Minimum Mitigation and Sampling Requirements for Reuse
NC DEQ Division of Waste Management
May 2024

To efficiently manage the resources of the North Carolina Department of Environmental Quality (DEQ) Division of Waste Management (DWM) programs that are involved in redevelopment, DWM has developed these minimum sampling requirements for vapor intrusion evaluations. These requirements are for DWM redevelopment projects, which include, but are not limited to, active eligible, post-recordation vapor-related Brownfields projects, and if necessary, on recorded Brownfields projects that fall under the statutory reopener criteria (NCGS §130A-310.33 (c) (1) through (5)). Strictly adhering to these requirements will allow for a more predictable process and quicker review and approval of Vapor Intrusion Mitigation Systems (VIMS) designs and sampling procedures associated with new construction on DWM-regulated properties. DWM has standardized the following pre-/post-occupancy vapor sampling requirements for redevelopment projects on DWM-regulated redevelopment properties. The need to move with the pace of business and construction demands often necessitates redevelopment prior to complete site delineation and/or long-term trend evaluation of site contaminants. The requirements outlined herein are to be utilized following adequate site assessment, characterization, and appropriate sampling density determinations given site-specific factors (building size, building configuration, penetrations through slab, post-occupancy sample results) in compliance with the most recent DWM guidance documents and in place of full site characterization, delineation, and trend establishment as is standard for other DWM-regulated properties. Sampling for townhome redevelopments may include additional requirements as noted in *North Carolina Brownfields Program, Minimum Requirements for Townhome Developments,* May 2020 (or as embodied in its most current version).

The document shall be used for all redevelopment projects under DWM jurisdiction; however, site reuse approvals are at DWM discretion based on proposed redevelopment plans, site-specific data, and the calculated risk output from one or more appropriately prepared sets of data utilizing the DEQ Risk Calculator. Once a reuse is approved by DWM, these matrix tables shall be used to define site-specific sampling requirements. They are designed to establish that there are no completed exposure pathways from sub-slab vapors into indoor air, and to have an endpoint to further monitoring. The following tables outline sampling requirements based on the set of calculated non-cancer Hazard Indices (HI) and Carcinogenic Risks (CR) generated as output in the most recent DEQ Risk Calculator at the time of VIMS implementation. For this guidance, the HI is utilized as a surrogate value to set guidelines for Vapor Intrusion (VI) mitigation and monitoring, rather than as a suggestion that non-carcinogenic risk is on a sliding scale. Use of a fraction of the HI threshold of 1.0 is incorporated herein as a safety factor to account for uncertainty in site assessment, limited data sets, site conditions, and the effects that changing conditions brought about by site redevelopment (e.g., placement of slabs where there previously were none) will have on migration of vapor contaminants in the subsurface.

DWM will use a tiered approach for use with the following matrix tables based on the types and age of sample data, and possible temporal changes in site data that have been collected on the redevelopment property based on contaminant migration and changes due to redevelopment such as slab placement. While the row of each matrix table is based on the detection of TCE in any medium, the HI used to identify which matrix table applies to a given VI dataset, will be based on the following HI outputs, in increasing tiers of validity: Groundwater to Indoor Air HI (groundwater data input), Soil Gas to Indoor Air HI (exterior soil gas data input), Soil Gas to Indoor Air HI (based on sub-slab vapor data input), and the Indoor Air HI (indoor air data input) when sub-slab vapor data is present. Note: that concurrent sub-slab vapor and indoor air data will be required in most situations reflected in the matrix table to evaluate whether indoor air contaminants are due to vapor intrusion or to a source of indoor air interference.

Unless prior approval is granted by the DWM Project Manager, initial risk analyses must be structured based on the use of site-wide maximum Exposure Point Concentrations or maximum Exposure Point Concentrations within a reasonable geographical distribution of contaminant data or source area, i.e., Exposure Units. Unless otherwise approved in advance by the DWM Project Manager, either approach must use the default parameters in the most current DEQ Risk Calculator without altering those default parameters. Risk calculator output based on individual sample points will not be accepted. Site-specific attenuation factors may be permitted at the discretion of the DWM Project Manager.

These requirements apply to both new construction projects as well as renovation of existing buildings with impacts originating on the DWM-regulated property, and/or from impacts migrating onto the DWM-regulated property. **Please note**: renovations of existing buildings and/or plumes migrating from off-site may present unique retrofit circumstances that could require additional actions that need to be discussed with your DWM regulatory project manager on a site-specific basis, including the potential for long-term monitoring of site conditions and special considerations of basements and crawlspaces. These requirements assume that construction and/or renovation activities have been completed in accordance with a DWM-approved VIMS design. If construction is not completed in accordance with a DWM-approved VIMS, sampling requirements may increase to confirm that the buildings are protective of public health.

The risk calculator output includes HI and CR values for construction worker exposures. However, construction worker safety is the responsibility of individual contractors working on the DWM-regulated property. Therefore, an evaluation of construction worker safety is excluded from this document although the risk calculator output may be shared with such contractors for informational purposes.

Following are three matrix tables, with end notes, and a one-page summary of these three matrices that outline specific mitigation, pressure measurements, and pre- and post-occupancy sampling requirements based on the detection of trichloroethylene (TCE), the type of sample data collected, the type of reuse, and calculated environmental risk values. Use your site's calculated HI and CR based on representative data to select the appropriate matrix table. Note that future sampling results on a given site may indicate that calculated HI/CR values have increased over those that were originally calculated for the DWM-regulated property. In such a situation, you will need to use the requisite matrix table based on the newly calculated HI/CR from the new dataset. Therefore, sampling requirements may increase to accommodate the newly calculated risk profile. However, a reduction in sampling frequency or density may occur based on lower HI/CR calculations, but only with prior written DWM approval.

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Matrix 1 of 3: Indoor Air Soil Gas to Indoor Air, and/or Groundwater to Indoor Air CR or HI output of:
HI >1.0 and/or CR > 1.0 E-04

Mitigation Requirement: VIMS Required (MUST meet DWM program-specific VI design requirements, must be ACTIVE, or passive with capability to be made Active)
Pressure Monitoring: Required to be conducted for active systems with each sampling event, subject to DWM requirements for system operations, maintenance, and monitoring (OM&M)
Alternative System Monitoring Strategies: Consideration to be given on a case-by-case basis to alternative monitoring (e.g., air flow measurements, continuous data-logged pressure measurements, tracer testing)

TCE Detected in Any Medium	Pre-Occupancy Sampling Requirements	Residential Post-Occupancy Sampling Frequency	Non-Residential Post-Occupancy Sampling Frequency
TCE Detected (includes J values, see note 2)	Concurrent indoor air and sub-slab vapor sampling required	**Indoor Air:** Semi-annual indoor air samples for no less than two (2) years for select Volatile Organic Compounds (VOCs) (list determined based on previous detections (includes J values, see note 3) in all media on-site or based on individual DWM Program requirements). Sampling has the potential to decrease/cease following two (2) years of sampling with prior written DWM approval.	**Indoor Air:** Semi-annual indoor air samples for no less than two (2) years for select VOCs (list determined based on previous detections (including J values, see note 3) in all media on-site). Sampling frequency and density have the potential to decrease/cease following two (2) years of sampling with prior written DWM approval.
		Sub-slab Vapor: Semi-annual sampling for no less than two (2) years for full list TO-15 VOCs from designed and previously installed sample points. Sampling has the potential to decrease/cease with prior written DWM approval.	**Sub-slab Vapor:** Semi-annual sampling for no less than two (2) years for full list TO-15 VOCs from designed and previously installed sample points. Sampling frequency and density have the potential to decrease/cease with prior written DWM approval.
TCE Not Detected	Concurrent indoor air and sub-slab vapor sampling required	**Indoor Air:** Sampling not required if pre-occupancy sampling meets risk thresholds and VIMS design criteria have been met [e.g., sufficient pressure influence at extents (4 pascals) for active systems]. **NOTE:** if post-occupancy sub-slab vapor sampling identifies significantly increased risk compared to baseline data, indoor air sampling may also be required for select VOCs (list determined based on previous detections in all media on-site).	**Indoor Air:** Sampling not required if pre-occupancy sampling meets risk thresholds and VIMS design criteria have been met [e.g., sufficient pressure influence at extents (4 pascals) for active systems]. **NOTE:** if post-occupancy sub-slab vapor sampling identifies significantly increased risk compared to baseline data, indoor air sampling may also be required for select VOCs (list determined based on previous detections in all media on-site).
		Sub-slab Vapor: Semi-annual sampling for no less than one (1) year for full list TO-15 VOCs from designed and previously installed sample points. Sampling has the potential to decrease/cease with prior written DWM approval.	**Sub-slab Vapor:** Semi-annual sampling for no less than one (1) year for full list TO-15 VOCs from designed and previously installed sample points. Sampling frequency and density have the potential to decrease/cease with prior written DWM approval.

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Matrix 2 of 3: Indoor Air, Soil Gas to Indoor Air, and/or Groundwater to Indoor Air CR or HI output of:
HI 0.1 to <1.0

Mitigation Requirement: VIMS RECOMMENDED, but not required (If installed, MUST meet program-specific DWM VI design requirements, and if passive, must have capability to be made Active)
Pressure Monitoring: Required to be conducted for active systems with each sampling event, subject to DWM requirements for system OM&M
Alternative System Monitoring Strategies: Consideration to be given on a case-by-case basis to alternative monitoring (e.g., air flow measurements, continuous data-logged pressure measurements, tracer testing)

TCE Detected in Any Medium	Pre-Occupancy Sampling Requirements	Residential Post-Occupancy Sampling Frequency	Non-Residential Post-Occupancy Sampling Frequency
TCE Detected (Includes J values, see note 2)	Concurrent indoor air and sub-slab vapor sampling required regardless of mitigation status	**Passive/Non-mitigated:** **Indoor Air:** Semi-annual indoor air samples for no less than two (2) years for select VOCs (list determined based on previous detections (includes J values, see note 3) in all media on-site). Sampling has the potential to decrease/cease following 2 years of sampling with prior written DWM approval. **Sub-slab vapor:** Semi-annual sampling for no less than two (2) years for full list TO-15 VOCs. Sampling has the potential to decrease/cease with prior written DWM approval. Note: If TCE is detected in indoor air below the action level of 2.1 µg/m^3, or subsequent level if modified in the future, during pre-occupancy sampling, post-occupancy indoor air sampling will also be required for three (3) consecutive monthly events followed by two (2) years of semi-annual sampling rounds. If the TCE action level is exceeded, proceed to DWM Response Actions guidance, including any required consultation with DWM Toxicologist.	**Passive/Non-mitigated:** No less than one (1) year of semi-annual indoor air and sub-slab vapor sampling for seasonal variability for select VOCs (list determined based on previous detections (includes J values) in all media on-site). Note: If TCE is detected in indoor air one order of magnitude below the action level of 8.8 µg/m^3 (i.e. 0.88 µg/m^3 or up to the action level) or subsequent level if modified in the future, during pre-occupancy sampling, post-occupancy indoor air sampling will also be required for three (3) quarterly events followed by one (1) semi-annual event six (6) months later. If the TCE action level is exceeded, proceed to DWM Response Actions guidance, including any required consultation with DWM Toxicologist.
		Active Mitigation: One (1) post-occupancy concurrent indoor air and sub-slab vapor sampling event, annual pressure data submittal.	**Active Mitigation:** One (1) post-occupancy concurrent indoor air and sub-slab vapor sampling event, annual pressure data submittal.
TCE Not Detected	Sub-slab vapor sampling required regardless of mitigation status	**Passive/Non-mitigated:** Semi-annual sub-slab vapor sampling for no less than one (1) year for full list TO-15 VOCs. Sampling has the potential to decrease/cease with prior written DWM approval.	**Non-mitigated:** Semi-annual sub-slab vapor sampling for no less than one (1) year for full list TO-15 VOCs. Sampling frequency and density have the potential to decrease/cease with prior written DWM approval.
		Active Mitigation: One (1) post-occupancy sub-slab vapor sampling event, annual pressure data submittal.	**Passive/Active Mitigation:** One (1) post-occupancy sub-slab vapor sampling event, annual pressure data submittal.

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Matrix 3 of 3: Indoor Air, Soil Gas to Indoor Air, and/or Groundwater to Indoor Air CR or HI output of:
HI <0.1

Mitigation Requirement: VIMS not required (If preemptively installed, recommend it meet program-specific DWM VI design requirements)
Pressure Monitoring: Required to be conducted for active systems with each sampling event, subject to DWM requirements for system OM&M
Alternative System Monitoring Strategies**:** Consideration to be given on a case-by-case basis to alternative monitoring (e.g., air flow measurements, continuous data-logged pressure measurements, tracer testing)

TCE Detected in Any Medium	Pre-Occupancy Sampling Requirements	Residential Post-Occupancy Sampling Frequency	Non-Residential Post-Occupancy Sampling Frequency
TCE Detected (Includes J values, see note 2)	**Only Exterior Soil Gas Data Available:** Not less than one (1) paired sub-slab vapor and indoor air sampling for full list TO-15 VOCs required regardless of mitigation status.	**Only Exterior Soil Gas Data Available:** Not less than one (1) sub-slab sampling event for full list TO-15 VOCs within 3-6 months of initial occupancy; if the HI remains below 0.1, no additional sampling required.	**Only Exterior Soil Gas Data Available:** Post-occupancy sampling may be waived.
	Sub-slab Vapor Data is Available within Previous 3 Years: Pre-occupancy sampling may be waived.	**Sub-slab Vapor Data is Available within Previous 3 Years:** Post-occupancy sampling may be waived.	**Sub-slab vapor is available within previous 3 years:** Post-occupancy sampling may be waived.
TCE Not Detected	Provided adequate reliable data in compliance with our assessment guidelines, pre-occupancy sampling is not required.	Provided adequate reliable data in compliance with our assessment guidelines, post-occupancy sampling is not required.	Provided adequate reliable data in compliance with our assessment guidelines, post-occupancy sampling is not required.

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Matrix Tables End Notes

1. Non-detects for TCE data with detection limits that exceed the applicable TCE vapor intrusion screening level (VISL) at the time of the analysis will be considered to be detections of TCE for the purposes of these sampling requirements; DWM would reconsider such determination if appropriate re-sampling or laboratory re-analysis of such data supports a different conclusion.

2. If TCE is only detected in soil or groundwater at J-flag estimated concentrations, the site will follow non-TCE relevant portions of the matrix, except when TCE is found in pre-occupancy sub-slab data. Then sites will transition to TCE-detection portions of the matrix.

3. J-flag values (estimated concentrations) of TCE above 0.2 µg/m^3 in air samples will be considered detections for use in this document.

4. With respect to phased construction, sampling requirements will be in accordance with the applicable matrix table.

5. If concrete pour back areas for future tenants are included in the VIMS design or if slab modifications are made in the future, communication testing will be required after completion of the concrete slab pour. Further, if ongoing tenant upfit activities result in damage to the VI barrier, inspections and communication testing will be required following repair of the VI barrier and patching of the slab. Finally, in the instance TCE is present in subsurface soil gas above acceptable risk-based thresholds, temporary mitigation measures (e.g., installing temporary ventilation of the space) will be required to be conducted prior to performing tenant upfit activities as reviewed and approved by DWM.

6. Analysis of samples for less than the full TO-15 list of analytes is subject to DWM's individual program requirements and prior written approval. DWM will base its decision on the reduction in the full TO-15 list for soil vapor, exterior soil gas, or indoor air samples on acceptable site-specific pre-redevelopment assessment data, chemical degradation products, potential impact from migration of contaminants from off-site, and other site-specific criteria.

7. DWM prefers the use of sub-slab vapor data for assessment and occupancy testing is because it provides better understanding of the conditions created by the redevelopment and the interaction with the subsurface contaminants.

8. If the contractor fails to install sub-slab vapor sampling points during construction, DWM has the discretion to default to post-construction indoor air sampling on a frequency and density to DWM's written satisfaction. However, the developer's team is encouraged to remain vigilant during construction to ensure this does not occur because the pairing of sub-slab vapor and indoor air sampling can account for potential indoor air interferences.

9. For active systems, a pressure differential resulting in depressurization below the slab of 4 pascals or greater at remote extents of each VIMS area is considered sufficiently depressurized. Low pressure readings such as 1 pascal will be acceptable if employed with continuous (multiple pressure readings per

hour) data logged pressure measurements during varied HVAC situations, weather events, and climate for winter and summer months from sub-slab ports that are at or have a lineal correlation with values from a permanent port that is located at the outer extent of the negative pressure field.

10. Cessation or decrease in sampling frequency is subject to DWM's prior written approval. DWM will base its decision on the cessation or decrease in sampling frequency on multiple lines of defensible evidence (e.g., decrease or stabilization in contaminant concentrations, decrease in appropriately calculated HI or CR risk values, and VIMS performance data). Systems with significant pressure differential above the 4-pascal goal, defined as 40 pascals or above at all remote extents and areas of least expected influence, will be considered for reductions in sampling frequency.

11. DWM evaluations with respect to occupancy of buildings will be based on a multiple lines of evidence approach using a comparison of site data and calculated risk output in combination with the performance data (e.g., pilot testing, influence testing, continued vacuum data) of any installed VIMS or operation of ventilation systems, and any contaminant-specific action levels.

12. As per *DWM Vapor Intrusion Guidance (March 2018, version 2)*, it is DWM policy that daycare facilities, schools, and any other similar structures where children (under 18) are the primary occupant are evaluated as residential use due to the potentially sensitive nature of the exposed population. Hotel use is considered to be non-residential even for extended stay hotels.

13**.** Brownfields-Specific Requirement: All pre-occupancy data are to be submitted to the BRS prior to occupancy for review and discussion of next steps. If the calculated risk for post-occupancy data does not exceed a hazard index of 0.1 as evaluated by the Prospective Developer (PD) team using a conservative scenario, these data may be submitted in the first annual Redevelopment Summary Report.

Summary
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			Pre-Occupancy Sampling				Post-Occupancy Sampling			
			Residential		Non-Residential		Residential		Non-Residential	
Calculated Risk Values	**Mitigation**	**Type of Sampling**	**TCE Detected**	**TCE Not Detected**	**TCE Detected**	**TCE Not Detected**	**TCE Detected**	**TCE Not Detected**	**TCE Detected**	**TCE Not Detected**
HI>1.0 and/or CR>1E-04	**Active OR Passive with Active Capability Required**	**IA**	Yes concurrent	Yes concurrent	Yes concurrent	Yes concurrent	SA min 2 yr select VOCs	Conditional See Matrix 1	SA min 2 yr select VOCs	Conditional See Matrix 1
		SSV	Yes concurrent	Yes concurrent	Yes concurrent	Yes concurrent	SA min 2 yr full TO-15 VOCs	SA min 1 yr full TO-15 VOCs	SA min 2 yr full TO-15 VOCs	SA min 1 yr full TO-15 VOCs
HI 0.1 to<1.0	**Non-Mitigated**	**IA**	Yes concurrent	No	Yes concurrent	No	SA min 2 yr select VOCs	No	SA min 1 yr select VOCs	No
		SSV	Yes concurrent	Yes	Yes concurrent	Yes	SA min 2 yr full TO-15 VOCs	SA min 1 yr full TO-15 VOCs	SA min 1 yr select VOCs	SA min 1 yr full-TO-15 VOCs
	Passive (with Active Capability)	**IA**	Yes concurrent	No	Yes concurrent	No	SA min 2 yr select VOCs	No	SA min 1 yr select VOCs	No
		SSV	Yes- concurrent	Yes	Yes concurrent	Yes	SA min 2 yr full TO-15 VOCs	SA min 1 yr full TO-15 VOCs	SA min 1 yr select VOCs	1 event
	Active	**IA**	Yes concurrent	No	Yes concurrent	No	1 concurrent event	No	1 concurrent event	No
		SSV	Yes concurrent	Yes	Yes concurrent	Yes	1 concurrent event; annual pressure data	1 event; annual pressure data	1 concurrent event; annual pressure data	1 event; annual pressure data
HI<0.1	**Not Required or Pre-Emptive**	**IA**	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3
		SSV	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3	Conditional See Matrix 3

Abbreviations: CR-cancer risk, HI – Hazard Index, TCE – trichloroethylene, IA – Indoor Air, min – minimum, SA – semi-annual, SSV-Sub-slab Vapor, yr – year
Concurrent event is defined as a contemporaneous paired indoor air and sub-slab vapor sample collection event.
Detections of TCE are defined in the end notes in *Minimum Mitigation and Sampling Requirements for Reuse* (DWM, May 2024)
Requirements may increase of decrease based on successive sampling results.
Townhome redevelopments may increase the sampling requirements.