**
	Utilities that will underly the passive vapor barrier have been installed, inspected by local building authority, as applicable.
	All utilities with risers or vertical components that will penetrate the passive vapor barrier have been installed, are labeled as to their function/purpose, and extend to a sufficient elevation that they will not be encapsulated in the concrete floor slab or flooring system installed above the passive barrier.

3	**Utilities**
	Minimum horizontal clearances around utility penetrations (>1”) are maintained (*e.g.* utility conduits/piping are not in contact with existing concrete or other penetrations).
	If minimum horizontal clearances around utility penetrations (>1”) cannot be maintained, grout blocks are used, as specified by the design engineer.
	Utility penetrations have >3” clearance between the plane of the barrier application and the nearest joint, bend, or other fitting.
	Utility penetrations are clear of tape, wraps, or foams to a minimum distance of 3” above the plane of the fluid applied barrier application;
	Horizontal alignments of utilities within the aggregate base do not obstruct vapor flow.
	Utilities are not in contact with or supported on existing concrete surfaces receiving application of the fluid applied barrier (>1” clearance between utility and surface).
4	**Soil Gas Sampling/Monitoring Points**
	Deeper soil gas monitoring points that extend into the subgrade zone below the passive vapor barrier’s aggregate vapor collection zone are installed and have passed leak check tests.
	Tubing for the deeper soil gas monitoring points and sub-slab vapor monitoring points that will be embedded within the passive vapor barrier’s aggregate vapor collection zone have been extended to the location of the probe surface completion(s).
	Exposed tubing within the aggregate vapor collection zone is protected against damage.
5	**Vapor Collection, Smoke Injection, & Conveyance Piping**
	Spacing, layout, and depth of sub-slab vapor collection and conveyance piping, and smoke injection ports/piping is consistent with design documents.
	Foundation penetration sleeves are installed.
	Vent risers do not penetrate the slab foundation within a firewall or shear wall.
	All vent risers have been installed, are labeled as to their function/purpose, and extend to a sufficient elevation so that they will not be encapsulated in the concrete floor slab or flooring system installed above the passive barrier.
6	**Aggregate Vapor Collection Zone**
	Spec sheet for delivered aggregate base matches the design specifications.

6	Aggregate Vapor Collection Zone
	Aggregate is free of vegetation or fine particles which could reduce vapor permeability.
	Aggregate is uniformly placed, compacted, and is free of protrusions or debris that may be a puncture hazard.
	Aggregate placed adjacent to perimeter footings, interior footings, column foundations, elevator pits, and other building structural components is free of voids or bridging that could affect vapor barrier system termination or adhesion during or following concrete slab or flooring system installation.
	Unobstructed aggregate depth meets the design specifications (> __inches) with measurements verified using a yard stick or other measuring device.

Surface Application

7	Application Surface: Existing Concrete Surfaces
	Concrete surfaces within the application area have a uniform plane.
	Concrete surfaces within the application area are free of debris, standing water, oil, grease, or other materials which may impede barrier adhesion.
	Expansion joint materials are not present on concrete or other surfaces onto which the vapor barrier will be terminated.
	All cold joint tie-ins are installed and dowels are epoxied or otherwise secured as required by other disciplines. Concrete surfaces within the application area where the barrier will terminate (vertically or horizontally) have a minimum of 4” of finished concrete free of rebar or other tie-ins.

8	Application Surface: Other Bulk Surfaces (*e.g.* plywood, sheet-piling, steel)
	Other bulk surfaces (*e.g.* plywood, sheet-piling, steel) are jointed such that surfaces are planar with no irregularities.
	Smooth surfaces are scarified sufficient to facilitate barrier adhesion.

9	Passive Vapor Barrier
	If a spray-applied barrier is installed, coupon testing is completed at the design specified rate to document that the vapor barrier thickness meets minimum design specifications. A coupon testing log/map is prepared identifying the inspector, date, and locations of all coupon tests.

9	Passive Vapor Barrier
	If a membrane-only system with sealed/overlapped seams is installed, all seams are inspected to verify that the proper overlap was achieved, consistent with the design specifications. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	Penetrations are prepared consistent with design specifications (*i.e.* zip ties, collar length).
	Termination sequence for the spray applied barrier is uninterrupted and consistent with design specifications.
	Spray applied barrier is free of debris and/or materials that may puncture the barrier (i.e., nails, wire, gravel, rebar).
	The barrier is free of pooling water or objects which may obstruct visual identification of smoke emitting from leaks.
	There are no visible tears in the barrier.

10	Passive Vapor Barrier Smoke Testing
	Smoke testing is conducted per the design specifications to verify that the vapor barrier is leak free. The extent of the smoke has been confirmed to ensure that all areas of the vapor barrier has been tested. This includes all termination areas and barrier penetrations. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	All observed emission points of smoke have been repaired and no major manufacturing defects are identified.
	Smoke emissions are confirmed at vent riser stub locations to confirm communication between the aggregate layer and the vapor collection piping.

Concrete/Flooring System Over Barrier Quality Assurance

11	Pre-Concrete/Flooring System Protective Layer Inspection (If Applicable)
	Geotextile fabric or other protective layer installed above the passive vapor barrier following smoke testing is placed and terminated per the design specifications with no gaps or voids.
	Topping sands or other materials installed above the passive vapor barrier are installed using methods/procedures outlined in the design specifications and inspected to verify that the required thicknesses were achieved. An inspection log/map is prepared identifying the inspector, date, and inspection areas.

12	Concrete/Flooring System Installation
	Concrete/flooring system has been installed using methods/procedures and the pour/installation sequence outlined in the design specifications.
	Reinforcing steel is not in contact with the barrier.
	Utilities stub-up beyond the finished plane or the concrete or are completed at the finished plane of the concrete (*e.g.* floor drains, slot trenches).
	Sacrificial elements associated with concrete screeding are in place. Where screed stakes penetrate the barrier, the stakes are sealed in accordance with the design specifications.
	If post-installation saw cutting of concrete floor slabs is completed, saw cutting is sufficiently shallow such that the underlying vapor barrier is not cut.
	If post-installation anchor installation is completed (i.e., for bollards, racking, dock levelers, etc.) anchors are sufficiently shallow such that the underlying vapor barrier is not damaged.
	If post-installation floor slab caulking/sealing is completed, caulk/sealant is installed using the specified sealant/methods at interior perimeter, column interface, footing boundary, utility penetrations, vent riser penetrations, and other areas, per design specifications. An inspection log/map is prepared identifying the inspector, date, and inspection areas.

13	Flooring System Installation Smoke Testing
	Smoke testing is conducted prior to any finished flooring (i.e., carpet/tile, etc.) per the design specifications to verify that the vapor barrier remains leak free following concrete floor slab/system installation. The extent of the smoke has been confirmed to ensure that all areas of the vapor barrier has been tested. This includes all termination areas and barrier penetrations. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	All observed emission points of smoke have been repaired and no major manufacturing defects are identified.
	Smoke emissions are confirmed at vent riser locations to confirm communication between the aggregate layer and the vapor collection piping.
	Smoke testing is conducted post finished flooring to confirm that during the installation process the liner was not breached. Smoke should not be placed directly into the venting system. Both pre and post finished flooring smoke testing is required. All observed emission points of smoke have been repaired, and no major manufacturing defects are identified.

Surface Coatings Quality Assurance

14	Surface Coatings
	If a surface-coating vapor barrier is installed, the slab is inspected for cracks, gaps, or other damage/imperfections, and those areas filled or repaired per the design specifications prior to installation of the surface coating.
	Concrete/substrate moisture testing and/or compatibility testing is conducted per the design specifications prior to installation of the surface coating.
	Thickness testing is conducted using a wet gauge or epoxy thickness gauge at the design specified rate to document that the surface coating thickness meets minimum design specifications. A testing log/map is prepared identifying the inspector, date, and locations of all coupon tests.

Ventilation System Quality Assurance

15	Vent Riser/Ventilation Piping
	Vent riser and associated piping is installed at locations (including wall and roof penetrations) consistent with the design specifications.
	Exterior vent riser outlets are located away from building air intakes, windows and entry points, or are of sufficient height, consistent with the design specifications, to avoid vented gases from entering the building envelope in accordance with published standards and requirements.
	Vent riser smoke injection/sample ports and valves installed at locations/elevations consistent with the design specifications.
	Vent riser and associated piping is appropriately supported/enclosed and sloped to promote drainage to the sub-slab environment, consistent with the design specifications.
	Required labels are affixed to all vent risers, at the required vertical intervals.
	If required by the design specifications, vent riser outlets are equipped with passive wind turbines, or other termination features. If present, passive wind turbines are documented to spin freely.
	A smoke pen or bellows is used to document upward vapor flow via the vent risers.

Attachment B.5-2 – Installation and Commissioning of a Passive Vapor Mitigation System (PVMS)

The Installation and Commissioning of a Passive Vapor Mitigation System (PVMS) includes the installation, commissioning, and the documentation necessary to show the PVMS was installed correctly and that it is functioning as designed.

Therefore, completion of this phase is based on the mitigation system being fully installed and shown to be successful in mitigating vapor intrusion. Documentation includes the final performance metrics and monitoring locations, as-built drawings, and system commissioning documentation of the installed PVMS. This report also should identify the specifics of the OM&M Plan as the system is installed, and all information is available to provide a detailed step-by-step process of the information and assessments necessary to document that the system remains protective.

Coversheet

The cover sheet should contain the following information:

- Site – site address with regulatory identifiers (Facility or Site name and ID#s).
- Owner – entity, address, contact information.
- System Designer and/or Environmental Consultant – entity, address, contact information.
- Building Engineer and/or Architect (if applicable) – entity, address, contact information.
- Submittal Date

1.0 Introduction and Conceptual Site Model

1.1 Introduction and Overview

This section should briefly describe the purpose of this document.

1.2 Site Setting and Description of Structures

This section should describe the site setting including the location, use, and current structures with a PVMS. This section should also include a description of the height, size, and general construction characteristics of the structure.

The results of a building survey should identify specific building characteristics, features, and configurations that affect the design and effectiveness of the PVMS. See Appendix 1 of Addendum A for an example of a building survey that should be performed immediately after the installation of the PVMS.

NOTE: Many buildings (particularly larger commercial/industrial buildings) have multiple foundation types and locations due to building additions over time; slab and sub-slab conditions often vary between building areas, and foundation walls or changes in floor elevation which may prevent airflow from one slab area to another. Other foundation features such as elevators, pits, sumps, floor drains, utilities, utility tunnels, and other structures located below the slab or floor level should be considered for their effect on mitigation designs.

Key Supporting Information

- Topographic Site Location Map (from USGS or site plans as available).
- General Site Feature Map that includes structures to scale with any property lines, right-of-way (ROW), and major utilities.
- Figure(s) in the plan view of the structure to be mitigated and that identifies the room divisions, footings known and estimated, and other key features such as the location of pits, sumps, vents, basements.
- Cross-sectional view figures and drawings for depicting other key features relative to the PVMS.
- Appendix with building survey that includes a photo log (see Appendix 1 of Addendum A).

1.3 Site History

This section should describe the current and past site use, operational history, as well as the type of hazardous or regulated substances currently and previously used at the property.

NOTE: Describing the site use and history aids in identifying the presence or likely presence of hazardous or regulated substances in, on, or at a property due to any release to the environment or conditions indicative of a release to the environment and may provide some general information on the concentrations of hazardous substances that could be expected to be encountered.

Key Supporting Information

- Table (optional depending on the complexity of the site) that provides a list of known activities or historical operations that may have led to a release of hazardous or regulated substances into the environment.
- Figure that identifies the locations of current and historical operations that may have or are known to have led to a release of a hazardous or regulated substance into the environment. These areas are typically referred to as RECs.

1.4 Geology/Hydrogeology

This section should describe the site geology and hydrogeology information. Information should include a description of soil types and depth to groundwater. Supporting data, including boring logs, should be provided. Soils may be described using either the USCS, USDA, or other soil classification system such as AASHTO/MDOT; regardless, the classification system should be identified. The potential for known or estimated seasonal variations in groundwater should be described. **The lithology and presence or absence of groundwater, including seasonal groundwater, should be evaluated to at least five (5) feet below the lowest part of the structure. The lowest part of the structure includes the maximum depth of any footings, sumps, drains, pits, and elevator shafts, etc.**

A cross section of the structure that is being mitigated should be provided with the site geology and hydrogeology information shown. Structures that have various footing depths, such as basements, elevators, tunnels, or pits, and those that are larger than 5,000 square feet, may require more than one cross-section clearly depicting these features to aid in the review.

Soil that will be brought on-site beneath the structure or as a component of the mitigation system should also be identified and described including information on the type, characteristics, and where it will be placed.

NOTE: Engineered and construction soils should be described based on the available information and should include a description of the subgrade, sub-base, and base-course soils to a depth of at least 12” below the lowest part of the structure.

Key Supporting Information

- Figure identifying boring locations used to classify the geological and hydrogeological information.
- Boring logs.
- Cross-section(s) depicting the current or proposed structure, below grade site features (foundations, utilities, etc.) and geological and hydrogeological information.
- Tables identifying any monitoring wells installed, depth of the wells, and the elevation of the groundwater.

1.5 Detailed Building Information

1.5.1 Below Grade Building Features and Foundations

This section should describe the foundation type (i.e., footings, pier, columns, cast pilings, etc.) and building portions that are below grade (basements, crawlspaces, elevator sumps, pits, utilities, tunnels, etc.) that are in contact with the soil. If there are any foundations that

are unknown that may impact the function of the PVMS, they should be identified here and addressed in Section 2.2.

Key Supporting Information

- All below grade building features and foundations should be identified in the plan view.
- Subsurface features should be depicted on the cross sections developed in Section 1.4.

1.5.2 Heating, Ventilation, and Air Conditioning (HVAC)

This section should describe the current or proposed HVAC system including any the location of air intakes and exhaust that are required for its operation.

Key Supporting Information

- Figure(s) should depict the location of any air intakes, vents, and discharge points including components on the roof or side of the structure.

1.5.3 Floor Slab and Condition

This section should describe and document the current condition of the floor.

Key Supporting Information

- Figure(s) that identify the location, type, and condition of the floor slabs.
- Appendix with building survey and photolog with representative photos.

1.5.4 Utility Penetrations and Man-Made Preferential Pathways

This section should describe and document the location of penetrations and sumps in which soil gas may enter and directly vent into the structure and utilities that directly come into contact with a vapor source. This evaluation is limited to those utilities that are in direct contact with a vapor source.

Key Supporting Information

- Figure(s) and cross-sections should identify the location of penetrations, sumps, and preferential pathways.

1.5.5 Historic Buildings (if applicable)

This section should describe any limitations to the system design or layout that are imposed on the structure due to a historic designation.

1.6 Source Areas and Contamination

1.6.1 Applicable Criterion

This section should identify the VIAP screening levels and/or criteria used to demonstrate that the response activity is necessary to protect the public health, safety, or welfare, or the environment, and identify the assumptions used in their development, the supporting information that the criteria are appropriate for use, and the values.

- **Generic Criteria or RBSLs**: If the use of the generic criteria is appropriate, supporting information should be described and presented.
- **SSVIAC or SSTLs**: When developed for the site or if VIAP Screening Levels (SLs) are used, the supporting documentation should be provided demonstrating the criteria are appropriate for use.

Key Supporting Information

- Table that identifies the criteria used.
- Separate appendix that provides supporting documentation for use of the VIAP Criteria, including any previous approvals for the use of the site-specific criteria.

1.6.2 Vapor Source

This section should identify the concentrations of the volatile hazardous or regulated substances that pose an unacceptable risk to the structures(s). The text should include a discussion of how the sample data aligns with the site history (Section 1.3). Representative soil, groundwater, and soil gas concentrations include any samples collected above and near the vapor source where vapors may enter structure.

Data that supports the design of the PVMS must be provided, including demonstrating that mitigation is warranted. Vapor data must support delineation of soil gas impacts in any areas where a PVMS is not proposed (i.e., outside of the mitigation footprint) though PVMS are typically installed across the entire footprint of a structure.

Key Supporting Information

- Tables that provide representative soil, groundwater, and vapor data compared to the applicable criteria.
- Figure(s) that identifies where the data was collected, including the sampled media and location of samples depicted on a scaled figure(s) relative to the structure(s).
- Representative detections above criteria relative to the structure should also be depicted on the figures.
- Appendix should include all analytical data and field forms.
- Cross sections should include below grade features with the chemical data depicted.

1.6 Man-Made Preferential Pathways Evaluation (if applicable)

This section should include an analysis of Section 1.5.4 above and if there is a need to design or propose a mitigation strategy for man-made preferential pathways or other preferential pathways that may not be addressed through the operation of the PVMS.

Key Supporting Information (as warranted)

- Text should reference the Figures identified in Section 1.6.2, as necessary, to identify preferential pathways that may pose an unacceptable risk due to their location within a source of vapors.

2.0 PVMS documentation and As-Builts

2.1 Overview of PVMS

This section should include a design basis that explains how vapors are entering, or may enter, the structure and how the PVMS prevents soil vapor from entering the building. It should include an overview of the type and function of the proposed mitigation system (e.g., vapor barrier, epoxy coating, passive sub-slab venting system, etc.).

2.2 Passive Vapor Barrier Selection

This section should briefly discuss why the vapor barrier or epoxy coating material(s) installed was selected and how it was determined to be appropriate for the intended application based on the results of chemical and physical testing data available for those material(s).

Briefly discuss any diffusion coefficients established for those materials, which hazardous substances they address, and whether they are capable of preventing unacceptable soil gas concentrations from the vapor source(s) identified from entering the building(s).

Key Supporting Information

- Figure(s) – cross-section that shows the vapor barrier or epoxy coating and the sampling locations.
- Appendix – manufacturer's product documentation that identifies established diffusion coefficients for the vapor barrier or epoxy coating material(s) used as part of the PVMS design.

2.3 As-Builts of the PVMS and Installation Documentation

This section should include details and as-builds of the installed components that make up the PVMS. It should include a description of the system and the specific components and elements described in Sections 2.3.1 through Section 2.3.12 below. Figures identified below may be combined when appropriate.

2.3.1 Liner

This section should include a general description liner and a figure that depicts the PVMS.

Key Supporting Information

- Figure(s) – cross-section(s) that show the liner portion of the PVMS.
- If a PVMS is to be installed in only a portion of the structure, an area map depicting its location.
- Photographs of the liner being installed.

2.3.2 Terminations and Penetrations

This section should include a depiction of how the liner was terminated against vertical surfaces and how the vertical features such as pipes or other penetrations were completed.

Key Supporting Information

- Figure(s) – cross-section(s) or callouts that depict the termination of the liner against vertical surfaces.
- Figure(s) – cross-section(s) or callouts that depict how piping or other penetrations will be completed.
- Figure(s) – depicting the location of every termination or penetration.
- Photographs of the termination and penetrations.

2.3.3 Liner Overlap, Joining, and Seaming (if necessary)

If the liner, as provided from the manufacturer, needed to be joined or seamed to allow for coverage of the entire floor space, this section should include a description of how that occurred, how it was verified to be successful, and how it is documented to be completed appropriately.

Key Supporting Information

- Figure(s) – cross-section(s) or callouts that how two liners are joined or seamed.
- Photographs documenting the seaming or joining process.

2.3.4 Permeable sub-slab layer

A venting system should be incorporated into the overall design of a PVMS. This section should provide a brief description of the materials used to create, maintain, or document the permeable sub-slab layer.

Key Supporting Information

- Figure(s) – cross-section(s) depicting the type of material(s) of the permeable sub-slab layer, the thickness of the layer, and any vapor collection piping installed within the permeable sub-slab layer.

2.3.5 Horizontal Conveyance Piping (if installed)

This section should include a general description of the horizontal conveyance piping used to direct the vapors through the structure or beneath the liner in subsurface.

Key Supporting Information

- Figure – depicting the horizontal conveyance piping layout of the PVMS.

2.3.6 Vertical Vent Risers

This section should include a general description of the vertical conveyance piping used to direct the vapors through the building and above the roof.

Key Supporting Information

- Figure(s) – cross-section of structure that details the vertical piping runs.

2.3.7 Exhaust Vents

This section should include a general description of the PVMS exhaust point location(s). This section should identify any distance(s) that were achieved between each exhaust point location and building features including height above structure or roof, other air intake(s), window(s), structure access point(s) such as a door or patio, and HVAC components based on AARST SGM-SF-2017 (with 12/20 revisions).

NOTE: All distances should be measured between the closest point of the exhaust opening and the closest point of all location requirements specified.

Key Supporting Information

- Figure(s) – plan view that depicts the roofing locations and any other vents or air intakes that influences the location of the exhaust.
- Figure(s) – cross-section of structure that details the exhaust vents height above the structure.
- Photographs of the completed vents.

2.3.8 Materials and Other Specifications

2.3.8.1 Component Labeling

This section should reaffirm that, when and where labeling was warranted, labeling practices followed standards such as AARST SGM-SF-2017.

Key Supporting Information

- List of required labels as per SGM-SF 2017.
- Figure(s) – depicting final labels and language.
- Figure(s) – identifying the physical location of each label.

2.3.8.2 Other Specifications (if necessary)

Additional information can be provided in this section if the design firm believes that the information is critical to the success of the installation of the PVMS design and has not been included elsewhere in this document.

Key Supporting Information

- Figures, tables, or appendix may be provided, as appropriate.

2.3.9 Preferential Pathways and other Unique Features (if necessary)

This section should describe the mitigation strategy for any preferential pathways identified in Section 1.7 that required mitigation.

Key Supporting Information

- Figure(s) that detail each unique mitigation approach implemented for preferential pathways.

2.3.10 Elevators and below grade pits or tunnels (if necessary)

This section describes the mitigation strategy and how it is effective for each elevator shaft, pit, sump, or tunnel that are part of the structure.

Key Supporting Information

Figure(s) – detailing each unique mitigation strategy implemented for any elevator shafts, pits, or tunnels.

2.3.11 Vertical/Sidewalls Below Grade (if necessary)

This section describes the mitigation strategy implemented for any vertical sidewall below grade where mitigation is necessary.

Key Supporting Information

- Figure(s) – detailing the mitigation strategy for the vertical wall(s) below grade.
- Appendix – providing additional supporting information, if necessary.

2.3.12 Groundwater in Contact (if necessary)

If groundwater is in contact or may come into contact with the structure (see Section 1.4), this section describes how the shallow groundwater was addressed to allow for the proper function of the PVMS.

Key Supporting Information

- Figure(s) – detailing the mitigation strategy implemented for shallow groundwater.
- Appendix – providing additional supporting information, if necessary.

2.3.13 Installation Documentation

This section provides an overview of the installation documentation that was collected, identifies any deficiencies, and reports any repairs that were completed during the installation process.

Key Supporting Information

- Appendix – Provides the supporting oversight and installation documentation. Appendix 1 of Addendum A provides a summary of the documentation that should be included.

2.4 Alarm and Performance Indicator (if installed)

This section describes any monitoring system(s) installed as part of the PVMS and describes the function of the alarm or performance indicator, what it measures, and how it relates to the system function. The section should be specific about any warnings that are relayed, if and how data is stored, how any alarms that are identified are documented, and what documentation (if any) is produced.

Key Supporting Information

- Figure(s) – detailing the location of alarms.
- Table – identifying any alarms that have been triggered to date and the completed response(s).

2.5 Building Codes and Permits

This section clearly states that other permits necessary for the installation of the PVMS that are not regulated by RRD have been obtained and compliance is being or has been achieved (e.g., building codes) through an affirmative statement similar to: “The system was installed and is operating in accordance with all local, state, and federal laws and rules.”

Key Supporting Information

- Appendix – providing any EGLE granted permits or documentation in lieu of a permit that is required.

2.6 Monitoring Points and Test Ports

This section describes the locations that facilitate confirmation of system operation.

Key Supporting Information

- Figure(s) – plan view depicting the location of each monitoring point in relation to any subsurface PVMS component.
- Table – providing detail on how each monitoring or test point was installed.

2.7 Performance Objectives

2.7.1 System Performance Metrics

This section should identify and establish the performance metrics that are met at each monitoring point identified in Section 2.6, above. It also describes how each performance metric is measured. This section should also present why the performance metrics are appropriate to evaluate the efficacy of the PVMS.

Key Supporting Information

- Table – if more than one performance metric is required or selected, identify the location and the specific performance metric(s) that are being measured and/or achieved.

- Figure – identifying the location that the performance metric is being evaluated.

NOTE: Because PMVS do not contain mechanical parts nor are they expected to have consistent or flow through the system, performance factors are typically limited, unless the liner or coating has been breached to the following:

- Confirming flow or connectivity from all portions of the floor to the vertical vent risers and confirming the prevention of advective and diffusive flow into the structure,
- Confirming flow up through the vertical vent risers,
- Confirming the operation of any meter or alarms, and
- Ensuring that the building has undergone any settlement or modifications that may have impacted the integrity of the PVMS.

2.8 System Commissioning Documentation

This section provides the analysis and supporting documentation that the system was installed as proposed and is functioning as designed.

It should include a summary of the on-site oversight, problems encountered, corrections made, daily field logs, photographic documentation, an analysis of the estimated supplies vs the actual, and any verification samples that were collected.

Key Supporting Information

- Table – identifying the performance metric(s), the locations monitored and the associated readings.
- Appendix – all field and other supporting documentation

3.0 Operation, Maintenance, and Monitoring (OM&M) PLAN

This section should include a brief overview of the OM&M Plan specific for the installed PVMS that is contained within a supplemental addendum and a summary table. The OM&M Plan must be based upon the installed equipment, specified equipment maintenance or calibration periods, required performance monitoring, and expected component life.

The supplemental addendum (see attached) should contain all the supporting information necessary for the actual OM&M Manual, and it should be formatted as a stand-a-lone submittal that contains the following information:

- General Description of the System
- Emergency contact and installer information
- Equipment and supplies necessary to perform the OM&M inspections and monitoring
- Installed alarms and appropriate responses for the alarms (if necessary)
- Inspection form(s)

- Survey and inspection of the structure where the PVMS is installed for changes or modifications in use, operation, configuration, or size
- Verification and calibration of the operation of any installed telemetry, monitoring equipment, or alarms (if necessary)
- A description of the visual inspection of system components including visible labels, sealants, hangers, other critical components
- Established operating performance specifications
- A description of what the inspector is looking for to evaluate whether repair is necessary
- Monitoring frequency and location
- The collection and the recording of performance measurements
- Installed equipment maintenance schedule
- Performance metrics that must be met
- An assessment of the inspections that were completed.
- Where the inspection notes and documentation are stored
- Verification of compliance with any permits
- Building Owner/Tenant Engagement Notification Forms and Documentation

Depending on the complexity of the system and the need for monitoring or documenting different processes, unique inspection forms are recommended to be included. The documentation necessary to maintain the PVMS is identified in the OM&M Manual.

Key Supporting Information

- Supplemental addendum (see attached)
- Table(s) – identifying the final performance specifications, the monitoring locations, required inspection locations, and required routine maintenance

Appendix 1 – System Documentation

NOTE: Inspections with recordkeeping are necessary during installation to document that the PVMS components were properly installed, meet the design specifications, were not damaged during construction, and remain leak free so that sub-slab vapors do not enter the building envelope. The inspections must account for construction phases and conditions that may affect the integrity and performance of the PVMS. Failure to provide actual field documentation may limit the ability to demonstrate the effectiveness of the installed liner system.

The table provided below identifies the information that must be available. It is insufficient to mark an item complete and not provide the actual documentation.

Passive Vapor Barrier Mitigation System
Installation Quality Assurance Elements

1	**Materials**
	Specifications for materials delivered to the site associated with the passive vapor barrier system are consistent with the design specifications (i.e., piping, tubing, aggregate, barrier material, mastics/tapes, etc.).
	Batch numbers/source identifiers for materials delivered to the site have been recorded with those records maintained.

Vapor Collection Zone Quality Assurance

2	**Subgrade Preparation: Underlying Soil Beneath Aggregate Vapor Collection Zone**
	Soil is uniformly compacted with no irregular surfaces and meets specifications of building/structural engineer.
	Horizontal and vertical surfaces are free puncture hazards (e.g. protrusions/debris).

3	**Utilities**
	Utilities that will underly the passive vapor barrier have been installed, inspected by local building authority, as applicable.
	All utilities with risers or vertical components that will penetrate the passive vapor barrier have been installed, are labeled as to their function/purpose, and extend to a sufficient elevation that they will not be encapsulated in the concrete floor slab or flooring system installed above the passive barrier.
	Minimum horizontal clearances around utility penetrations (>1”) are maintained (*e.g.* utility conduits/piping are not in contact with existing concrete or other penetrations).
	If minimum horizontal clearances around utility penetrations (>1”) cannot be maintained, grout blocks are used, as specified by the design engineer.

3	**Utilities**
	Utility penetrations have >3” clearance between the plane of the barrier application and the nearest joint, bend, or other fitting.
	Utility penetrations are clear of tape, wraps, or foams to a minimum distance of 3” above the plane of the fluid applied barrier application;
	Horizontal alignments of utilities within the aggregate base do not obstruct vapor flow.
	Utilities are not in contact with or supported on existing concrete surfaces receiving application of the fluid applied barrier (>1” clearance between utility and surface).
4	**Soil Gas Sampling/Monitoring Points**
	Deeper soil gas monitoring points that extend into the subgrade zone below the passive vapor barrier’s aggregate vapor collection zone are installed and have passed leak check tests.
	Tubing for the deeper soil gas monitoring points and sub-slab vapor monitoring points that will be embedded within the passive vapor barrier’s aggregate vapor collection zone have been extended to the location of the probe surface completion(s).
	Exposed tubing within the aggregate vapor collection zone is protected against damage.
5	**Vapor Collection, Smoke Injection, & Conveyance Piping**
	Spacing, layout, and depth of sub-slab vapor collection and conveyance piping, and smoke injection ports/piping is consistent with design documents.
	Foundation penetration sleeves are installed.
	Vent risers do not penetrate the slab foundation within a firewall or shear wall.
	All vent risers have been installed, are labeled as to their function/purpose, and extend to a sufficient elevation so that they will not be encapsulated in the concrete floor slab or flooring system installed above the passive barrier.
6	**Aggregate Vapor Collection Zone**
	Spec sheet for delivered aggregate base matches the design specifications.
	Aggregate is free of vegetation or fine particles which could reduce vapor permeability.
	Aggregate is uniformly placed, compacted, and is free of protrusions or debris that may be a puncture hazard.
	Aggregate placed adjacent to perimeter footings, interior footings, column foundations, elevator pits, and other building structural components is free of voids or bridging that could affect vapor barrier system termination or adhesion during or following concrete slab or flooring system installation.

6	Aggregate Vapor Collection Zone
	Unobstructed aggregate depth meets the design specifications (> __inches) with measurements verified using a yard stick or other measuring device.

Surface Application

7	Application Surface: Existing Concrete Surfaces
	Concrete surfaces within the application area have a uniform plane.
	Concrete surfaces within the application area are free of debris, standing water, oil, grease, or other materials which may impede barrier adhesion.
	Expansion joint materials are not present on concrete or other surfaces onto which the vapor barrier will be terminated.
	All cold joint tie-ins are installed, and dowels are epoxied or otherwise secured as required by other disciplines. Concrete surfaces within the application area where the barrier will terminate (vertically or horizontally) have a minimum of 4” of finished concrete free of rebar or other tie-ins.

8	Application Surface: Other Bulk Surfaces (*e.g.* plywood, sheet-piling, steel)
	Other bulk surfaces (*e.g.* plywood, sheet-piling, steel) are jointed such that surfaces are planar with no irregularities.
	Smooth surfaces are scarified sufficient to facilitate barrier adhesion.

9	Passive Vapor Barrier
	If a spray-applied barrier is installed, coupon testing is completed at the design specified rate to document that the vapor barrier thickness meets minimum design specifications. A coupon testing log/map is prepared identifying the inspector, date, and locations of all coupon tests.
	If a membrane-only system with sealed/overlapped seams is installed, all seams are inspected to verify that the proper overlap was achieved, consistent with the design specifications. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	Penetrations are prepared consistently with design specifications (*i.e.* zip ties, collar length).
	Termination sequence for the spray applied barrier is uninterrupted and consistent with design specifications.
	Spray applied barrier is free of debris and/or materials that may puncture the barrier (i.e., nails, wire, gravel, rebar).
	The barrier is free of pooling water or objects which may obstruct visual identification of smoke emitting from leaks.

9	Passive Vapor Barrier
	There are no visible tears in the barrier.

10	Passive Vapor Barrier Smoke Testing
	Smoke testing is conducted per the design specifications to verify that the vapor barrier is leak free. The extent of the smoke has been confirmed to ensure that all areas of the vapor barrier has been tested. This includes all termination areas and barrier penetrations. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	All observed emission points of smoke have been repaired, and no major manufacturing defects are identified.
	Smoke emissions are confirmed at vent riser stub locations to confirm communication between the aggregate layer and the vapor collection piping.

Concrete/Flooring System Over Barrier Quality Assurance

11	Pre-Concrete/Flooring System Protective Layer Inspection (If Applicable)
	Geotextile fabric or other protective layer installed above the passive vapor barrier following smoke testing is placed and terminated per the design specifications with no gaps or voids.
	Topping sands or other materials installed above the passive vapor barrier are installed using methods/procedures outlined in the design specifications and inspected to verify that the required thicknesses were achieved. An inspection log/map is prepared identifying the inspector, date, and inspection areas.

12	Concrete/Flooring System Installation
	Concrete/flooring system has been installed using methods/procedures and the pour/installation sequence outlined in the design specifications.
	Reinforcing steel is not in contact with the barrier.
	Utilities stub-up beyond the finished plane or the concrete or are completed at the finished plane of the concrete (*e.g.* floor drains, slot trenches).
	Sacrificial elements associated with concrete screeding are in place. Where screed stakes penetrate the barrier, the stakes are sealed in accordance with the design specifications.
	If post-installation saw cutting of concrete floor slabs is completed, saw cutting is sufficiently shallow such that the underlying vapor barrier is not cut.
	If post-installation anchor installation is completed (i.e., for bollards, racking, dock levelers, etc.) anchors are sufficiently shallow such that the underlying vapor barrier is not damaged.

12	Concrete/Flooring System Installation
	If post-installation floor slab caulking/sealing is completed, caulk/sealant is installed using the specified sealant/methods at interior perimeter, column interface, footing boundary, utility penetrations, vent riser penetrations, and other areas, per design specifications. An inspection log/map is prepared identifying the inspector, date, and inspection areas.

13	Flooring System Installation Smoke Testing
	Smoke testing is conducted prior to any finished flooring (i.e., carpet/tile, etc.) per the design specifications to verify that the vapor barrier remains leak free following concrete floor slab/system installation. The extent of the smoke has been confirmed to ensure that all areas of the vapor barrier has been tested. This includes all termination areas and barrier penetrations. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	All observed emission points of smoke have been repaired and no major manufacturing defects are identified.
	Smoke emissions are confirmed at vent riser locations to confirm communication between the aggregate layer and the vapor collection piping.
	Smoke testing is conducted post finished flooring to confirm that during the installation process the liner was not breached. Smoke should not be placed directly into the venting system. Both pre and post finished flooring smoke testing is required. All observed emission points of smoke have been repaired, and no major manufacturing defects are identified.

Surface Coatings Quality Assurance

14	Surface Coatings
	If a surface-coating vapor barrier is installed, the slab is inspected for cracks, gaps, or other damage/imperfections, and those areas filled or repaired per the design specifications prior to installation of the surface coating.
	Concrete/substrate moisture testing and/or compatibility testing is conducted per the design specifications prior to installation of the surface coating.
	Thickness testing is conducted using a wet gauge or epoxy thickness gauge at the design specified rate to document that the surface coating thickness meets minimum design specifications. A testing log/map is prepared identifying the inspector, date, and locations of all coupon tests.

Ventilation System Quality Assurance

15	Vent Riser/Ventilation Piping
	Vent riser and associated piping is installed at locations (including wall and roof penetrations) consistent with the design specifications.
	Exterior vent riser outlets are located away from building air intakes, windows and entry points, or are of sufficient height, consistent with the design specifications, to avoid vented gases from entering the building envelope in accordance with published standards and requirements.
	Vent riser smoke injection/sample ports and valves installed at locations/elevations consistent with the design specifications.
	Vent riser and associated piping is appropriately supported/enclosed and sloped to promote drainage to the sub-slab environment, consistent with the design specifications.
	Required labels are affixed to all vent risers, at the required vertical intervals.
	If required by the design specifications, vent riser outlets are equipped with passive wind turbines, or other termination features. If present, passive wind turbines are documented to spin freely.
	A smoke pen or bellows is used to document upward vapor flow via the vent risers.

Addendum A – Operation, Maintenance, and Monitoring Plan (OM&M) Plan

1.0 Introduction

1.1 Site Information

The following information shall be identified:

- Site – site address with regulatory identifiers (Facility name and ID#s)
- Owner – entity, address, contacts
- Building Survey

1.2 Purpose of the Document

This section should identify the purpose of this document.

This plan can be submitted as an appendix to the install and commissioning documentation or submitted as a stand-alone document. However, if the OM&M Plan is submitted as a standalone document, the information provided in the installation and commission report is still required to complete the review (see Section 1.6 below).

1.3 Installer and Design Firm

This section should identify the installer and the design firm.

1.4 Party Responsible for Data Collection

This section should identify who is collecting data, for what purpose, and where it will be stored.

1.5 Design and Commissioning Information

(Required only if the OM&M is submitted apart from the Installation and Commissioning Report)

This section should include, in an appendix, all the information contained in the Installation and Commissioning Report or reference where it can be found. If not previously provided, it can be provided as a separate appendix.

Key Supporting Information

- Appendix – System installation and commissioning information.

1.6 System Operation Documentation

This section should discuss how the system operation will be documented.

1.7 Installed Alarms

This section should identify the installed alarms, typically only associated with methane or explosive conditions; the expected operating life of the equipment and any routine maintenance that must occur to ensure that the system continues to function as designed; the appropriate response times; and procedures to follow if a warning or alarm has gone off.

1.8 OM&M Inspections and Monitoring Equipment

This section should identify what tools, instruments (and their associated calibration), monitoring frequency, and forms are necessary to perform the OM&M identified.

2.0 Maintenance and Visual Inspections

2.1 Mechanical Equipment (if applicable)

This section should identify the expected operating life of the equipment and any routine maintenance that must occur to ensure that the system continues to function as designed.

Key Supporting Information

- Figure(s) – identifying the location of the equipment.
- Table – identifying the equipment, what maintenance should be performed, and when it should occur.
- Inspection Form (optional) documenting that maintenance was performed.

2.2 Calibration and Testing for Alarms, and Telemetry (if applicable)

This section should identify the expected operating life and any required calibration procedures to ensure that any alarm(s) or telemetry continues to function as installed and within operating parameters.

Key Supporting Information

- Figure(s) – identifying the location of the equipment.
- Table – identifying the equipment and what maintenance or calibration should be performed and when it should occur.
- Inspection Form (optional)documenting that calibration was performed.

2.3 Sealants, Barriers, Batteries

This section should identify the expected life and where materials are used such as sealants, barriers, and batteries.

Key Supporting Information

- Figure(s) – identifying the location(s) of any sealants, barriers, and/or batteries.
- Table – identifying the equipment, required maintenance and calibration or replacement should be performed, and when it should occur.
- Inspection Form (optional)documenting the maintenance, calibration, or replacement of any sealants, barriers, or batteries.

3.0 Monitoring and Measurements

This section should identify inspections that will occur, the frequency, and the performance measurements that will be collected.

Visual inspections should be based on previously reported and documented information obtained on the latest building inspection form and from interviews with on-site personnel or the individual with appropriate firsthand knowledge.

Items that should be reported on the visual inspection forms include the following:

- Changes or modifications in use, operation, configuration, structural changes, or size of the structure
- Visual PVMS components such as labels for readability and presence, sealants, building system.
- PVMS components for audible or visual indicators that a repair or replacement is warranted.

Other information that should be described in this section includes:

- Location – where the inspection will occur.
- Frequency – how often the inspection will occur.
- Observations – what observations should be made and noted.
- Operation – that the PVMS is operating.
- Response – what steps should be taken if the visual inspection identifies a response is necessary.

NOTE: The recommended inspection not to exceed frequency for PMVS is as follows:

- Annual building integrity and confirmation that the building has not undergone any settlement or modifications that may have impacted the integrity of the PVMS,
- Every five years confirm flow or connectivity and barrier competency. Connectivity should be from all portions of the floor to the vertical vent risers and flow up through the vertical vent risers, and
- As specified by the manufacturing company, the operation of any meter or alarms (typically limited to methane).

Key Supporting Information

- Figure(s) – identifying the inspection point(s)
- Table – identifying portion of the PVMS that is being inspected and specific information that should be document.
- Inspection Form (optional) allowing the inspection to be performed in a standardized and routine manner, produce a record that that the inspections have occurred, and show that the system continues to function as designed.

4.0 Data and Documentation

4.1 Data Documentation

This section should identify how the information collected above is stored (i.e., inspection forms, other supporting documentation, repair, and telemetric records), analyzed, and who is responsible to correct any issues identified. All data and inspection forms should be included as a separate appendix based on purpose and type of information collected.

4.2 Data Analysis

This section should include how the data collected in Section 2 and Section 3 will be evaluated for effectiveness.

4.3 Building Owner/Tenant Engagement Notification Forms and Documentation

This section should identify how key information about the PVMS including operation, notice, and, if appropriate, installed alarms will be provided to the building owner and/or tenants. If a notice is prepared, an example should be included as an attachment and the process that will be used to provide the information should be described.

Key Supporting Information

- In an attachment or appendix, examples of the notices.

Appendix 1 – Building Survey

NOTE: This building survey is intended to be used only as an example in developing a building survey that is specific to the site with the appropriate information for the structure in which a vapor mitigation system has been installed. This form may not contain all of the information necessary. The development and use of this form is fundamentally important in documenting site conditions during future inspections to confirm if any modifications to the structure have been made, and whether a more detailed assessment is warranted. It should be updated on an annual basis.

Survey performed by:

Date:

Address:

1. OCCUPANT

Owner Occupied: ☐ Yes ☐ No

2. OWNER OR LANDLORD

Name:

Address:

City and State:

County:

Home Phone

Office Phone:

3. BUILDING CHARACTERISTICS

General description of property use and construction:

☐ Residential ☐ Multi-family Residential ☐ Office

☐ Strip Mall ☐ Commercial ☐ Industrial

☐ School ☐ Restaurant ☐ Other: _____

Building Description:

Building Footprint: _____ ft^2

Year Constructed:

Number of floors at or above grade:

Number of floors below grade:

General Description of structure(s) below grade:

☐ Basement ☐ Crawl space ☐ Slab on grade ☐ Not Applicable
☐ Other: _____

If the property includes any structures (besides footings) below grade:

Depth of structure below grade: _____ ft
Footprint: _____ ft^2

If the property includes residential, which of the following describes the property?

☐ Ranch ☐ Multi-family ☐ Two-story single family
☐ Duplex ☐ Split Leve ☐ Mobile Home
☐ Apartment ☐ Townhouses/Condos ☐ Modular
☐ Log Home ☐ Other: _____

If the property includes commercial use:

Business type(s):
Does it include residences (i.e., multi-use)? ☐ Yes ☐ No
If yes, how many units?

If industrial use:

Type:

Level	**General Use** (e.g., family room, bedroom, laundry, workshop, storage)
Basement:	
1st Floor:	
2nd Floor:	
3rd Floor:	
4th Floor:	

Use additional page(s) as necessary.

4. CONSTRUCTION CHARACTERISTICS

General description of above grade construction

☐ Wood frame ☐ Concrete/Cement ☐ Stone ☐ Brick ☐ Other: _____

General Description of structure(s) below grade structures

☐ Basement ☐ Crawl space ☐ Slab on grade ☐ Not Applicable
☐ Foundation/Footings ☐ Other: _____

General Description of below grade construction

☐ Wood frame ☐ Concrete/Cement ☐ Stone ☐ Brick ☐ Other:

General Description of Basement Type

☐ Full ☐ Crawlspace ☐ Slab ☐ Other:

General Description of Lowest Level flooring

☐ Concrete ☐ Dirt ☐ Stone ☐ Other: _____

General Description of foundation walls:

☐ Block ☐ Stone ☐ Poured concrete/cement ☐ Other:

Is there an attached garage? ☐ Yes ☐ No
If yes, does it have a separate heating unit? ☐ Yes ☐ No

Sump's present? ☐ Yes ☐ No

If yes, how many?

Sumps sealed: ☐ Yes ☐ No ☐ Not Applicable

Water in Sump: ☐ Yes ☐ No ☐ Not Applicable

General description of location of each sump:

Type of ground cover outside of building:

☐ Grass ☐ Concrete ☐ Asphalt ☐ Other: _____

5. HEATING, VENTING, and AIR CONDITIONING

General Description of heating system(s) used in this building:

☐ Hot Air Circulation ☐ Heat Pump ☐ Hot Water Baseboard
☐ Space Heaters ☐ Steam Radiation ☐ Radiant Floor
☐ Electric Baseboard ☐ Wood Stove ☐ Outdoor Wood Boiler

☐ Other:

General Description primary fuel type used:

☐ Natural Gas ☐ Fuel Oil ☐ Kerosene ☐ Electric
☐ Propane ☐ Solar ☐ Wood ☐ Coal

General location of boiler/furnace:

☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other

General location of hot water heater:

☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other:

Type of venting for HVAC components and hot water heater:

☐ Direct-vent ☐ Power-vent

Air Conditioning present? ☐ Yes ☐ No

Whole house or attic fan? ☐ Yes ☐ No

6. UTILITIES

Identify all utilities that enter below grade into the structure:

☐ Electric ☐ Gas ☐ Sewer ☐ Cable ☐ Communications

☐ Other:

7. DOCUMENTATION

Pictures that document items 3-6 above and the conditions at the time of the survey

Pictures attached: ☐ Yes ☐ No

Scaled drawings of the building floor plan and configuration at the time of the survey

Figures attached: ☐ Yes ☐ No

Attachment B.5-3 – Operation, Maintenance, and Monitoring (OM&M) of a Passive Vapor Mitigation System (PVMS)

The purpose of OM&M is to document and ensure the PVMS continues to function as designed until the vapor source(s) no longer poses an unacceptable risk to receptors. During the OM&M, the PVMS continues to be operated, maintained/repaired, and monitored in accordance with the performance metrics established during the Installation and Commissioning.

Repairs or modifications to PVMS should be handled in a manner consistent with contingency actions or a contingency plan established for non-performance of specific system components and the design performance requirements associated with each. Any new additions or significant modifications to the PVMS moves the PVMS back into Phase 2 – System Installation/Commissioning.

Coversheet

The cover sheet for the PVMS design should contain the following information:

- Site – site address with regulatory identifiers (Facility or Site name and ID#s).
- Owner – entity, address, contact information.
- System Designer and/or Environmental Consultant – entity, address, contact information.
- Building Engineer and/or Architect (if applicable) – entity, address, contact information.
- Submittal Date

1.0 Site Information

The following information shall be identified:

- Site – site address with regulatory identifiers (Facility or Site name and ID#s).
- Owner – entity, address, contacts.
- Building Survey (current, see Appendix 1, update as necessary)
- PVMS Installation Date
- Last OM&M Report submittal
- OM&M Report Period

1.1 Purpose of the Document

This section should identify the purpose of this document.

1.2 Installer and Design Firm

This section should identify the installer and the design firm.

1.3 Data Collection and Oversight

This section should identify who collected what data and where it is stored.

1.4 As-Builds and Commissioning Information

This section should provide a description of the PVMS, the installation oversight documentation, the commissioning information, the performance metrics, and an as-built drawing set of the installed mitigation system.

Key Supporting Information

- As-builds done to scale or other information that includes any key components or the location that was monitored as part of the OM&M.
- Appendix with the install and commissioning information from the Installation and Commissioning TOC.

1.5 System Installation and Operation Documentation

This section should discuss the installation documentation and the timeframes that the system operation can be documented and provide the supporting documentation.

Key Supporting Information

- Appendix with the supporting information including the information in Appendix 2.

1.6 Alarms

This section should identify the installed alarms, if any alarms have been triggered during this reporting period, the response times, and any supporting documentation.

Key Supporting Information

- Appendix with the supporting information.

1.7 OM&M Inspections and Monitoring Equipment

This section should identify what tools, instruments (and their calibration), frequency, and forms were used to perform the OM&M identified.

1.8 Changes and System Modifications

This section should identify any changes or modifications to the system or building (Building Inspection Reports) since the last reporting period and any modifications as a result of any identified changes or modifications.

Key Supporting Information

- Appendix with the supporting information.

2.0 Maintenance and Inspections

2.1 Mechanical Equipment (if applicable)

This section should identify and discuss the equipment and what maintenance or equipment repair was performed. If any of the mechanical equipment was repaired or replaced it should be described here.

Key Supporting Information

- Figure(s) – Identifying the location of the equipment.
- Table – Identifying the equipment and what and when maintenance should be performed.
- Inspection Form (optional) documenting that maintenance was performed.

2.2 Calibration and Testing for Alarms, and Telemetry (if applicable)

This section should identify and discuss any calibration or testing of alarms or telemetry that was performed and when the next calibration and testing will occur.

Key Supporting Information

- Figure(s) – identifying the location of the equipment.
- Table – identifying the equipment and what and when maintenance or calibration should be performed.
- Inspection Form (optional) documenting that calibration was performed.

2.3 Sealants, Barriers, Batteries

This section should identify and discuss any inspections on sealants, barriers, and batteries that was performed, and any replacement or repairs that were made.

Key Supporting Information

- Figure(s) – identifying the location.
- Table – identifying the equipment and what maintenance, calibration, or replacement was performed and when it occurred.
- Inspection Form (optional) documenting that it was performed.

3.0 Monitoring and Measurements

This section should identify the inspections that occurred and provide a discussion of the following:

- Changes or modifications in use, operation, configuration, structural changes, or size of the structure.
- Visual non-mechanical PVMS components such as labels for readability and presence, sealants, and building system.

- Mechanical PVMS components for audible or visual indicators that a repair or replacement was necessary.

Other information that should be described in this section includes:

- Location – where the inspection occurred.
- Frequency – how often the inspection occurred.
- Observations – what observations were made and noted.
- Operation – that the PVMS continues to operate.
- Response – what steps were taken if the visual inspection identified a response was necessary or warranted.

Key Supporting Information

- Figure(s) – identifying the inspection point.
- Table – identifying what was inspected and what information was document.
- Inspection Form (optional) allowing the inspection to be performed in a standardize and routine approach, a record that the inspection(s) occurred, and that the system continues to function as designed.

4.0 Data and documentation

4.1 Data Documentation

This section should identify how the information collected above is stored (i.e., inspection forms, other supporting documentation, repair, and telemetric records), analyzed, and who is responsible to correct any issues identified. All data and inspection forms are placed in a unique appendix based on purpose and type of information collected.

4.2 Data Analysis

This section should include how the collected data collected in Section 2 and Section 3 was evaluated for effectiveness.

4.3 Building Owner and/or Tenant Engagement Notification Forms and Documentation

This section should identify how key information about the PVMS including operation, notice, and, if appropriate, installed alarms, was provided to the building owner and/or tenants, including a record that documents it occurred. If a notice was prepared, include a copy of the notice should be provided.

Appendix 1 – Building Survey

NOTE: This building survey is intended to be used only as an example in developing a building survey that is specific to the site with the appropriate information for the structure in which a vapor mitigation system has been installed. This form may not contain all of the necessary information for a particular structure. The development and use of this form is fundamentally important in documenting site conditions during future inspections to confirm if any modifications to the structure have been made, and whether a more detailed assessment is warranted. It should be updated on an annual basis.

Survey performed by:

Date:

Address:

1. OCCUPANT

Owner Occupied: ☐ Yes ☐ No

2. OWNER OR LANDLORD

Name:

Address:

City and State:

County:

Home Phone

Office Phone:

3. BUILDING CHARACTERISTICS

General description of property use and construction:

☐ Residential ☐ Multi-family Residential ☐ Office

☐ Strip Mall ☐ Commercial ☐ Industrial

☐ School ☐ Restaurant ☐ Other: _____

Building Description:

Building Footprint: _____ ft^2

Year Constructed:

Number of floors at or above grade:

Number of floors below grade:

General Description of structure(s) below grade:

☐ Basement ☐ Crawl space ☐ Slab on grade ☐ Not Applicable
☐ Other: _____

If the property includes any structures (besides footings) below grade:
Depth of structure below grade: _____ ft
Footprint: _____ ft^2

If the property includes residential, which of the following describes the property?
☐ Ranch ☐ Multi-family ☐ Two-story single family
☐ Duplex ☐ Split Leve ☐ Mobile Home
☐ Apartment ☐ Townhouses/Condos ☐ Modular
☐ Log Home ☐ Other: _____

If the property includes commercial use:
Business type(s):
Does it include residences (i.e., multi-use)? ☐ Yes ☐ No
If yes, how many units?

If industrial use:
Type:

Level	**General Use** (e.g., family room, bedroom, laundry, workshop, storage)
Basement:	
1st Floor:	
2nd Floor:	
3rd Floor:	
4th Floor:	

Use additional page(s) as necessary.

4. CONSTRUCTION CHARACTERISTICS

General description of above grade construction

☐ Wood frame ☐ Concrete/Cement ☐ Stone ☐ Brick ☐ Other: _____

General Description of structure(s) below grade structures

☐ Basement ☐ Crawl space ☐ Slab on grade ☐ Not Applicable
☐ Foundation/Footings ☐ Other: _____

General Description of below grade construction

☐ Wood frame ☐ Concrete/Cement ☐ Stone ☐ Brick ☐ Other:

General Description of Basement Type

☐ Full ☐ Crawlspace ☐ Slab ☐ Other:

General Description of Lowest Level flooring

☐ Concrete ☐ Dirt ☐ Stone ☐ Other: _____

General Description of foundation walls:

☐ Block ☐ Stone ☐ Poured concrete/cement ☐ Other:

Is there an attached garage? ☐ Yes ☐ No
If yes, does it have a separate heating unit? ☐ Yes ☐ No

Sump's present? ☐ Yes ☐ No

If yes, how many?

Sumps sealed: ☐ Yes ☐ No ☐ Not Applicable

Water in Sump: ☐ Yes ☐ No ☐ Not Applicable

General description of location of each sump:

Type of ground cover outside of building:

☐ Grass ☐ Concrete ☐ Asphalt ☐ Other: _____

5. HEATING, VENTING, and AIR CONDITIONING

General Description of heating system(s) used in this building:

☐ Hot Air Circulation ☐ Heat Pump ☐ Hot Water Baseboard
☐ Space Heaters ☐ Steam Radiation ☐ Radiant Floor
☐ Electric Baseboard ☐ Wood Stove ☐ Outdoor Wood Boiler

☐ Other:

General Description primary fuel type used:

☐ Natural Gas ☐ Fuel Oil ☐ Kerosene ☐ Electric
☐ Propane ☐ Solar ☐ Wood ☐ Coal

General location of boiler/furnace:

☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other

General location of hot water heater:

☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other:

Type of venting for HVAC components and hot water heater:

☐ Direct-vent ☐ Power-vent

Air Conditioning present? ☐ Yes ☐ No

Whole house or attic fan? ☐ Yes ☐ No

6. UTILITIES

Identify all utilities that enter below grade into the structure:

☐ Electric ☐ Gas ☐ Sewer ☐ Cable ☐ Communications

☐ Other:

7. DOCUMENTATION

Pictures that document items 3-6 above and the conditions at the time of the survey

Pictures attached: ☐ Yes ☐ No

Scaled drawings of the building floor plan and configuration at the time of the survey

Figures attached: ☐ Yes ☐ No

Appendix 2 – System Documentation

NOTE: Inspections with recordkeeping are necessary during installation to document that the PVMS components were properly installed, meet the design specifications, were not damaged during construction, and remain leak free so that sub-slab vapors do not enter the building envelope. The inspections must account for construction phases and conditions that may affect the integrity and performance of the PVMS. Failure to provide actual field documentation may limit the ability to demonstrate the effectiveness of the installed liner system.

The table provided below identifies the information that must be available. It is insufficient to mark an item complete and not provide the actual documentation.

Passive Vapor Barrier Mitigation System
Installation Quality Assurance Elements

1	**Materials**
	Specifications for materials delivered to the site associated with the passive vapor barrier system are consistent with the design specifications (i.e., piping, tubing, aggregate, barrier material, mastics/tapes, etc.).
	Batch numbers/source identifiers for materials delivered to the site have been recorded with those records maintained.

Vapor Collection Zone Quality Assurance

2	**Subgrade Preparation: Underlying Soil Beneath Aggregate Vapor Collection Zone**
	Soil is uniformly compacted with no irregular surfaces and meets specifications of building/structural engineer.
	Horizontal and vertical surfaces are free puncture hazards (e.g. protrusions/debris).

3	**Utilities**
	Utilities that will underly the passive vapor barrier have been installed, inspected by local building authority, as applicable.
	All utilities with risers or vertical components that will penetrate the passive vapor barrier have been installed, are labeled as to their function/purpose, and extend to a sufficient elevation that they will not be encapsulated in the concrete floor slab or flooring system installed above the passive barrier.
	Minimum horizontal clearances around utility penetrations (>1”) are maintained (*e.g.* utility conduits/piping are not in contact with existing concrete or other penetrations).

3	Utilities
	If minimum horizontal clearances around utility penetrations (>1”) cannot be maintained, grout blocks are used, as specified by the design engineer.
	Utility penetrations have >3” clearance between the plane of the barrier application and the nearest joint, bend, or other fitting.
	Utility penetrations are clear of tape, wraps, or foams to a minimum distance of 3” above the plane of the fluid applied barrier application;
	Horizontal alignments of utilities within the aggregate base do not obstruct vapor flow.
	Utilities are not in contact with or supported on existing concrete surfaces receiving application of the fluid applied barrier (>1” clearance between utility and surface).

4	Soil Gas Sampling/Monitoring Points
	Deeper soil gas monitoring points that extend into the subgrade zone below the passive vapor barrier’s aggregate vapor collection zone are installed and have passed leak check tests.
	Tubing for the deeper soil gas monitoring points and sub-slab vapor monitoring points that will be embedded within the passive vapor barrier’s aggregate vapor collection zone have been extended to the location of the probe surface completion(s).
	Exposed tubing within the aggregate vapor collection zone is protected against damage.

5	Vapor Collection, Smoke Injection, & Conveyance Piping
	Spacing, layout, and depth of sub-slab vapor collection and conveyance piping, and smoke injection ports/piping is consistent with design documents.
	Foundation penetration sleeves are installed.
	Vent risers do not penetrate the slab foundation within a firewall or shear wall.
	All vent risers have been installed, are labeled as to their function/purpose, and extend to a sufficient elevation so that they will not be encapsulated in the concrete floor slab or flooring system installed above the passive barrier.

6	Aggregate Vapor Collection Zone
	Spec sheet for delivered aggregate base matches the design specifications.
	Aggregate is free of vegetation or fine particles which could reduce vapor permeability.
	Aggregate is uniformly placed, compacted, and is free of protrusions or debris that may be a puncture hazard.

6	Aggregate Vapor Collection Zone
	Aggregate placed adjacent to perimeter footings, interior footings, column foundations, elevator pits, and other building structural components is free of voids or bridging that could affect vapor barrier system termination or adhesion during or following concrete slab or flooring system installation.
	Unobstructed aggregate depth meets the design specifications (> __inches) with measurements verified using a yard stick or other measuring device.

Surface Application

7	Application Surface: Existing Concrete Surfaces
	Concrete surfaces within the application area have a uniform plane.
	Concrete surfaces within the application area are free of debris, standing water, oil, grease, or other materials which may impede barrier adhesion.
	Expansion joint materials are not present on concrete or other surfaces onto which the vapor barrier will be terminated.
	All cold joint tie-ins are installed, and dowels are epoxied or otherwise secured as required by other disciplines. Concrete surfaces within the application area where the barrier will terminate (vertically or horizontally) have a minimum of 4” of finished concrete free of rebar or other tie-ins.

8	Application Surface: Other Bulk Surfaces (*e.g.* plywood, sheet-piling, steel)
	Other bulk surfaces (*e.g.* plywood, sheet-piling, steel) are joined such that surfaces are planar with no irregularities.
	Smooth surfaces are scarified sufficient to facilitate barrier adhesion.

9	Passive Vapor Barrier
	If a spray-applied barrier is installed, coupon testing is completed at the design specified rate to document that the vapor barrier thickness meets minimum design specifications. A coupon testing log/map is prepared identifying the inspector, date, and locations of all coupon tests.
	If a membrane-only system with sealed/overlapped seams is installed, all seams are inspected to verify that the proper overlap was achieved, consistent with the design specifications. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	Penetrations are prepared consistent with design specifications (*i.e.* zip ties, collar length).
	Termination sequence for the spray applied barrier is uninterrupted and consistent with design specifications.

9	Passive Vapor Barrier
	Spray applied barrier is free of debris and/or materials that may puncture the barrier (i.e., nails, wire, gravel, rebar).
	The barrier is free of pooling water or objects which may obstruct visual identification of smoke emitting from leaks.
	There are no visible tears in the barrier.

10	Passive Vapor Barrier Smoke Testing
	Smoke testing is conducted per the design specifications to verify that the vapor barrier is leak free. The extent of the smoke has been confirmed to ensure that all areas of the vapor barrier has been tested. This includes all termination areas and barrier penetrations. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	All observed emission points of smoke have been repaired, and no major manufacturing defects are identified.
	Smoke emissions are confirmed at vent riser stub locations to confirm communication between the aggregate layer and the vapor collection piping.

Concrete/Flooring System Over Barrier Quality Assurance

11	Pre-Concrete/Flooring System Protective Layer Inspection (If Applicable)
	Geotextile fabric or other protective layer installed above the passive vapor barrier following smoke testing is placed and terminated per the design specifications with no gaps or voids.
	Topping sands or other materials installed above the passive vapor barrier are installed using methods/procedures outlined in the design specifications and inspected to verify that the required thicknesses were achieved. An inspection log/map is prepared identifying the inspector, date, and inspection areas.

12	Concrete/Flooring System Installation
	Concrete/flooring system has been installed using methods/procedures and the pour/installation sequence outlined in the design specifications.
	Reinforcing steel is not in contact with the barrier.
	Utilities stub-up beyond the finished plane or the concrete or are completed at the finished plane of the concrete (*e.g.* floor drains, slot trenches).
	Sacrificial elements associated with concrete screeding are in place. Where screed stakes penetrate the barrier, the stakes are sealed in accordance with the design specifications.

12	Concrete/Flooring System Installation
	If post-installation saw cutting of concrete floor slabs is completed, saw cutting is sufficiently shallow such that the underlying vapor barrier is not cut.
	If post-installation anchor installation is completed (i.e., for bollards, racking, dock levelers, etc.) anchors are sufficiently shallow such that the underlying vapor barrier is not damaged.
	If post-installation floor slab caulking/sealing is completed, caulk/sealant is installed using the specified sealant/methods at interior perimeter, column interface, footing boundary, utility penetrations, vent riser penetrations, and other areas, per design specifications. An inspection log/map is prepared identifying the inspector, date, and inspection areas.

13	Flooring System Installation Smoke Testing
	Smoke testing is conducted prior to any finished flooring (i.e., carpet/tile, etc.) per the design specifications to verify that the vapor barrier remains leak free following concrete floor slab/system installation. The extent of the smoke has been confirmed to ensure that all areas of the vapor barrier has been tested. This includes all termination areas and barrier penetrations. An inspection log/map is prepared identifying the inspector, date, and inspection areas.
	All observed emission points of smoke have been repaired and no major manufacturing defects are identified.
	Smoke emissions are confirmed at vent riser locations to confirm communication between the aggregate layer and the vapor collection piping.
	Smoke testing is conducted post finished flooring to confirm that during the installation process the liner was not breached. Smoke should not be placed directly into the venting system. Both pre and post finished flooring smoke testing is required. All observed emission points of smoke have been repaired, and no major manufacturing defects are identified.

Surface Coatings Quality Assurance

14	Surface Coatings
	If a surface-coating vapor barrier is installed, the slab is inspected for cracks, gaps, or other damage/imperfections, and those areas filled or repaired per the design specifications prior to installation of the surface coating.
	Concrete/substrate moisture testing and/or compatibility testing is conducted per the design specifications prior to installation of the surface coating.
	Thickness testing is conducted using a wet gauge or epoxy thickness gauge at the design specified rate to document that the surface coating thickness meets minimum design specifications. A testing log/map is prepared identifying the inspector, date, and locations of all coupon tests.

Ventilation System Quality Assurance

15	Vent Riser/Ventilation Piping
	Vent riser and associated piping is installed at locations (including wall and roof penetrations) consistent with the design specifications.
	Exterior vent riser outlets are located away from building air intakes, windows and entry points, or are of sufficient height, consistent with the design specifications, to avoid vented gases from entering the building envelope in accordance with published standards and requirements.
	Vent riser smoke injection/sample ports and valves installed at locations/elevations consistent with the design specifications.
	Vent riser and associated piping is appropriately supported/enclosed and sloped to promote drainage to the sub-slab environment, consistent with the design specifications.
	Required labels are affixed to all vent risers, at the required vertical intervals.
	If required by the design specifications, vent riser outlets are equipped with passive wind turbines, or other termination features. If present, passive wind turbines are documented to spin freely.
	A smoke pen or bellows is used to document upward vapor flow via the vent risers.