Pfeiffer, Jane K - DNR

From:	Pfeiffer, Jane K - DNR
Sent:	Tuesday, November 29, 2022 3:59 PM
To:	Shane LaFave; Robert Reineke
Cc:	Hedman, Curtis J - DHS; Mylotta, Pamela A - DNR; Que El-Amin; Pratap Singh
Subject:	Community Within the Corridor West Block (02/41-587376) - Immediate Action Required
Attachments:	ContinuousMonitoring_FactSheet.pdf; 20210325 _DNR_VI_Immed.Response_Inquiry_DHS_Reply-Combined.pdf
Importance:	High

Greetings Shane and Robert,

I just called and left voicemails for each of you concerning the subject site. The Department of Natural Resources (DNR) reviewed the second round of vapor mitigation system (VMS) commissioning data, collected in September 2022 and received on November 11 and 23, 2022, without a DNR review fee. The data was submitted on behalf of Community Within the Corridor Limited Partnership by K. Singh & Associated, Inc. The results show that trichloroethylene (TCE) was found at concentrations that equal or exceed its applicable vapor action level (VAL) of 2.1 micrograms per cubic meter ($\mu g/m^3$) at three separate locations. The DNR understands that these three locations are located in communal spaces/hallways, not within any residential units.

TCE poses a short-term (i.e., acute) health risk to certain populations when identified in indoor air at concentrations exceeding its VAL. More specifically, TCE presents an acute risk of fetal heart malformation that may occur when a pregnant mother is exposed to TCE vapors in the first trimester of pregnancy, as indicated in Section 3.4.1 of DNR's Vapor Intrusion guidance, *Addressing Vapor Intrusion at Remediation & Redevelopment Sites in Wisconsin*, RR-800. Given that the Community Within the Corridor West Block consists of several adjoined, multi-level apartment buildings that include 1-3 bedroom units, it is likely that women of child-bearing years are present within the site buildings. Attached is a letter, dated March 25, 2021, from the Department of Health Services (DHS) to the DNR that presents additional information on acute health risks and recommended timeframes for follow-up actions that are required in Code to address threats to health. More specifically, DHS indicates that a VMS should be installed within two weeks and that women in the above-described sensitive demographic should be consulted about these TCE health risks in order for them to make informed decisions about whether to stay within the dwelling, given the TCE identified greater than its residential VAL at select locations. This notification of the data and health risk to the tenants by the responsible party (RP) is also required in Wis. Admin. Code §§ NR 714 & NR 716.14.

Considering the above-information, the following actions are required, per Wis. Admin. Code:

1. Wis. Admin. Code § NR 716.01 states that the purpose of site investigation is to determine the nature, degree and extent of contamination and to define the sources of contamination. Additional investigation of indoor air contamination is required to determine the source of the indoor air contamination along with its degree and extent. This investigation should occur as soon as possible. The DNR strongly suggests the additional investigation into the source of the TCE in indoor air be performed by continuous monitoring technology using a portable gas chromatograph/electron capture detector GC/ECD unit. This methodology allows for real-time data to be collected and close to 160 samples can be collected in a day. The primary goal is to quickly identify the source of the TCE and modify the VMS, if necessary, to assure it is protective of human health from the environmental contamination. **Present your plan and a schedule to accomplish this additional investigation to the DNR by Thursday, December 1, 2022**. The quick timeframe is due to the potential for acute risk. Attached is

a document about the GC/ECD methodology and listed below is a contact person that can answer questions concerning this methodology :

   a. Vapor Safe® – The World Leader in Real Time Chemical Vapor and Monitoring Solutions
   b. Mark Kram, Ph.D., CGWP
      Groundswell Technologies, LLC
      7127 Hollister Ave., Suite 25A-108
      Goleta, CA 93117 USA
      805-899-8142 (office)
      805-844-6854 (cell)
      mark.kram@groundswelltech.com
      www.groundswelltech.com

2. Per Wis. Admin. Code § NR 714.07, the responsible party (RP) shall conduct necessary notification activities considering the threats to public health, safety or welfare. This notification must include the following:
   a. A description of the contamination;
   b. The response actions that are planned or underway;
   c. Phone numbers and addresses of persons to contact regarding the information. Contacts should include a representative for the RP and should also include myself as the DNR Project Manager and Curtis Hedman (cc'd on this email, (609) 287-4152, Curtis.Hedman@dhs.wisconsin.gov) as the Environmental Health contact with DHS.

   Wis. Admin. Code § NR 716.14 requires the RP to report all sampling results to the occupants of the property. Due to the amount of data and the number of occupants, a summary of the data is recommended with contact information for tenants to obtain more details.

   Wis. Admin. Code § NR 714.07 includes additional details on different methods of notifying that may be used. The DNR recommends that letters and/or leaflets be distributed to each of the tenants that are presently occupying the building to ensure all occupants receive the notification. DNR and DHS are also able to assist with an informational meeting with your tenants following tenant notification, if desired.

   Each of these Wis. Admin. Codes (NR 714.07 & NR 716.14) must be reviewed and implemented as you prepare and present your notifications for and to the occupants of the property. DNR strongly recommends DHS's, *TCE in Indoor Air*, fact sheet (document here) be included with your notifications along with DNR's guidance document, *What is Vapor Intrusion?*, RR-892. **Notifications to all occupants should be sent by Tuesday, December 6, 2022.** Copies of the notifications and attachments must be submitted to the DNR.

Please do not hesitate to reach out should you have any questions concerning the information presented in this email.

Thank you, Jane

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Jane K. Pfeiffer
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FACT SHEET

Continuous Monitoring for Vapor Intrusion

Introduction

The assessment of vapor intrusion (VI) is complicated by a high degree of spatial and temporal variability. This fact sheet will focus on recent applications of a continuous monitoring (CM) technology that provides quantitative measurements of vapor concentrations in the field. CM can help to address site-specific building conditions that influence the VI pathway over time.

Technology Background

Real-time monitoring involves the collection and reporting of data and sampling results on the order of seconds to minutes. The CM system is designed to provide readings of contaminant concentrations in indoor air every 5 to 10 minutes depending on the analyte list (Figure 1). This provides a high density of time-correlated data across daily ranges of environmental conditions (144 measurements per 24-hour day from up to 16 locations). Typically, a one- to five-day deployment of the instrument is adequate. With regulatory stakeholder approval, CM can be used independently to monitor site conditions and/or in concert with conventional VI sampling techniques such as Summa™ canisters.

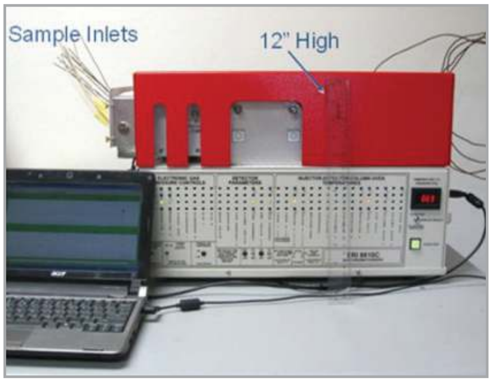

Figure 1. CM Instrument with Laptop (Courtesy of Groundswell Technologies)

How Does It Work?

CM is accomplished using a modified gas chromatograph (GC) equipped with an electron capture detector (ECD). The device is multiplexed with a 16-port valve to achieve sequential sample collection from multiple locations. CM can be applied to monitor tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), carbon tetrachloride, methane, benzene, toluene, ethylbenzene, and xylene, as well as several other volatile organic compounds (VOCs). Sampling lines can be extended up to 980 feet from the analytical instrument. Air from each sampling point is continuously drawn through each sampling line and sequentially analyzed. Analytical results are available within one minute. The analytical results may be combined with simultaneous measurements of barometric pressure, pressure differential across the foundation, wind speed, and temperature to identify time-correlated factors driving VI at the site. Remote processing can include automated contour displays and alerts based on project-specific thresholds.

How Can It Help?

The information collected can help to:

- ☐ Determine if a VI issue is present,
- ☐ Locate preferential pathways,
- ☐ Identify driving factors and corresponding vapor behavior, and
- ☐ Differentiate between VI from subsurface sources versus background VOCs from indoor sources.

Case Study 1: Naval Air Station North Island | Case Study 2: NALF San Clemente Island | Lessons Learned

CASE STUDY 1

Naval Air Station North Island

Project Objective: CM was deployed for nine days to evaluate potential VI risks associated with a documented TCE release under Building 379 at Naval Air Station North Island (NASNI), San Diego, California (Hosangadi et al., 2017; Kram et al., 2019). The main objective of this project was to understand exposure risks over space and time and to evaluate potential mechanisms controlling VI that could be used to design a long-term risk reduction strategy.

Site Background: Building 379 is used for carpentry, machining, and similar industrial operations. It overlies a high-concentration plume of TCE, PCE, and Stoddard solvent. The building was built in the 1940s and the concrete floor was in poor condition with over 15,000 ft of cracks that required sealing. Numerous floor drains were also present. Sub-slab soil vapor TCE concentrations as high as 6,000,000 µg/m³ have been documented. Six indoor monitoring points were established for CM application in the 172,000-square-feet facility.

Results: Several visualizations of the CM data for TCE are shown in Figure 2. The lower left panel displays TCE concentration patterns from one of the sampling locations over three days, with regular peak concentrations of 300 to 400 µg/m³ occurring late in the morning each day. The table in the lower right panel provides a record of alerts based on project-specific thresholds. The top three panels display geospatial contours of readings that include: instantaneous, 1-hour time-weighted average, and 24-hour time-weighted average.

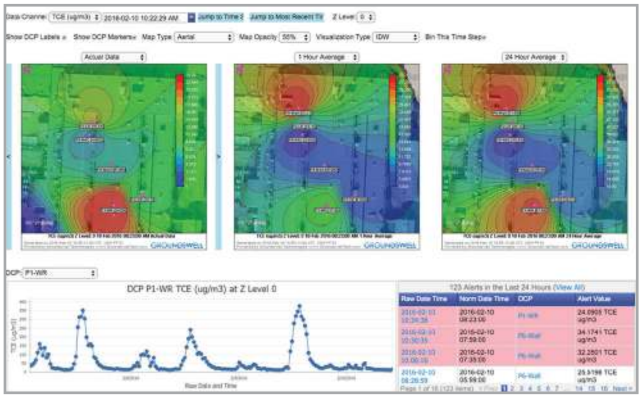

Figure 2. VI Monitoring Dashboard at NASNI (Courtesy of Kram et al., 2019)

The women's restroom in Building 379 was selected for additional evaluation because it represented an area of concern from an acute TCE risk perspective and because the highest observed concentrations were recorded there during prior VI sampling events. The pressure differentials between the indoor air and sub-slab were also continuously monitored. Findings from the continuous testing indicated that chlorinated volatile organic compounds (CVOCs) in indoor air showed peaks at noon and midnight, along with a corresponding trend in pressure differential (Figure 3).

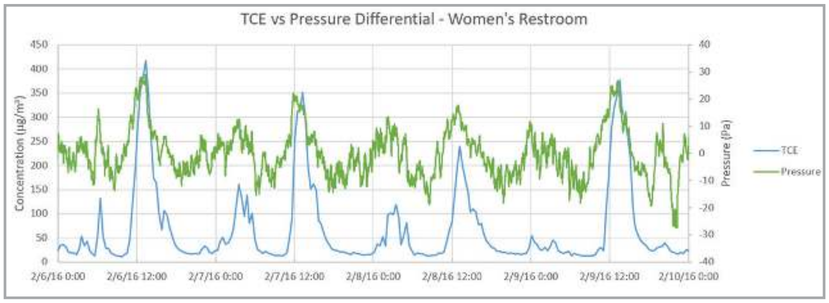

Figure 3. TCE Monitoring Results by ECD and Pressure Differential (Courtesy of Battelle)

An increase in pressure differential was found to correlate with an increase in TCE concentration. A statistical analysis indicated a positive correlation (r^2 of 0.6) between the TCE concentration in indoor air and positive pressure differential values. These data suggest that naturally occurring diurnal pressure changes can influence the pressure differential across a slab driving advective intrusion of TCE and resulting in the potential for short-duration exposure events.

Outcome: The CM results suggested that air sampling designs reliant on randomly timed grab or time-averaged samples could lead to over- or underestimations of indoor air concentrations. The CM system was also later deployed to confirm that the soil vapor extraction (SVE) system installed in the nearby subsurface successfully mitigated VI to Building 379.

NALF San Clemente Island

Project Objective: CM was deployed for one week at Installation Restoration (IR) Site 17, Power Plant Building at Naval Auxiliary Landing Field (NALF), San Clemente Island, California (NAVFAC, 2020). The purpose of the CM investigation was to determine whether unacceptable PCE and TCE concentrations were present inside of the main power plant building at IR Site 17.

Site Background: IR Site 17 is an active power plant originally built in 1968 and remodeled in 1993. The building is a metal-sided structure on a concrete slab on a relatively flat, graded area. During reconstruction in 1993, chlorinated solvents and petroleum products were identified adjacent to and underneath the building. Contaminated soil was over-excavated, but impacted soils were left in place under the building. Sub-slab soil gas samples were collected from 12 locations under the building footprint in 2006 and modeling indicated no unacceptable risk. Three follow-up sub-slab soil gas samples were collected in 2013 from below the central portion of the generator room. The maximum concentrations of benzene, TCE, and PCE exceeded respective California residential risk screening levels and the maximum PCE concentration exceeded the industrial screening level. Although the results of a human health risk assessment indicated that unacceptable risks to workers were unlikely, the state regulator recommended additional monitoring of VOCs.

Results: CM was performed for one week to quantify concentrations of PCE and TCE in sub-slab air, indoor air, and background/outdoor air (see example plot in Figure 4). A pressure differential sensor was also installed at the sub-slab monitoring point. One-liter Summa™ canister samples of indoor air, outdoor air, and sub-slab soil gas were collected during a time period matching one cycle of the CM (~10 minutes) from a location immediately adjacent to the CM sampling point. Confirmation samples were analyzed by an off-site laboratory for comparison to CM results.

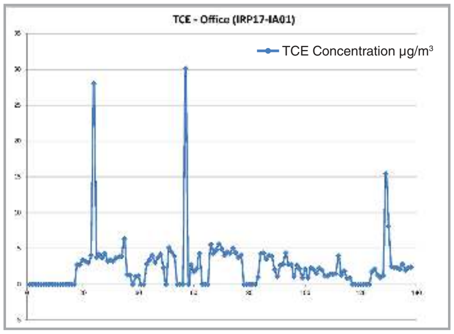

Figure 4. A Time Series Plot of TCE at NALF San Clemente Island (Courtesy of NAVFAC, 2020)

PCE and TCE were detected in each of the five indoor CM sampling points. For the office location, TCE results ranged from non-detect to 30.1 μg/m^3 (see Figure 4). No patterns were found to correlate indoor air values with wind speed or direction, pressure differentials, or office occupancy. All of the indoor air Summa™ canister confirmation analyses were non-detect for both PCE and TCE, which is consistent with the CM results for the contemporaneous time periods. The ECD was successfully calibrated for the low concentrations in indoor air. However, the higher concentrations reported in the sub-slab were found to exceed the calibration range of the ECD. The TCE concentration in the sub-slab was found to be up to 860 μg/m^3 via Summa™ canister sampling. There were no background or ambient air contributions to the indoor air VOCs.

Time-weighted averages were developed for the shifts in which the highest TCE concentrations were reported by CM in the office and switch room. A typical worker in the power plant building works 10-hour shifts for seven consecutive days every other week, resulting in an exposure frequency of 182 days per year. The site-specific parameters were input into the EPA Vapor Intrusion Screening Level Calculator (VISL-C) for a commercial/industrial scenario. The Annual Average and Lifetime Average Daily Exposures and the Hazard Quotient (HQ) and Excess Lifetime Cancer Risk (ELCR) were calculated (see Table 1).

Table 1. Annual Average and Lifetime Average Daily Exposures, Hazard Quotient, and Cancer Risk			
Annual Average Daily Exposure [μg/m^3]	0.472	Hazard Quotient [HQ]	2.36E^{-01}
Lifetime Average Daily Exposure [μg/m^3]	0.168	Excess Lifetime Cancer Risk [ELCR]	6.19E^{-07}

Outcome: The resulting HQ is well below the acceptable level of 1. The resulting ELCR is below the lower end of the target risk range of 1E^{-06} to 1E^{-04}. Based on this calculation, TCE concentrations in indoor air do not pose an unacceptable risk to the IR Site 17 power plant workers. CM provided the detailed evidence to establish that unacceptable human health risks were not present with a high degree of confidence.

Return to Menu

Conclusions

High-frequency, real-time VI data from multiple locations provides critical, spatial, and temporal resolution. This allows practitioners to rapidly respond to dynamic vapor migration processes and controlling factors. These two case studies provide important lessons learned including:

- ☐ Understanding the temporal and spatial variability in indoor contaminant concentrations can support the selection and design of effective mitigation measures.
- ☐ Indoor vapor concentration dynamics are typically governed by barometric pressure changes, indoor air handling actions, and responses to active remediation efforts.
- ☐ Barometric pressure dynamics and building air-handling can induce pressure differentials adequate to cause advective vapor flux from the subsurface into buildings.
- ☐ CM supports precise identification of vapor entry locations, can generate correlated data to distinguish between indoor vapor sources and VI, and can be applied in active, adaptive strategic configurations to fine tune and optimize ongoing mitigation and remediation actions.
- ☐ As in the NASNI site case study, the use of CM can support remedy implementation by ensuring VI mitigation strategies are working and monitoring the potential for VI exposures.
- ☐ As in the NALF San Clemente Island case study, where the potential for VI was expected to be low, CM provided the detailed evidence to establish that unacceptable human health risks were not present, with a high degree of confidence.
- ☐ Through automated CM and programmed response plans, VI mitigation performance issues can be corrected before concentration levels exceed thresholds by better understanding the site-specific causes of VI.
- ☐ There are limitations to be aware of in relation to the type and the amount of VOCs present at a site. The system does not analyze for all compounds typically included in a traditional laboratory TO-15 method. The system only analyzes for a subset of VOCs, principally halogenated compounds. In addition, the CM system could be prone to interferences if an abundance of VOCs exists at a site.
- ☐ Information on the potential concentration range at the site is needed in order to avoid exceeding the calibrated concentration range for the CM system. This information will allow for the best detector to be selected and better calibration of the CM system.

Disclaimer

This publication is intended to be informational and does not indicate endorsement of a particular product(s) or technology by the Department of Defense (DoD), nor should the contents be construed as reflecting the official policy or position of any of those Agencies. Mention of specific product names, vendors or source of information, trademarks, or manufacturers is for informational purposes only and does not constitute or imply an endorsement, recommendation, or favoring by the DoD.

References

Hosangadi, V., B. Shaver, B. Hartman, M. Pound, M.L. Kram, and C. Frescura. 2017. High frequency continuous monitoring to track vapor intrusion resulting from naturally occurring pressure dynamics. Remediation, 27(2), 9–25.

Kram, M., B. Hartman, and C. Frescura. 2016. Vapor intrusion monitoring method cost comparisons: Automated continuous analytical versus discrete time-integrated passive approaches. Remediation, 26(4), 41–52.

Kram, M., B. Hartman, and N. Clite. 2019. Automated continuous monitoring and response to toxic subsurface vapors entering overlying buildings–Selected observations, implications and considerations. Remediation, 29, 31-38.

NAVFAC. 2020. Final Technical Memorandum for Vapor Intrusion Study, Installation Restoration Site 17, Naval Auxiliary Landing Field, San Clemente Island, California.

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March 25, 2021

Christine Haag
Program Director
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
101 S. Webster Street, P.O. Box 7921
Madison, WI 53707-7921

Subject: DHS response to Request for Assistance: Actions for Trichloroethylene at Acute Risk Levels

Dear Ms. Haag:

The Wisconsin Department of Health Services (DHS) received your letter dated October 18, 2019 requesting clarification on the definition of acute risk and timeline justifications for responding to various scenarios where the acute risk is related to volatile organic compounds (VOCs) and vapor intrusion (VI).

This request for clarification is intended to augment a December 7, 2017 DHS letter to the Wisconsin Department of Natural Resources (DNR) providing recommendations for when immediate action is needed in response to written comments on proposed revisions to the RR-800 document. Specifically, DHS concurred with DNR's position that immediate action is justified when indoor air is found to be present at three (3) times the indoor air vapor action level (VAL) or sub-slab vapor risk screening level (VRSL) for a non-carcinogen or ten (10) times the VAL or VRSL for a carcinogen. In addition, DHS supported the DNR's position that immediate action be taken when trichloroethylene (TCE) is present in indoor air above the VAL and when women of child-bearing age are present.

DHS response:

DHS clarification statements defining acute risk and justifying timelines for responding to acute risk follow for each of the DNR scenarios presented in the request letter:

1. **Clarification from DHS that acute risk necessitates immediate action as defined in s. NR 700.03(28), Wis. Admin. Code.**

   To reinforce the finding in the December 7, 2017 letter, DHS is in agreement that DNR's immediate action as defined in s. NR 700.03(28), Wis. Admin. Code is warranted when acute risk is observed as discussed in DNR's Vapor Intrusion Guidance RR800 (2018). For all contaminants with the exception of trichloroethylene (TCE) when women of childbearing years (age 15 to 44) are present, acute risk is defined as indoor air concentrations that are three times over the vapor action limit (VAL) for non-carcinogens or ten times over the VAL for carcinogens. For TCE where people who are or may become pregnant occupy a dwelling, acute risk is defined as indoor air concentrations that are equal to or over the VAL (HI ≥ 1). These immediate action guidelines are in agreement with EPA guidance. The following statement is from the EPA OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (EPA 2015): "Although the indoor air concentrations may vary temporally, an appropriate exposure concentration estimate (e.g., time-integrated or time-averaged indoor air concentration measurement in an occupied space) that exceeds the health-protective concentration levels for acute or short-term exposure (i.e., generally considered to be a hazard quotient (HQ) greater than one for an acute or short-term exposure period) indicates vapor concentrations that are generally considered to pose an unacceptable human health risk."

2. **Clarification from DHS that trichloroethylene (TCE) present in indoor air above the applicable VAL qualifies as an acute risk to women of child-bearing years.**

DNR basis its VAL and VRSL values on EPA regional screening levels (RSLs) for indoor air. These values are developed using reference concentrations (RfCs) from EPA's toxicological assessments developed for its Integrated Risk Information System (IRIS). The non-cancer chronic inhalation RfC of $2x10^{-3}$ mg/m^3 in EPAs toxicological assessment for TCE (2011) is based upon two rodent drinking water exposure studies. One study (Kiel et al., 2009) reported an immunotoxic effect of TCE presenting as a reduced thymus weight in female mice. The other study reported an increased incidence of fetal cardiac malformations (Johnson et al., 2003). The cardiac malformation developmental endpoint drives the concern over short term exposure to TCE. Although some limitations were reported with the Johnson et al. study (2003), the cardiac malformations finding has been confirmed by several reviews since, including the EPA Office of Solid Waste and Emergency Response (2014), ATSDR (2014), the Massachusetts Department of Environmental Protection (MADEP, 2014), a group of EPA researchers (Makris et al, 2016), and the North Carolina Department of Environmental Quality (NC DEQ, 2018). These reviews found that a two- to three-fold increase in congenital heart defects were observed in multiple animal studies and that the most frequently observed heart defects were also reported in humans exposed to TCE-containing VOCs in several epidemiological studies (Brender et al. 2014, Dawson et al. 1993). These reviews also found that mechanistic support exists with studies in avian and mammalian cells demonstrating that TCE exposure alters processes that are critical to normal valve and septum formation. Although a recent EPA TSCA Risk Evaluation for TCE (2019) used the immunotoxic end point and not the fetal cardiac malformation end point for their risk determinations, the EPA Science Advisory Committee on Chemicals (SACC) was split on whether to use the fetal heart malformations endpoint for risk consideration and the TSCA Risk Evaluation was not allowed to consider epidemiological evidence or the effects of TCE exposure from air, contaminated waste sites, groundwater used for drinking water, and food in their evaluation.

The EPA identifies that a single exposure at any of several developmental stages may be sufficient to produce an adverse developmental effect (EPA, 1991). In humans, the cardiac system is the second to develop following fertilization, with cardiac development beginning at approximately 3 weeks following implantation. Substantial cardiac system development continues through 8 to 9 weeks post implantation, with the most sensitive period of cardiac development occurring in 3 to 6 weeks (Smart and Hodgson, 2018). These critical fetal heart development windows occur during a time period when an individual may not yet know they are pregnant. Rapid actions should be taken to minimize the potential for TCE exposures during these timeframes (EPA 2014, EPA Region V, 2020).

3. **Health-based recommended responses including the definition of critical exposure windows with scientific justification to help inform DNR determination of time lines for immediate (s. NR 700.03(28), Wis. Admin. Code) and interim (s. NR 700.03(29), Wis. Admin. Code) actions in the following scenarios:**

   a. **TCE is present beyond the envelope of a building at or above the applicable Vapor Risk Screening Level (VRSL);**

   DHS recommends an evaluation of the demographics for the building. If persons of childbearing years occupy the dwelling, indoor air samples should have a quick turnaround time (24 to 72 hours, EPA Region 9, 2014). Women in the sensitive demographic should be consulted about the potential TCE developmental toxicity risk so they may make informed decisions in terms of staying in the dwelling during the timeframe of the indoor air assessment. DHS or local health can assist with this consultation. If the indoor air TCE sample result exceeds the VAL, DHS recommends interim action (carbon filter unit) and rapid installation of sub-slab depressurization system within two weeks. If the indoor air TCE sample result is less than the VAL, mitigate and monitor indoor air in interim to ensure exposure is not occurring and move toward installation of a mitigation system within 4 to 8 weeks, depending upon the building's complexity and need for system design.

   b. **Non-carcinogenic compounds are present beyond the envelope of a building at or above three (3) times the applicable VRSL;**

   The U.S. EPA defines a reference concentration (RfC) as an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure of a chemical to the human population through inhalation (including sensitive subpopulations), that is likely to be without an appreciable risk of deleterious effects during a lifetime (IRIS Glossary, 2020). When a non-carcinogenic VOC is three times above the applicable VRSL, the risk of that VOC being present in indoor air at levels that can cause an adverse health effect is high enough to warrant urgent action including indoor air sampling with 24 to 72 hour turnaround time and mitigation within 4 to 8 weeks, or sooner where indoor air sampling results indicates a VAL exceedance.

c. Carcinogenic compounds are present beyond the envelope of a building at or above ten (10) times the applicable VRSL;

VRSLs are established in Wisconsin with a 10^{-5} cancer risk. When a carcinogenic compound is present in indoor air at or above ten times the applicable VRSL, the cancer risk exceeds 10^{-4} cancer risk. The risk of cancer occurrences from continuous exposure is therefore high enough to warrant the installation of a mitigation system within 4 to 8 weeks, depending upon the building's complexity and need for system design.

d. TCE is present in indoor air below the applicable VAL

Review sub-slab results when available. If sub-slab TCE data is also below VRSL, additional assessment should take place with normal laboratory turnaround time to confirm results are below action levels. If women of childbearing years occupy the building, an additional sampling round should take place as soon as feasible to ensure levels above VAL/VRSL is not present.

e. Non-carcinogenic compounds are present in indoor air between the applicable VAL and three (3) times the applicable VAL;

Move toward mitigation system installation within 4 to 8 weeks, depending upon complexity and need for system design. Perform indoor air sampling to confirm mitigation system is effective.

f. Carcinogenic compounds are present in indoor air between the applicable VAL and ten (10) times the applicable VAL;

Move toward mitigation with a recommended timeframe of 4 to 8 weeks, depending upon complexity and need for system design. Perform indoor air sampling to confirm mitigation system is effective.

g. TCE is present in indoor air at or above the applicable VAL;

DHS recommends an evaluation of the demographics for the building. If women of childbearing years occupy the building, implement interim actions such as carbon filtration units to interrupt the TCE exposure. Move toward installation of a mitigation system within two weeks. Women in the sensitive demographic should be consulted about the potential TCE developmental toxicity risk so they may make informed decisions in terms of staying in the dwelling during the timeframe of the indoor air assessment.

h. Non-carcinogenic compounds are present in indoor air at or above three (3) times the applicable VAL;

The U.S. EPA defines a reference concentration (RfC) as an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure of a chemical to the human population through inhalation (including sensitive subpopulations), that is likely to be without an appreciable risk of deleterious effects during a lifetime (IRIS Glossary, 2020). When a non-carcinogenic VOC is three times above the applicable VAL, the risk of adverse health effects occurring from continuous exposure is high enough to warrant the installation of a mitigation system within 4 to 8 weeks, depending upon the building's complexity and need for system design. Depending upon how far above the VAL the concentration is, more urgent actions may be needed, and the local health officer should be consulted for potential abatement orders, placarding, and temporary relocation of occupants per Section 254 Wis. Admin. Code.

i. **Carcinogenic compounds are present in indoor air at or above ten (10) times the applicable VAL.**

When a carcinogenic compound is present in indoor air at or above ten times the applicable VAL, the cancer risk exceeds 10^{-4} cancer risk. The risk of cancer occurrences from continuous exposure is therefore high enough to warrant the installation of a mitigation system within 4 to 8 weeks, depending upon the building's complexity and need for system design. Depending upon how far above the VAL the concentration is, more urgent actions may be needed, and the local health officer should be consulted for potential abatement orders, placarding, and temporary relocation of occupants per Section 254 Wis. Admin. Code.

4. **Health-based recommendations for when sampling indoor air at commercial or industrial businesses is necessary in light of the recent Department of Defense study on sewers and utility tunnels as preferential pathways (*Sewers and Utility Tunnels as Preferential Pathways for Volatile Organic Compound Migration into Buildings: Risk Factors And Investigation Protocol*, ESTCP Project ER-201505).**

DHS agrees with the finding in the DoD study that indoor air should be part of the VI assessment where evidence of preferential pathways might be feasible. This evidence may include detection of VOCs in sewer lines or utility corridors. Recent experience has shown instances where indoor air levels are found at high levels due to preferential pathway contamination through open sumps, openings in foundations, and poorly sealed conduits. DHS also recommends sampling indoor air when environmental sampling (groundwater, soil, or soil gas) indicates that indoor air action levels could be exceeded. When TCE is the contaminant of concern, indoor air should always be evaluated to assist with the risk assessment and be able to interrupt exposures as soon as possible to sensitive populations to prevent the known reproductive/developmental endpoint. When commercial or industrial businesses are users of the VOCs being studied, those chemicals may need to be temporarily removed prior to the indoor air assessment, where feasible.

Thank you for the opportunity to provide feedback on this topic. Please contact me at (608) 266-6677, or curtis.hedman@wisconsin.gov if you have any follow up questions or comments about this response.

Sincerely,

Curtis Hedman, Ph.D.
Toxicologist
Bureau of Environmental and Occupational Health

Cc: Jennifer Borski, Vapor Intrusion Team Leader, DNR R&R Program
Judy Fassbender, NR Program Manager, DNR R&R Program
Roy Irving, Chief, DHS Hazard Assessment Section, BEOH
Mark Werner, Chief, DHS BEOH

Enc: Summary of DHS response to Request for Assistance: Actions for Trichloroethylene at Acute Risk Levels

References:

WI DNR Remediation and Redevelopment Program Publication RR-800 (2018). *Addressing Vapor Intrusion at Remediation & Redevelopment Sites in Wisconsin*. Available at: https://dnr.wi.gov/files/PDF/pubs/rr/RR800.pdf

U.S. EPA, Office of Solid Waste and Emergency Response, 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. OSWER Publication 9200.2-154 http://www.epa.gov/vaporintrusion/technical-guide-assessing-and-mitigating-vapor-intrusion-pathway-subsurface-vapor

IRIS 2011a. *Trichloroethylene; CASN 79-01-6*. Integrated Risk Information System (IRIS) Chemical Assessment Summary. U.S. Environmental Protection Agency. National Center for Environmental Assessment. Available at: https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=199

IRIS 2011b. *Toxicological Review of Trichloroethylene (CAS No. 79-01-6) In Support of Summary Information on the Integrated Risk Information System (IRIS)*. U.S. Environmental Protection Agency, Washington, DC. September 2011. EPA/635/R-09/011F. Available at: https://www.epa.gov/iris/supporting-documents-trichloroethylene

IRIS 2011c. *Toxicological Review of Trichloroethylene Appendices (CAS No. 79-01-6) In Support of Summary Information on the Integrated Risk Information System (IRIS)*. U.S. Environmental Protection Agency, Washington, DC. September 2011. EPA/635/R-09/011F. Available at: https://www.epa.gov/iris/supporting-documents-trichloroethylene

Keil, D; Peden-Adams, M; Wallace, S; Ruiz, P; Gilkeson, G. (2009). *Assessment of trichloroethylene (TCE) exposure in murine strains genetically-prone and non-prone to develop autoimmune disease*. J Environ Sci Health A Tox Hazard Subst Environ Eng 44: 443-453.

Johnson, P; Goldberg, S; Mays, M; Dawson, B. (2003). *Threshold of trichloroethylene contamination in maternal drinking waters affecting fetal heart development in the rat*. Environ Health Perspect 111: 289-292.

U.S. EPA, Office of Solid Waste and Emergency Response, 2014. *Compilation of Information Relating to Early/Interim Actions at Superfund Sites and The TCE IRIS Assessment.* https://clu-in.org/download/contaminantfocus/tce/TCE-compilation-final-2014.pdf

ATSDR (2019) Agency for Toxic Substances and Disease Registry (ATSDR). 2019. *Toxicological profile for Trichloroethylene (TCE)*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

(MADEP, 2014) MADEP, 2014. *Assessing the Congenital Cardiac Toxicity of Trichloroethylene: Key Scientific Issues*. Massachusetts Department of Environmental Protection Office of Research and Standards. March 2014.

Wikipedia The Free Encyclopedia. Trichloroethylene, available at: https://en.wikipedia.org/wiki/Trichloroethylene

(Makris et al, 2016) Makris et al., 2016. *A Systemic Evaluation of the Potential Effects of Trichloroethylene Exposure on Cardiac Development*. Reproductive Toxicology. 2016, 65:321-358. August 2016. http://dx.doi.org/10.1016/j.reprotox.2016.08.014

NC Department of Environmental Quality Report to the Secretaries' Science Advisory Board (2018). *Trichloroethylene (TCE) Inhalation Immediate Action Levels and Response Guidance for Indoor Air Protective of Cardiac Developmental Defects*. Available at: https://files.nc.gov/ncdeq/GenX/SAB/DEQ-TCE-IA-AL-Report-101518.pdf

Brender et al., 2014. *Maternal Residential Proximity to Chlorinated Solvent Emissions and Birth Defects in Offspring: A Case–Control Study*. Environmental Health 2014, 13:96.

Dawson et al., 1993. Dawson, B., Johnson, P., Goldberg, S., Ulreich, J. *Cardiac teratogenesis of halogenated hydrocarbon-contaminated drinking water*, J. Am. Coll. Cardiol.21 (1993) 1466–1472, http://dx.doi.org/10.1016/0735-1097(93)90325-U .

U.S. EPA 1991b. U.S. Environmental Protection Agency. *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decis*ions. OSWER Directive 9355.0-30.

Smart and Hodgson, 2018. *Molecular and Biochemical Toxicology*. Edited by Smart, Robert C.; Hodgson, Ernest, North Carolina State University, Raleigh, NC, USA. Wiley & Sons, Inc. Hoboken, NJ.

U.S. EPA Region 5 (2020). Superfund and Emergency Management Division Vapor Intrusion Handbook.

U.S. EPA *IRIS Glossary*. Terminology Services (TS). U.S. Environmental Protection Agency, Washington, DC. Available at: https://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do

US DOD (2018). *Sewers and Utility Tunnels as Preferential Pathways for Volatile Organic Compound Migration into Buildings: Risk Factors and Investigation Protocol*, ESTCP Project ER-201505

Enclosure: Summary of DHS response to Request for Assistance: Actions for Trichloroethylene at Acute Risk Levels

DNR Ask	DHS Response	Supporting Reference(s)
1) Clarification from DHS that acute risk necessitates immediate action as defined in s. NR 700.03(28), Wis. Admin. Code.	**A)** Immediate action as defined in NR 700.03(28) warranted if: for compounds except TCE = 3x VAL, or 10x VAL carcinogens; TCE w/ women age 15-44 = VAL	**A)** December 7, 2017 DHS letter and EPA OSWER Tech Guide (2015)
2) Clarification from DHS that trichloroethylene (TCE) present in indoor air above the applicable VAL qualifies as an acute risk to women of child-bearing years	**A)** VALs&VRSLs based on EPA RSLs **B)** RSL for TCE is based on immunotox. and fetal cardiac development endpoints **C)** findings confirmed by reviews **D)** also consistent with epi study findings **E)** single exposure during development can have harmful effect **F)** critical development window 3 to 6 weeks **G)** rapid action warranted for TCE > RSL	**A)** EPA tox assessment TCE (2011) **B)** Kiel et al. (2009) Johnson et al. (2003) **C)**EPA OSWER (2014), ATSDR (2014), MADEP (2014), Makris et al (2016), NC DEQ (2018) **D)**Brender et al. (2014), Dawson et al. (1993) **E)**EPA (1991) **F)** Smart and Hodgson (2018) **G)** EPA 2014, EPA Region V (2020)
3) Health-based recommended responses including the definition of critical exposure windows with scientific justification to help inform DNR determination of time lines for immediate (s. NR 700.03(28), Wis. Admin. Code) and interim (s. NR 700.03(29), Wis. Admin. Code) actions in the following scenarios:		
a) TCE is present beyond the envelope of a building at or above the applicable Vapor Risk Screening Level (VRSL)	**A)** evaluate demographics in building **B)** sample indoor air with 24-72 hour TAT **C)** consult w/ women 15-44 about TCE **D)** if TCE >VAL, carbon filtration w/in 48 hours and sub-slab system w/in 2 weeks **E)** if TCE <VAL, perform another indoor air sample and sub-slab system w/in 4-8 weeks	**B)** EPA Region 9, (2014) WI DNR RR800 (2018), EPA Reg V (2020)
b) Non-carcinogenic compounds are present beyond the envelope of a building at or above three (3) times the applicable VRSL	**A)** RfC is estimate, ca. order of magnitude, of concentration w/o harm over lifetime **B)** >3x that level cuts significantly into that safety factor **C)** indoor air sampling with 24-72 hour TAT **D)** sub-slab system w/in 4-8 weeks if >VAL	**C)** EPA Region 9, (2014) WI DNR RR800 (2018), EPA Reg V (2020)
c) Carcinogenic compounds are	**A)** VRSLs est. w/ 10^{-5} cancer risk	WI DNR RR800 (2018), EPA Reg. V (2020)

	present beyond the envelope of a building at or above ten (10) times the applicable VRSL	**B)** >10x that exceeds 10^{-4} cancer risk **C)** sub-slab system w/in 4-8 weeks if >10x VRSL	
d)	**TCE is present in indoor air below the applicable VAL**	**A)** verify TCE in sub-slab is not >VRSL **B)** If TCE also <VRSL; one more sampling event **C)** do follow up samples soon as possible if women age 15-44 live in building	WI DNR RR800 (2018), EPA Reg. V (2020)
e)	**Non-carcinogenic compounds are present in indoor air between the applicable VAL and three (3) times the applicable VAL**	**A)** sub-slab system w/in 4-8 weeks **B)** sample to confirm system is effective	WI DNR RR800 (2018), EPA Reg. V (2020)
f)	**Carcinogenic compounds are present in indoor air between the applicable VAL and ten (10) times the applicable VAL**	**A)** sub-slab system w/in 4-8 weeks **B)** sample to confirm system is effective	WI DNR RR800 (2018), EPA Reg. V (2020)
g)	**TCE is present in indoor air at or above the applicable VAL**	**A)** evaluate demographics in building **B)** consult w/ women 15-44 about TCE **C)** carbon filtration w/in 48 hours and sub-slab system w/in 2 weeks	WI DNR RR800 (2018), EPA Reg. V (2020)
h)	**Non-carcinogenic compounds are present in indoor air at or above three (3) times the applicable VAL**	**A)** RfC is estimate, ca. order of magnitude, of concentration w/o harm over lifetime **B)** >3x that level cuts significantly into that safety factor **C)** sub-slab system w/in 4-8 weeks **D)** if >>VAL, consult health officer for actions available under Section 254 WI Administrative Code	WI DNR RR800 (2018), EPA Reg. V (2020)
i)	**Carcinogenic compounds are present in indoor air at or above ten (10)**	**A)** VRSLs est. w/ 10^{-5} cancer risk **B)** >10x that exceeds 10^{-4} cancer risk **C)** sub-slab system w/in 4-8 weeks	WI DNR RR800 (2018), EPA Reg. V (2020)

times the applicable VAL	**D)** if >>VAL, consult health officer for actions available under Section 254 WI Administrative Code	
4) Health-based recommendations for when sampling indoor air at commercial or industrial businesses is necessary in light of the recent Department of Defense study on sewers and utility tunnels as preferential pathways (*Sewers and Utility Tunnels as Preferential Pathways for Volatile Organic Compound Migration into Buildings: Risk Factors And Investigation Protocol*, ESTCP Project ER-201505)	**A)** DHS agrees with DOD study findings **B)** DHS recommends sampling indoor air when soil gas results suggest indoor air levels may be exceeded **C)** Indoor air should always be assessed where TCE is contaminant of concern due to acute reproductive endpoint **D)** when assessing indoor air in commercial buildings, may need to relocate COCs that are used in production during sampling	US DOD ESTCP Project ER-201505 (2018)