Vapor Intrusion Assessment and Work Plan

Document No.: D3924000.268-R2
Revision: 2

Tyco Fire Products LP
Marinette, Wisconsin

One Stanton Street Site
January 30, 2025

Vapor Intrusion Assessment and Work Plan

Client name:	Tyco Fire Products LP		
Project name:	One Stanton Street Site		
Client reference:	Marinette, Wisconsin	**Project no:**	D3924000
Document No.:	D3924000.268-R2	**Project manager:**	Heather Ziegelbauer
Revision:	2	**Prepared by:**	Jacobs
Date:	January 30, 2025	**File name:**	TycoRevisedVIAssessmentAndWP-20250130

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Acronyms and Abbreviations

µg/L	microgram(s) per liter
2019 Work Plan	*Vapor Intrusion Assessment and Work Plan*
2021 Work Plan	*Revised Vapor Intrusion Assessment and Work Plan*
2025 Work Plan	*Vapor Intrusion Assessment and Work Plan – Revision 2*
AF	attenuation factor
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
cDCE	cis-1,2-dichloroethylene
ChemDesign	ChemDesign Products, Inc.
COC	chain of custody
CSM	conceptual site model
Eurofins	Eurofins Air Toxics, LLC
EPA	Environmental Protection Agency
GC/MS	gas chromatography-mass spectrometry
GWCTS	groundwater collection and treatment system
HASP	health and safety plan
MDL	method detection limit
MIBK	methyl isobutyl ketone
OSHA	Occupational Safety and Health Administration
PAL	preventive action limit
PCE	tetrachlorethylene
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
site	Tyco Fire Products LP facility in Marinette, Wisconsin
SOP	standard operating procedure
SSGSL	sanitary sewer gas screening level

SSSG	subslab soil gas
TCE	trichloroethylene
Tyco	Tyco Fire Products LP
VAL	vapor action level
VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound
VRSL	vapor risk screening level
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollutant Discharge and Elimination System

1. Introduction

This document presents an updated evaluation of potential vapor intrusion (VI) at the Tyco Fire Products LP (Tyco) facility in Marinette, Wisconsin (site) (Figure 1-1) and a revised work plan (revision 2) (2025 Work Plan) for additional VI evaluation activities to be conducted at the site. This document addresses and incorporates comments provided by the U.S. Environmental Protection Agency (EPA) and the Wisconsin Department of Natural Resources (WDNR) in multiple letters and meetings detailed below, and incorporates work that has been performed, following the original VI evaluation and work plan submittal in 2019.

1.1 Background

Tyco submitted a VI evaluation and work plan on September 27, 2019 (2019 Work Plan) (Jacobs 2019b). The 2019 Work Plan addressed comments provided by EPA and WDNR in EPA's letter dated March 14, 2019 (EPA 2019a) related to their review of the site's 2018 *Five-Year Technical Review* (Jacobs 2018). Specifically, Comment 6 of Enclosure 1 of EPA's letter (EPA 2019a) noted the presence of volatile organic compounds (VOCs) in groundwater sampled from several monitoring wells, including MW041S and MW045S, located proximate to occupied buildings. As a result, EPA recommended that a VI investigation be conducted consistent with EPA and WDNR RR-800 VI guidance[1] to evaluate potential exposure of onsite workers to vapors emanating from groundwater or through preferential pathways.[2] A similar comment was made by WDNR that was included in Enclosure 2 of EPA's letter (EPA 2019a).

On December 18, 2019, EPA provided comments on the 2019 Work Plan (EPA 2019b), and on behalf of Tyco, Jacobs submitted a response letter on February 14, 2020, with a proposed revised approach (Jacobs 2020a). As part of their December 2019 comments, EPA also requested that indoor air sampling be conducted as soon as possible at Building 14 (where the groundwater collection and treatment system [GWCTS] is housed; Figure 1-2) for analysis of trichloroethylene (TCE) and its common degradation compounds cis-1,2-dichloroethylene (cDCE) and vinyl chloride (VC) because of the presence of TCE in nearby shallow groundwater monitoring wells. While revising the work plan to address EPA's comments, two indoor air sampling events were conducted in February and April 2020 at Building 14 consistent with EPA's request. Appendix A presents the indoor air sampling results. No TCE, cDCE, or VC was detected in indoor air. Note that the Building 14 footprint was expanded and equipment and equipment layouts changed during the GWCTS improvements in 2022 and 2023; therefore, Building 14 will be re-evaluated as part of the 2025 Work Plan. The details provided in Appendix A are to document the 2020 work that was completed.

Following Jacobs' February 2020 response letter detailing a revised approach (Jacobs 2020a), EPA provided a follow-up comment letter dated April 29, 2020 (EPA 2020b). Based on the EPA's comments and a presentation to the agencies during the August 27, 2020, project status meeting, Jacobs prepared a revised VI assessment and work plan (2021 Work Plan) (Jacobs 2021), which was submitted to EPA and WDNR on March 17, 2021. The revised approach described in the 2021 Work Plan was drafted in alignment with WDNR RR-800 VI guidance Table 5a #5 and Table 5b #3 (WDNR 2018), as site conditions

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[1] See EPA 2015; WDNR 2018.

[2] The EPA Region 5 VI handbook also was reviewed as part of this assessment and work plan preparation (EPA 2020a).

limit the ability to carry out subslab soil gas (SSSG) sampling effectively because impacted groundwater intersects or may intersect the building foundation.[3]

On December 20, 2023, EPA and WDNR provided comments (EPA 2023) to the 2021 Work Plan. These comments were discussed during an April 4, 2024, meeting between Tyco and the agencies. During that meeting, Tyco presented further modifications to the VI investigation approach, including a real-time assessment of preferential pathways to better inform conventional VI sampling consistent with WDNR RR-800 and RR-649 guidance (WDNR 2018, 2021).[4] EPA arranged a follow-up meeting between Tyco and the agencies on August 8, 2024, to further discuss the comments to the 2021 Work Plan and Tyco's April 2024 presentation. Tyco submitted a memorandum on September 4, 2024, (Jacobs 2024b) to respond to the agencies' comments to the 2021 Work Plan and address points raised during the April and August 2024 follow-up meetings. EPA provided a response to this memorandum on December 4, 2024 (EPA 2024b).

This *Vapor Intrusion Assessment and Work Plan – Revision 2* (2025 Work Plan) incorporates the agencies' comments, changes made based on discussions with the agencies, new VI guidance from WDNR, and work that has been performed, following the original VI evaluation and work plan submittals in 2019 and its revision in 2021.

Separately, Tyco submitted the site's 2023 *Five-Year Technical Review* (Jacobs 2024a) on April 1, 2024, which was used to update pertinent site characteristics and analytical data in this document.

1.2 Document Organization

The document is organized into the following sections:

1. **Introduction –** Provides background information and the document organization.
2. **Site Overview and Conceptual Site Model –** Provides pertinent information related to the site and a conceptual site model (CSM) related to the presence of VOCs in soil and groundwater.
3. **Desktop Vapor Intrusion Evaluation –** Describes the approach and results of an updated desktop evaluation to identify site buildings that may require additional VI evaluation based on building configuration and use, as well as soil and shallow groundwater data collected to date.
4. **Work Plan for Vapor Intrusion-Related Field Activities –** Presents the revised VI-related field activities to be conducted as a follow-up to the updated desktop evaluation and to address preferential pathway concerns.
5. **Field Schedule –** Presents the proposed field schedule.
6. **Reporting –** Provides the reporting and document deliverable details.
7. **References –** Provides the references.

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[3] Proximity of the groundwater with building foundations—along with a request to use the Wisconsin Administrative Code (WAC) Chapter NR140 preventive action limits (PALs) for all VOCs to assess groundwater concentrations as part of the VI evaluation—was one of the comments provided by EPA in its December 2019 letter (refer to Comment 4 in EPA 2019b).

[4] WDNR's VI guidance RR-649 related to preferential pathways (WDNR 2021) was issued 3 months after the 2021 Work Plan was submitted to the agencies.

2. Site Overview and Conceptual Site Model

Pertinent site information has been described in prior reporting[5] and is summarized as follows:

- The site is an active industrial manufacturing facility in northeastern Wisconsin encompassing approximately 48 acres of land adjacent to the southern shore of the Menominee River (Figure 1-1). Tyco owns the property and conducts manufacturing operations there. A portion of the site is leased to ChemDesign Products, Inc. (ChemDesign), who also conducts manufacturing operations.
- Tyco or prior occupants have used the property since 1915 for various manufacturing operations, including arsenical-based agricultural herbicides from 1957 to 1977, with arsenic being a key subsurface remediation driver at the site.
- Several investigations and corrective measures have taken place at the site since 1974 under various Wisconsin remedial action programs and the Resource Conservation and Recovery Act (RCRA) program, including installation of a containment barrier system (slurry wall or sheet pile sections) surrounding several areas of the site (Figure 1-1)[6] to prevent offsite migration of arsenic in groundwater. A groundwater extraction and treatment system is operated at the site to manage groundwater levels within the contained areas. This system consists of several extraction wells which manage groundwater recharge within the various containment areas. The extraction wells maintain the water table below ground surface to prevent site flooding in the Main Plant and Wetlands Area, and maintain the water table below a target elevation in the former Salt Vault and former 8th Street Slip.

Site geology consists of an upper soil layer of sand/gravel fill underlain by alluvial deposits of fine- to coarse-grained sand and gravel, transitioning to denser, finer-grained deposits, glacial till, and then bedrock at a depth of about 40 feet below ground surface (bgs). Regional groundwater generally flows northeast toward the Menominee River; however, the local flow direction is affected by the site's containment barrier system. Groundwater flow within the containment barrier varies locally under the influence of the pumping wells. The Main Plant area is a topographic high and groundwater generally moves in a direction consistent with the topography. Thus, groundwater in the Main Plant-contained area generally flows to the west/northwest but is also influenced by the pumping wells.

The depth to water inside the contained Main Plant and Wetlands Area has generally ranged from 1 to 3 feet bgs or more over the last several years, with some spatial and temporal variability dependent on the amount of precipitation and flow rate of the groundwater pumping system.[7] Shallow groundwater conditions could limit the ability to carry out SSSG sampling effectively because impacted groundwater may intersect the building foundations in some areas of the Main Plant. This could limit VI investigation options to indoor air sampling in some buildings (refer to WDNR RR-800 VI guidance Table 5a #5 and Table 5b #3 [WDNR 2018]). Table 2-1 summarizes the June and October 2024 water table elevation data[8] in the Main Plant area where buildings are located (Figures 1-1 and 1-2) and the depths relative to ground surface.

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[5] See, for example, *Five-Year Technical Review* (Jacobs 2024a).

[6] These site areas include four containment areas: (1) the Main Plant, (2) the former Salt Vault, (3) the former 8th Street Slip, and (4) the Wetlands Area.

[7] As a result of above-normal precipitation and subsequent above-normal lake and river levels (as noted by Lake Michigan water levels), the Menominee River levels were abnormally high from 2019 to 2021, and caused the groundwater inside the contained Main Plant and Wetlands Area to rise to less than 1 foot bgs.

[8] Shallow monitoring wells typically have a depth of 15 feet bgs, with a 10-foot screened interval. The groundwater table can therefore be above the screened area, such that depth-to-water measurements at certain shallow wells may be representative of the hydraulic head beneath the water table rather than the actual depth of the water table.

RCRA facility investigations conducted through 2000 identified the presence of VOCs in site soil and groundwater in several areas at concentrations exceeding applicable screening levels or standards (URS 2001). These VOCs include benzene, toluene, ethylbenzene, and xylenes (BTEX), as well as naphthalene, ketones, and chlorinated VOCs, including TCE, VC, methylene chloride, and chlorobenzenes. The presence of VOCs at the site has been attributed to historical spills (URS 2001, Sections 1.2.4 and 6.1). While VOCs are not considered primary remediation drivers, Tyco continues to monitor VOCs in groundwater. Groundwater samples collected from selected monitoring wells in 2009, 2015, 2018, 2019, 2021, and 2023 were analyzed for VOCs.[9]

VI can occur when vapors from VOC-containing soil or groundwater migrate into the indoor space of overlying buildings. Note that VOCs can also be identified in indoor air based on current use of VOC-containing chemicals or other background contributions. Based on available information, the VI CSM for VOCs at the site is:

- The presence of VOCs in groundwater resulted from accidental spills during historical manufacturing operations.[10]
- Vapors could originate from VOC-containing groundwater near the water table or from residual VOC sources in the vadose zone (if such residual sources remain present) and potentially migrate into nearby buildings.
- Potential site receptors include the onsite workers. If the VI pathway were complete, these receptors would potentially be exposed to VOC vapors originating from the subsurface and entering buildings via diffusion across the building slab, via advection through foundation cracks or gaps, or along atypical preferential pathways (for example, sumps, utility lines).
- In an atypical preferential pathway scenario, such as a sump or sewer utility conduit, VOC-containing groundwater could potentially migrate into a conduit or sump located below the water table; VOCs volatilizing from that groundwater could potentially migrate into the building air if the sump or conduit is not properly isolated (for example, open sump, defective plumbing, dry p-trap).

An illustrated VI CSM for this site is included as Figure 2-1 presenting the potential VI pathways considered in preparation of the 2025 Work Plan. This CSM will be updated and refined as more information becomes available, including the findings from future VI investigations.

The following are considerations pertinent to planning the VI investigation:

- Shallow water table – The relatively shallow depth of the water table and relatively permeable nature of the deposits are factors that could be conducive to potential VI issues. The shallow depth may also allow the water table to intersect with the building foundation; this can potentially limit the ability to carry out SSSG sampling effectively and limit VI investigation options to indoor air sampling (WDNR 2018, Table 5a #5 and Table 5b #3).
- Buildings where slabs serve as secondary containment – Some structures at the facility have concrete slabs that serve as secondary containment, including Building 14 that houses the GWCTS and the site's wastewater treatment system. The integrity of the concrete slab is a critical component to the building's secondary containment capabilities, and it is important not to compromise it by drilling probes, which limits SSSG probe installation to elevated building floor areas that are not within the secondary containment footprint.

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[9] The groundwater samples collected in June 2019 and June 2021 for VOC analysis were intended to support the assessment of potential VI using updated groundwater monitoring data, as further described in Section 3.

[10] Including constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation (TRC) 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System on the Web, which are highlighted orange on the tables and figures in this document, where applicable.

- Building moisture vapor barriers – Information on building moisture barriers is provided as supplemental information and is not intended to be used to screen out buildings for VI. A Drago Vapor Intrusion Barrier was installed in summer 2022 under the slab for the new building addition on the west side of Building 14, and smoke testing was conducted to check the integrity of the barrier (Appendix B). A standard moisture vapor barrier is present beneath the slab for the remainder of the Building 14 footprint. SSSG probe installation is proposed for areas that are not within the new building addition footprint.
- Preferential pathways – The 2019 Work Plan and 2021 Work Plan were submitted before WDNR released RR-649 preferential pathway guidance in June 2021 (WDNR 2021). The 2025 Work Plan has been updated to be consistent with WDNR RR-649 guidance.
    - The following terms are defined in RR-649 (WDNR 2021, p. 3) and are applied throughout this document:
        - Preferential pathway (also referred to as atypical preferential pathway) is a general term used to define all high-capacity transport pathways for vapors in the vadose zone or for groundwater flow; human-made preferential pathways include utility corridors and features within a building such as sumps, floor drains, plumbing vent pipes, and plenums.
        - Utility corridor means an underground or buried utility line or pipe (conduit), including bedding or excavated and subsequently backfilled trench, in which the utility line or pipe was constructed or placed; utility corridors include sanitary and storm sewers, utility tunnels, water lines, gas lines, sewer force mains, buried electric power distribution lines and buried telephone, or cable television or telecommunications lines.
    - As noted previously, vapors could potentially migrate into buildings through atypical preferential pathways, including utility corridors, which can be deeper than the groundwater table at the site, given the shallow water table, and may potentially collect infiltrating groundwater that contains VOCs. Note that the potential pathways may no longer be complete because of work completed onsite. Specifically: (1) most of the site sewers have been relined or abandoned; (2) industrial lines have been directed to sanitary sewers or to Wisconsin Pollutant Discharge and Elimination System (WPDES) outfall OF004 that discharges to the Menominee River to the north of Building 14 (Figure 1-2); and (3) stormwater management has been moved above grade as part of work conducted from 2016 to 2023.
- Site industrial and chemical manufacturing use – The site is an active industrial facility, including ChemDesign's specialty chemical manufacturing. The site is not accessible to the public. Several VOCs are still in use onsite, including chlorinated solvents, such as methylene chloride and chlorobenzene.
- Past TCE usage – TCE is no longer used at the site. The presence of TCE in groundwater is limited to the northwestern corner of the site, and the maximum shallow groundwater concentrations measured most recently in shallow monitoring wells (screened at the water table) have not exceeded 100 micrograms per liter (µg/L) (Section 3.3).

As requested by EPA and WDNR, this work plan includes further assessment and investigation to characterize the VI pathway at the site buildings. In many instances, it is expected that the potential VI pathway will be incomplete or insignificant because of several factors, including the absence of a significant source of VOCs or VOC concentrations that are below levels of concern for VI to occur. Additionally, as recognized by WDNR in its guidance (WDNR 2018, Section 6.1), it is important to emphasize that background levels of many VOCs, including BTEX, are common in indoor air, even at locations where VI is not occurring (EPA 2011, 2016), such that it can be difficult to distinguish background contributions from potential VI. This is particularly applicable to settings like the Tyco site, which is regulated by the Occupational Safety and Health Administration (OSHA) and where manufacturing processes actively occur onsite using some of the same VOCs that have been observed in shallow groundwater.

3. Desktop Vapor Intrusion Evaluation

3.1 Overview

To help identify enclosed site buildings where VI investigation may be warranted, the site was screened for potential VI as follows:

- Groundwater: Existing groundwater data (2000 to 2023) were reviewed to identify shallow monitoring wells (screened at the water table) where the concentrations of one or more VOCs exceed calculated vapor risk screening levels (VRSLs) or the Wisconsin Administrative Code (WAC) Chapter NR 140 preventive action limit (PAL) for TCE. The VRSLs were developed using the EPA- and WDNR-based approach detailed in Section 3.2.[11] The following approach was used for further evaluation of the shallow groundwater and to identify buildings to include in the VI investigation:
  - If shallow groundwater monitoring data relevant to the VI evaluation were collected earlier than 2014 and had a VRSL exceedance, then a new groundwater sample was collected from that well for VOC analysis during the June 2019 sampling events (Section 3.3).[12]
  - If the shallow groundwater monitoring data, including the 2023 data, exceeded VRSLs or the TCE PAL, then the buildings within 100 feet of the shallow monitoring well with exceedance[13] were further evaluated for potential VI and a follow-up VI sampling strategy in accordance with WDNR VI guidance requirements, as further described in Sections 3.3 and 3.7.
  - For buildings with: (1) limited or no groundwater data available, (2) not within 100 feet of a shallow monitoring well with VRSL exceedance, and (3) in an area of the site where VRSLs could potentially be exceeded (such as the northwestern portion of the site), VI potential and a follow-up VI sampling strategy were also evaluated. For instance, Building 36 was included in the list of buildings to be evaluated because it is in the northwestern portion of the site and there is limited well coverage around the building (Sections 3.3 and 3.7).
  - If no enclosed buildings were identified within 100 feet of a shallow monitoring well with VRSL exceedance, then further VI evaluation was deferred until site conditions change (for example, new building construction or renovations enclosing a previously open structure).
- Soil: Soil data collected as part of the historical RCRA facility investigations conducted through 2000 (URS 2001, Appendix B) were reviewed and assessed for the presence of VOCs and related potential VI concerns. As further described in Section 3.4, buildings that were not otherwise identified based on the groundwater data evaluation and which had nearby VOC detections in soil were further evaluated for potential VI and a follow-up VI sampling strategy, if needed. The soil data were also used to supplement the VOC analyte list initially established based on groundwater data.

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[11] As detailed in the agencies' guidance, VOCs need to be present in the upper reaches of the groundwater table for VI to potentially occur; a clean water lens will impede vapor flux to the vadose zone (EPA 2015, Section 2.1). Therefore, groundwater quality data from intermediate and deep monitoring wells screened below the water table were not compared with the VRSLs when a shallow monitoring well screened at (or near) the water table was present.

[12] Monitoring wells that were abandoned, destroyed, or otherwise inaccessible and for which data with VISL exceedance(s) was more than 5 years old were evaluated on a case-by-case basis, with either nearby alternate wells selected for sampling, or temporary well points installed and sampled. Additional monitoring wells were also sampled to verify they were consistent or less than historical groundwater data.

[13] EPA generally recommends a buffer zone of approximately 100 feet (laterally or vertically from the boundary of subsurface vapor concentrations of potential concern) to determine which buildings to include in VI investigations (EPA 2015, Section 6.2.1). Wisconsin also uses the 100-foot criterion (WDNR 2018, Figure 3a), although this distance is reduced to up to 30 feet for petroleum VOCs (WDNR 2018, Figure 3b).

- Buildings: A survey of site buildings was conducted in February 2020 and updated in 2024 based on information provided by facility personnel, to gather building details and support the VI evaluation. The buildings were reviewed individually to assess: (1) building use and occupancy, (2) the type of groundwater VOCs in exceedance of VRSLs, (3) whether TCE in groundwater was in exceedance of the PAL, (4) nearby soil VOC detections, and (5) WDNR VI guidance requirements (Section 3.5).
- Preferential Pathways and Utility Conduits: The utilities and possible points of entry were reviewed based on existing site figures. The evaluation focused on the northwestern corner of the site (Section 3.6). The utilities will be further assessed during the initial field assessment (Section 4.2) to identify potential atypical preferential pathways in alignment with WDNR RR-649 guidance (WDNR 2021).

3.2 Vapor Risk Screening Level Development

To derive VRSLs suitable for evaluating site groundwater data, Jacobs relied on EPA and WDNR VI guidance and used the EPA vapor intrusion screening level (VISL) calculator (EPA 2024a) to obtain VRSLs consistent with WDNR's approach (WDNR 2018, Section 6.2). The VISL calculator can compute indoor air, vapor, or groundwater screening levels for selected VOCs based on an assumed exposure duration scenario, VOC-specific toxicity and volatility information, generic and conservative subsurface-to-indoor air attenuation factors (AFs), and assumed risk targets for the cancer risk and noncancer effects. To compute VISLs for site groundwater, Jacobs made the following assumptions (Table 3-1):

- An onsite worker exposure duration scenario corresponding to the VISL calculator default assumptions for non-residential exposure (that is, exposure duration of 8 hours per day for 250 days per year for 25 years)
- An excess lifetime (70-year) cancer risk target of 1 per 100,000 (10^{-5}) and a target hazard index of 1.0, whichever is smaller, consistent with WDNR screening level approach (WDNR 2018, Section 6.2.1)[14]
- Corrected groundwater volatilization effects for temperature by assuming the groundwater temperature was approximately 10 degrees Celsius (equivalent to 50 degrees Fahrenheit), which corresponds to a reasonable upper-bound value for the groundwater temperature in the Marinette area (EPA 2001, Figure 1)
- A groundwater-to-indoor air AF of 10^{-4} consistent with the default value for industrial buildings recommended by WDNR (WDNR 2018, Table 6a), as well as a more conservative AF of 10^{-3} proposed as the default value for industrial buildings with shallow water table conditions, which also is consistent with EPA's recommended generic value of 10^{-3} (EPA 2015, Table 6-1, Sections A.3.2 and A.4).[15] In consideration of this information and review of the building types at the site, no additional AFs (for

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[14] Consistent with WDNR VI guidance, for monitoring wells where several VOCs were found in groundwater, the total risk associated with the VOCs was evaluated. This corresponds to the additive risk of each VOC individually, with total cancer and noncancer risk targets not to exceed 10^{-5} and 1.0, respectively.

[15] In its guidance, WDNR recommends using the SSSG-to-indoor air AF in lieu of the groundwater-to-indoor air AF if VOC-containing groundwater is within a few feet of the depth of the building foundation; that is, AFs of 0.03 (3×10^{-2}) in lieu of 10^{-3} for residential and small commercial settings and 0.01 (10^{-2}) in lieu of 10^{-4} for industrial and large commercial settings (WDNR 2018, Table 6a). This WDNR approach, however, is overly conservative and not supported by data. For instance, the EPA VI database (which focuses on residential settings) yields median and 95th percentile groundwater-to-indoor air AF of 6×10^{-4} and 7×10^{-3}, respectively, for data sets where the depth to water is less than 1.5 meter (5 feet) (EPA 2012, Section 6.2). This is indicative of more attenuation than the corresponding AF of 0.03 recommended by WDNR, with 0.03 being four times more conservative than EPA's 95th percentile value. For industrial and large commercial settings, it has been Jacobs' technical experience that an upper-bound groundwater-to-indoor air AF of 10^{-3} (rather than the 10^{-2} recommended by WDNR) is largely representative of shallow water table conditions with most AF falling below 10^{-4} regardless of water table depth (Venable et al. 2015, Section 6.2.2.2, Figures 6.24 to 6.29; Lutes et al. 2021, Section 4.2, Figure 8-8; Levy et al. 2023).

example, small commercial, residential) were needed beyond the AFs associated with industrial/large commercial buildings.[16]

The previously described approach was used for all VOCs detected in groundwater samples at the site for which VRSLs are available. The only exception is TCE, for which WAC Chapter NR 140 enforcement standards of 5 µg/L (WDNR 2023, Table 1) was used, consistent with WDNR RR-800 VI guidance, which accounts for potential short-term effects associated with TCE exposure (WDNR 2018, Section 3.4.1, Figure 3a, Table 6a). The enforcement standard of 5 µg/L is lower than the calculated groundwater VRSL for TCE[17] and therefore was used for comparison with groundwater data.

Per EPA's request in the December 18, 2019, comment letter (EPA 2019b) and consistent with WDNR VI guidance (WDNR 2018, Figures 3a and 3b), the WAC Chapter NR 140 PALs were also considered as potential VRSLs because of the shallow groundwater elevations that have been observed at the site in the past, creating the potential for groundwater to be in contact with building foundations. A potential limitation of using groundwater PALs for assessing VI is that these values are not derived on the basis of the VI inhalation pathway; they are instead a percentage of the enforcement standards (WDNR 2023, Table 1), which are based on maximum contaminant levels for drinking water or health-based levels. Therefore, the PALs are not necessarily representative of or commensurate with VI inhalation-related risks. The PALs were included in the desktop VI evaluation; however, based on the VI inhalation-related risks, only the PAL for TCE was used consistently across the site to identify buildings to include in the VI investigation. Additionally, VOCs with groundwater concentrations exceeding their respective PALs were retained for the VOC analytical list for the VI investigation (see Section 3.3).

3.3 Comparison of Groundwater Data with Vapor Risk Screening Levels and Preventive Action Limits

The most recent groundwater data available were compiled for the site's shallow monitoring wells (screened at the water table) to identify locations with a VRSL exceedance. This included:

- Data obtained in 2023 as part of the 5-year review (Jacobs 2024a).
- Data obtained in 2021 from two shallow groundwater monitoring wells (MW054S and MW114S) near Building 69 to evaluate potential for VI from groundwater in the vicinity of that building (Jacobs 2022). The samples were analyzed for the VOC analytical list used for other monitoring wells at the site. VOC results from monitoring wells MW054S and MW114S indicate that the potential VI-related concerns associated with groundwater vapors beneath Building 69 are unlikely. Notably, there were no detections of tetrachlorethylene (PCE) or TCE in the groundwater at either well; therefore, no additional VI investigation activities are proposed at Building 69.
- Data obtained in 2019 (Jacobs 2020b, 2020c) where shallow monitoring well data obtained before 2014 showed a VRSL exceedance at that time.
- Data from 2009 (CH2M 2010) was used for monitoring wells with no sampling and VOC analysis conducted in 2018 (Jacobs 2019a), and data from the 2000 groundwater sampling event (URS 2001, Appendix B) was used only if more recent data were unavailable.

Table 3-2 summarizes VOC groundwater quality monitoring data used in this evaluation. Table 3-2 also lists the VRSLs, where available, for each detected VOC. The monitoring well locations are shown on Figure

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[16] All the buildings onsite are industrial or large commercial buildings, except for Building 61 (office trailer) and the guard shack (Building 9), which may be considered small commercial buildings. Building 61 will be included in the initial HAPSITE assessment and follow-up conventional sampling. Building 9 is outside the area of potential VOC concerns.

[17] The VISL for TCE using the previously described assumptions would be 437 µg/L for an AF of 10^{-4} and 43.7 µg/L for an AF of 10^{-3}.

1-2. For comparison, the available TCE concentrations in medium-depth monitoring well groundwater data were also reviewed, and there were no medium-depth well locations with a TCE detection that did not also have a corresponding shallow well location that was already screened in for TCE.

Using the previously described approach, the following exceedances were identified:

- Three shallow monitoring wells with industrial and shallow water table VRSL exceedances (MW045S, MW067S [replacement monitoring well for MW005S, which was abandoned], and TW-1 [using results obtained from replacement wells MW041S and MW045S])
- One additional shallow monitoring well with shallow water table VRSL exceedances was identified in the 2018 data (MW041S); however, the 2023 data no longer have an exceedance
- Two shallow monitoring wells (MW041S and MW108S) with PAL exceedance for TCE

Table 3-3 includes the list of VOCs identified in groundwater at concentrations above VRSLs or PALs. As noted previously, the PALs were used to determine the VOC analytical list for the VI investigation. The table provides the maximum groundwater concentration measured in shallow monitoring wells (as obtained from the data summarized in Table 3-2), along with a comparison with the PAL and the shallow water table VRSL. The vapor action levels (VALs) (which are intended for comparison with indoor air data but not groundwater data) also are provided for reference (EPA 2024a; WDNR 2024).

Based on the PAL and VRSL exceedances identified in groundwater, 14 groundwater-related VOCs are proposed for VI sampling analyses (Table 3-4).[18] Although 4-methyl-2-pentanone (also known as methyl isobutyl ketone [MIBK]) was detected in groundwater at concentrations exceeding its PAL, this VOC is not considered a VI driver. As noted earlier, the PALs are not derived based on the VI inhalation pathway, and the PAL for this compound is not commensurate with the inhalation risk (Table 3-5). As shown in Table 3-5, even if full volatilization of the maximum MIBK concentration measured in site groundwater was assumed based on Henry's air-water partitioning law, the resulting MIBK concentration indoor air in equilibrium with groundwater would be more than one order of magnitude below its VAL. For that reason, MIBK was not included in the proposed VOC analytical list (Table 3-4).

3.4 Review of Soil Data

Soil data evaluation is complicated because low-level and localized VOC detections in soil are not necessarily an indicator of source, especially if these VOCs were not found in groundwater. VRSL/VISL for soils do not exist, and soil data typically are not recommended for assessing VI.[19] Equivalent soil gas concentration estimates can be obtained using mass partitioning equations;[20] however, there are uncertainties associated with such calculations.[21]

With these potential limitations acknowledged, the 2000 RCRA facility investigation report (URS 2001, Appendix B) was reviewed to evaluate soil sampling data collected in 2000. During the investigation, 187 soil samples were analyzed for VOCs. The screening levels or standards historically used for evaluating VOC concentrations in soil in the 2000 RCRA facility investigations were either the WAC Chapter NR 720.10 generic residual contaminant levels for soil based on the protection of groundwater or equivalent values based on EPA Region 3 risk-based concentrations for soil at industrial sites (URS 2001,

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[18] Note that one analyte, xylenes, includes the three congeners o-, m-, and p-xylenes. In air analyses, the concentration of o-xylene is typically reported separately from the concentration of m- and p-xylenes. Also, note that the table includes an additional four analytes proposed based on a review of soil data. This review is presented in Section 3.4.

[19] See, for example, EPA 2014, 2015 (pp. 119–120, footnote 191).

[20] See, for example, Environmental Quality Management, Inc. 1997, Section 2.2.

[21] See EPA 2014, 2015 (pp. 119-120, footnote 191).

Appendix B at Section 5). These values should not be construed as VISLs, which typically are not derived from soil data.

In general, elevated VOC concentrations in soil were consistent with the presence of these VOCs in groundwater. However, there were several buildings with soil data for which nearby shallow groundwater data were unavailable. These buildings include Buildings 36, 38, and 61, which are included in the VI assessment and investigation because they are located in the northwestern portion of the facility with the highest VOC concentrations in shallow groundwater.

In addition, 12 VOCs were identified in soil samples that did not have groundwater detections or exceedances above PALs (Table 3-6). After further evaluation of these VOCs, including frequency and magnitude of soil detections, presence and concentration magnitude in groundwater, and existence and magnitude of VALs, four VOCs were added to the VOC analyte list (Table 3-4): PCE, 1,2,4-trichlorobenzene, Freon-12 (dichlorodifluoromethane), and styrene. Thus, the total VOC analyte list includes 18 analytes (Table 3-4).

3.5 Survey of Site Buildings

Jacobs initially surveyed the site buildings in February 2020 to better understand building use, occupancy, and configuration. A follow-up review was conducted in 2024 with facility personnel to identify changes since this initial field survey. There are currently 25 buildings (1 building was constructed in 2021 and 3 buildings were demolished in 2022); 11 are operated by Tyco and 14 are operated by ChemDesign.[22] Table 3-7 provides relevant information for each building and indicates the occupant (ChemDesign or Tyco), general usage, work being performed, occupancy, general building information, and products or chemicals stored or in use in the building.

3.6 Review of Site Utilities

Appendix C includes site utility figures reviewed as part of this evaluation. Figure 3-1 identifies the proposed initial utility investigation area in the northwestern portion of the site. The Appendix C figures will be used during the initial field assessment (Section 4.2) to review atypical preferential pathways (such as utility corridors) and identify where utility features might enter a building consistent with WDNR RR-649 guidance (WDNR 2021). The initial field assessment will focus on utilities located in the northwestern portion of the site where VOC-containing groundwater exceeds VRSLs or TCE PAL and those near the buildings identified for further VI investigation in Section 3.7.

3.7 Results of Vapor Intrusion Evaluation

The following is a summary of the eight buildings screened in for further VI investigation (Table 3-8 and Figure 3-1) either within 100 feet of a shallow groundwater monitoring well with VOCs greater than VRSLs/TCE PAL or in an area of the site where VRSLs could potentially be exceeded but no groundwater data are available:

- Building 14 – As previously discussed, this building is near the northwestern corner of the site and houses the GWCTS and the site's wastewater treatment system. Building indoor air was sampled in February and April 2020 because of the presence of TCE in nearby shallow groundwater monitoring wells (refer to Section 1.1 and Appendix A). No TCE was detected in indoor air. However, the building footprint was expanded during the GWCTS improvements in 2022 and 2023 and Building 14 will, therefore, be re-evaluated.

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[22] Building 41/42, which is operated by ChemDesign, was counted as one building.

- Building 36 – This building is an occupied manufacturing building operated by Tyco for the production of fire extinguishers. The building is in the western portion of the site south of Building 14. TCE and other VOCs are present in groundwater monitoring wells near the northwestern corner of the site and there is no shallow groundwater data immediately adjacent to the building. VOCs (but not TCE) were also detected in soil north of the building (URS 2001, Appendix B at Figures 17 and 18).
- Building 38 – This building is used for chemical processing and is located in the western portion of the site south of Building 14. TCE and other VOCs are present in groundwater monitoring wells near the northwestern corner of the site and there is no shallow groundwater data immediately adjacent to the building. VOCs (but not TCE) were also detected in soil north of the building (URS 2001, Appendix B at Figures 17 and 18).
- Building 41/42 – This building is in the northwestern portion of the site and is used by ChemDesign as an open-air storage structure (one building half) and as an enclosed refrigerated storage (other building half). The enclosed refrigerated storage portion of Building 41/42 will be included in the VI investigation because of the possible presence of TCE and other VOCs in groundwater and soil in this area.
- Building 61 – This building is a permanent trailer that is currently being used by ChemDesign as storage, an office area for one staff, and a bathroom. TCE and other VOCs are present in groundwater monitoring wells near the northwestern portion of the site; there is no shallow groundwater data immediately adjacent to the building; however, some groundwater VRSL exceedances were identified farther to the north (TW-1; Figure 1-2). VOCs were also detected in soil north-northwest of the building (URS 2001, Appendix B at Figures 17 and 18). A trailer does not necessarily preclude the occurrence of VI (EPA 2015, Section 2.4), particularly if the trailer is enclosed by a skirt, as is Building 61.
- Building 62 – This building is a ChemDesign manufacturing building for the transfer and distillation of solvents. The building is located in the northwestern portion of the site. Building 62 will be included in the VI investigation because of the possible presence of TCE and other VOCs in groundwater and soil in this area.
- Building 71 – This building includes office space, a laboratory, a mailroom, and a maintenance area, all used by Tyco. VOC VRSL exceedances were noted in shallow monitoring wells immediately to the west (MW041S and TW-1; Figure1-2). VOCs were also identified in soil samples collected nearby (URS 2001, Appendix B at Figures 17 and 18).
- Building 86 – This building is a pump house operated by Tyco. Although this building is confirmed to be outside a radius of 100 feet from shallow monitoring wells with VOC concentrations greater than the VRSL or TCE PAL, Building 86 will be included in the VI investigation in consideration of its general location in the northwestern portion of the facility.

4. Work Plan for Vapor Intrusion-Related Field Activities

This section describes proposed investigation activities to be conducted as a follow-up to the desktop evaluations presented in Section 3. The objective of these field activities is to assess whether there is a complete VI pathway related to VOCs at certain site buildings, via either migration from soil or groundwater vapor sources into buildings or through atypical preferential pathways. This VI assessment will be conducted in alignment with WDNR RR-800 and RR-649 VI guidance (WDNR 2018, 2021) and include SSSG, sewer gas, or indoor air sampling within or near the eight buildings identified in Section 3.7 to determine whether there is evidence of a potentially complete VI pathway representing a risk to building occupants.

The investigation activities include a building survey of the eight buildings identified in the desktop VI evaluation and an initial real-time assessment followed by conventional VI sampling informed by the results of the initial real-time assessment. The initial real-time assessment will use a portable gas chromatography-mass spectrometry (GC/MS) instrument such as a HAPSITE to: (1) conduct initial sampling of indoor air in buildings and (2) assess the potential for VI through the sanitary sewers and other identified utility conduits. The HAPSITE data will not be used to make human health risk calculations or risk-management decisions. The data will be used as a line of evidence to help refine locations for conventional sampling with a canister or passive sampling for laboratory analysis.

The HAPSITE assessment results will be used to confirm the proposed conventional VI investigation locations to include indoor air and SSSG sampling where SSSG sampling is possible, and locations for preferential pathway sampling. Results from conventional sampling will be compared to the VALs, VRSLs, and sanitary sewer gas screening levels (SSGSLs) set by WDNR (WDNR 2018, 2021). Consistent with WDNR RR-800 guidance (WDNR 2018), two sampling events will be performed using conventional sampling for analysis of the 18 VOCs listed in Table 3-4, with one event taking place during the heating season. A technical explanation will be provided if fewer than two sampling events are used to rule out the VI pathway (WDNR 2018, refer to note [d] of Table 5c).

The VI assessment tasks to be conducted are described in the following subsections. Standard operating procedures (SOPs) that will be relied on are provided in Appendix D and include the following:

- SOP-1: Conducting Building Surveys for Vapor Intrusion Investigations (also includes the EPA non-residential indoor air quality evaluation form)
- SOP-2: Analytical Method for the Determination of Volatile Organics in Soil Vapor or Air Using the HAPSITE Field GC/MS
- SOP-3: Sewer Gas Sampling
- SOP-4: Indoor, Outdoor, and Crawlspace Air Sampling Using Canisters
- SOP-5: Indoor, Outdoor, and Crawlspace Air Sampling Using Passive Samplers
- SOP-6: Utility Clearance for Intrusive Operations
- SOP-7: Installation and Abandonment of Vapor Pins as Subslab Soil Vapor Probes
- SOP-8: Subslab Soil Vapor Sampling from Vapor Pins

4.1 Building Survey

Before commencing the HAPSITE assessment activities in a building, a walk-through and survey of the building will be conducted with the assistance of knowledgeable facility personnel and will be compared to the initial information obtained during the February 2020 survey and 2024 update summarized in Table 3-7. The objectives of this survey are as follows:

- Confirm information related to building use, occupancy, and general condition.
- Assess the presence of features susceptible to affect the VI pathway (for example, crawlspace, basement, buried utilities, trenches, sumps or pits, cracks on slab or basement walls, groundwater infiltration).
- Review the type and settings of the heating, ventilation, and air conditioning system being used in the buildings.
- Confirm whether VOC-containing chemicals and materials are currently stored or used in the buildings, or have been stored or used in the past, if known.

Information obtained as part of the survey will be used to adjust, if needed, the proposed target areas for the HAPSITE assessment or locations for the conventional sampling. Appendix D includes SOP-1 and the EPA non-residential indoor air quality evaluation form that will be used to conduct the building survey.

4.2 Initial Real-Time Vapor Intrusion Assessment

4.2.1 Overview

Use of a HAPSITE is planned to assess VI potential through the sanitary sewers and other identified utility conduits and will also be used to fine tune the conventional VI sampling approach (Section 4.3).[23]
The HAPSITE real-time assessment tasks are summarized as follows:

1. Preferential pathway investigation, in alignment with WDNR RR-649 VI guidance (WDNR 2021)
   a. Sample potential VI entry points associated with utility conduits (for example, pluming and drains in buildings).
   b. Sample vapor from sumps or areas (for example, crawlspace) that may contain groundwater using an approach analogous to WDNR RR-986 procedure (WDNR 2014).
   c. Sample vapor in exterior manholes within 100 feet of VOC-containing groundwater exceeding VRSLs or TCE PAL, and potentially step out to more distant manholes based on real-time data.
2. Refine conventional VI sampling approach and locations
   a. Collect and evaluate VOC concentrations in indoor air of eight identified buildings with potential VI to determine whether the proposed sampling locations should be modified based on these initial sampling results.
   b. Identify or verify background VOC indoor sources, and determine whether such sources are present at concentrations that may interfere with the proposed conventional sampling program of canister or passive sampling.

Additional details regarding sampling with the HAPSITE are included in SOP 2 (Appendix D). Refer to Appendix E building figures showing proposed initial sampling locations within the eight identified buildings, as well as Figure 3-1 for the initial utility investigation area. Site utility figures are in Appendix C.

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[23] Use of a portable GC/MS (such as a HAPSITE) is one of the assessment methods referenced in WDNR RR-649 VI guidance (WDNR 2021, p. 13).

4.2.2 HAPSITE Decision Criteria for Initial Assessment of Preferential Pathways

During the initial assessment, and in instances where HAPSITE-measured concentrations in a sanitary sewer main or other identified exterior utility conduits are less than 10% of the SSGSLs, we propose that, consistent with WDNR guidance, the HAPSITE data be considered sufficient to conclude that no further sampling in the corresponding sewer main or utility is needed, consistent with the chart presented in WDNR guidance (WDNR 2021, Figure 5).[24] Table 4-1 shows the VOCs of interest along with their SSGSLs and the corresponding HAPSITE reporting limits, which are well below 10% of the SSGSLs. WDNR guidance indicates that if the results from the initial grab samples are less than 10% of the SSGSL, neither continued sampling at the same manholes nor assessment of impact to adjacent structures is needed (WDNR 2021, p. 15).

Preferential pathway locations with HAPSITE data showing concentrations greater than 10% of the SSGSLs will be reviewed following the event to identify and inform the preferential pathway locations to include as part of the conventional VI sampling and determine if adjustments are needed for the proposed default building sampling locations.

4.2.3 Replicate Sampling to Validate Initial HAPSITE Assessment

To further demonstrate the adequacy of the HAPSITE, replicate grab samples will be collected using pre-evacuated canisters from a subset of the locations sampled with the HAPSITE. Approximately one to two replicate canister samples will be collected each day the HAPSITE assessment is conducted. The replicate grab samples will be collected from both preferential pathway and building indoor air locations, with a preference for locations where the HAPSITE detects VOCs, if possible.

Canister samples will be collected into pre-evacuated, batch-certified 1-liter canisters (sewer gas) or individually certified 6-liter canisters (indoor air) equipped with a flow metering valve, to allow for a sample collection period of 1-minute. The samples will be collected at the same time as the 1-minute fill time of the HAPSITE. Additional information on collecting replicate grab samples is included in SOP-3 and SOP-4 (Appendix D).[25] The canister samples will be submitted to Eurofins Air Toxics, LLC (Eurofins) under typical chain-of-custody (COC) protocol for GC/MS analysis of the VOCs listed in Table 3-4, using the EPA TO-15 analytical method.

4.2.4 Passive Versus Canister Sampling Evaluation

During the initial assessment, a “passive versus canister” sampling evaluation will also be conducted to evaluate the passive samplers and the potential for interferences from VOCs actively or recently used onsite. This evaluation will include collecting co-located indoor air or sewer gas samples, including 3- to 5-day samples using passive samplers and 8-hour samples using canisters at up to three locations: (1) Building 14 control or lunch room, (2) one location at Building 62, and (3) a sewer manhole location where an 8-hour canister sample can be collected. The final locations will be determined based on the HAPSITE data. The passive samplers and canisters will be deployed concurrently, meaning that the 8-hour

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[24] This approach will be used for preferential pathway samples collected outside a building as the use of SSGSLs is not appropriate for screening indoor plumbing or unsealed sumps (WDNR 2021; EPA 2024b).

[25] Sewer gas samples are typically collected into 1-liter canisters. While indoor air samples are typically collected using 6-liter, individually certified canisters over several hours (commonly 8 or 24 hours), replicate grab indoor air samples will also be collected into 1-liter canisters. These replicate samples are intended for comparison with the HAPSITE data, and not for making risk-management decisions. Conventional indoor air sampling using 6-liter canisters or passive samplers is described in Section 4.3.1.

sampling period for the canister will correspond to the initial sampling period of the 3- to 5-day passive sampler.

The indoor air canister samples will be collected at breathing zone height approximately 5 feet above the building floor, into pre-evacuated, individually certified, 6-liter canisters equipped with flow controllers set for a sampling duration of 8 hours, as is typical in non-residential settings (WDNR 2018, Section 5.4.3). Additional details on collecting the indoor air canister samples are included in SOP-4 (Appendix D). The sewer gas canister sample will be collected into a pre-evacuated, individually certified, 6-liter canister equipped with a flow controller set for a sampling duration of 8 hours. The canister tubing will be placed approximately 1 to 2 feet above the top of the wastewater surface (or bottom of the manhole if dry), so that the tubing does not come in contact with the wastewater. Additional details on collecting the sewer gas canister samples are included in SOP-3 (Appendix D). The samples will be submitted to Eurofins under typical COC protocol for GC/MS analysis of the VOCs listed in Table 3-4, using the EPA TO-15 analytical method.

The 3- to 5-day passive samplers will be collected into passive samplers (for example, Beacon samplers [with hydrophobic sorbents and lower uptake rates] for sewer gas, and Radiello samplers [with lower reporting limits] for indoor air). For the indoor air samples, the samplers will be set at breathing zone height. For the sewer gas samples, the sampler will be deployed approximately 1 to 2 feet above the top of the wastewater surface (or bottom of the manhole if dry), so that the sampler does not come in contact with the wastewater. Additional details on collecting the indoor air and sewer gas passive samples are included in SOP-5 and SOP-3, respectively (Appendix D). The passive air samples will be submitted to Eurofins under typical COC protocol for GC/MS analysis of the VOCs listed in Table 3-4, using the EPA TO-17 analytical method.

4.3 Conventional VI Sampling

Two conventional VI sampling events will be conducted in the eight identified buildings using canisters or passive samplers[26] for collecting indoor air, outdoor air, and preferential pathway samples. SSSG samples will be collected using canisters, to the extent possible, as further described in Section 4.3.2.

Default proposed indoor air and SSSG sampling locations are shown on the building figures provided in Appendix E. Preferential pathway locations will be determined based on the HAPSITE investigation results; the selected sampling locations will likely be within the initial investigation area identified on Figure 3-1 and site utility figures are in Appendix C.

Table 3-8 provides a summary of building characteristics and proposed conventional VI sampling activities for each building. The proposed default sampling locations will be used assuming that the building configuration and operations, buried utility clearance survey, or HAPSITE results do not otherwise indicate that these locations should be adjusted. Even if some sampling locations are adjusted based on the HAPSITE results, there will still be a minimum number of samples per building as summarized in Table 3-8 and as further described in this section.

4.3.1 Indoor Air Sampling

The proposed indoor air sampling program at the eight buildings will include the following (also refer to Table 3-8 and the building figures in Appendix E):

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[26] Passive samplers are planned for sampling unless HAPSITE results or the passive versus canister sampling evaluation indicate that canister sampling is preferred at a specific location or building (for example, if issues with passive sampling such as sorbent saturation are encountered due to interferences from VOCs actively used onsite).

- One to six indoor air samples per building based on building size[27]
- One "crawlspace" air sample to be collected from under the trailer (Building 61) within its skirt-enclosed portion
- One duplicate indoor air sample per 10 samples
- Each building will have an outdoor (ambient) air sample collected concurrent with the indoor air samples, either upgradient of the building relative to the prevalent wind direction or near the building air intake, if readily accessible

Passive samplers (10-day) are planned for indoor air sampling unless HAPSITE results or the passive versus canister sampling evaluation (Section 4.2.4) indicates that canister sampling (8-hour) is preferred at a specific location or building. If canisters are used, they will be individually certified prior to use.

Indoor air sampling locations within each building will be adjusted, as needed, to focus on routinely occupied areas such as offices and breakrooms that are not used for manufacturing. As noted previously, the default proposed locations are tentative and may be adjusted based on the updated building survey, HAPSITE results, building configuration, field observations, and input from facility personnel.

The passive air samples will be collected in accordance with SOP-5 (Appendix D) and as previously described in Section 4.2.4. The canister samples, if used in lieu of passive sampling, will be collected in accordance with SOP-4 (Appendix D) and as previously described in Section 4.2.4.

The samples will be submitted to Eurofins under typical COC protocol for GC/MS analysis of the VOCs listed in Table 3-4, using the EPA TO-17 method (passive samplers) or TO-15 method (canisters).

The site is an active manufacturing site that is subject to OSHA regulations; for chemicals that remain actively used, indoor air samples will also be compared to applicable OSHA standards.[28]

4.3.2 Subslab Soil Gas Sampling

SSSG sampling is planned at seven of the buildings and the proposed SSSG sampling program will include the following (also refer to Table 3-8 and the building figures in Appendix E):

- One to six SSSG samples per building based on building size (except Building 14)[29]
- One duplicate SSSG sample per 10 samples
- For Building 14, only one sample is proposed in the limited portion of the building footprint outside the secondary containment

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[27] Neither WDNR nor EPA VI guidance specify the number of indoor air samples to be obtained for a given building surface area, and both indicate this number depends on site conditions (EPA 2015, Section 6.4.1; WDNR 2018, Section 5.5.2, Table 5c). We will follow EPA and WDNR guidance; however, the proposed number of samples is based on recommendations in New Jersey guidance (NJDEP 2021, Table 3-3).

[28] WDNR RR-800, Section 6.1, OSHA Regulated Settings (WDNR, 2018): When the contaminant of concern is also a chemical used in a manufacturing or commercial process, OSHA (Occupational Safety and Health Administration) standards or other occupational inhalation exposure guidelines apply to the occupational exposure in the indoor air as long as the entity continues to use the chemical in question. Once the OSHA standards or occupational exposure guidelines no longer apply at a building, then the indoor air must meet the vapor action levels discussed below.

[29] Neither WDNR nor EPA VI guidance specify the number of SSSG samples to be obtained for a given building surface area, and both indicate this number depends on site conditions (EPA 2015, Section 6.4.3; WDNR 2018, Section 5.5.2, Table 5c). We will follow EPA and WDNR guidance; however, the proposed number of samples is based on recommendations in New Jersey guidance (NJDEP 2021, Table 3-2).

- For Building 61, no SSSG will be collected (trailer with enclosed skirt); however, a crawlspace air sample will be collected (refer to Section 4.3.1)

Building 14 SSSG sampling locations were adjusted, and some locations may need to be adjusted or eliminated at the time of sampling based on the following:

- Presence of a vapor barrier designed to mitigate VI (for instance, the new addition on the west side of Building 14).
- Potential for damaging a concrete slab that acts as a secondary containment (for instance, the GWCTS at Building 14).
- Shallow water table that may be in contact with the building foundation, which limits the feasibility of collecting SSSG or exterior soil gas samples. Feasibility will be reassessed at the time of sampling based on current groundwater table elevations.

The SSSG samples will be collected using semi-permanent probes (vapor pins) installed in the buildings. Before installing these probes, utility and rebar clearance will be completed in accordance with SOP-6 (Appendix D). The SSSG samples will be collected into pre-evacuated, batch-certified 1-liter canisters equipped with flow controllers set to a flow rate of 200 milliliters per minute, corresponding to a sampling collection period of about 5 minutes. SSSG will be collected into a Tedlar bag during probe purging for field screening of total VOCs and other parameters (for example, oxygen, carbon dioxide, and methane) using a photoionization detector and a gas meter. Additional details on installing vapor probes are included in SOP-7, and details on collecting SSSG samples are included in SOP-8 (Appendix D). Removal of the vapor probes will not occur until after the sampling and reporting activities described herein are completed and approved by the agencies.

4.3.3 Preferential Pathway Sampling

Sewer gas samples will be collected from exterior manholes. As noted previously, the sampling locations will be identified and adjusted, as needed, based on the findings of the HAPSITE investigation. Passive samplers (5- to 10-day duration) are planned for sewer gas sampling unless the HAPSITE results or the passive versus canister sampling evaluation (Section 4.2.4) indicate that canister sampling is preferred. The use of canisters or passive samplers will also depend on site conditions as follows:

- Passive sampling: A passive sampler will be used when the manhole lid can be removed, or a hole is present in the lid that is large enough to put the sampler through, and the wastewater in the sewer is expected to stay at a fairly consistent level for a period of 5 to 10 days.
- 8-hour canister sampling: A canister will be used for collecting a sewer gas sample over a period of 8 hours when conditions prevent the use of a passive sampler.[30] The 8-hour canister can be placed in the manhole/access hole and the lid replaced, or if it is in a non-traffic area where tubing can be run through the lid, and the wastewater in the sewer is expected to stay at a fairly consistent level for a period of 8 hours.
- Grab canister sampling: A grab sample will be collected with a canister when neither condition above can be achieved.

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[30] As noted at the beginning of Section 4.3, passive samplers are planned for sampling unless HAPSITE results or the passive versus canister sampling evaluation indicate that canister sampling is preferred at a specific location or building (for example, issue with passive sampling due to interferences from VOCs actively used onsite). For preferential pathway sampling, site sewer conditions may also prevent the use of passive samplers (for example, variation in wastewater levels that could saturate the passive samplers with liquid and ruin the sample).

The appropriate approach for sampling preferential pathways other than sewer conduits, if identified, will be determined based on the location and type of media to sample.

Additional details on collecting sewer gas samples are included in SOP-3 (Appendix D) and as previously described in Sections 4.2.2, 4.2.3, and 4.2.4. For quality control (QC) purposes, 1 duplicate sample will be collected per 10 samples. The samples will be submitted to Eurofins under typical COC protocol for GC/MS analysis of the VOCs listed in Table 3-4, using the EPA TO-17 method (for passive samplers) or TO-15 method (for canisters).

4.4 Water Sampling

Groundwater samples will be collected from building sumps — if such sumps are encountered and found to contain groundwater — to further evaluate VI potential from the shallow groundwater. The samples will be analyzed for the VOC analytical list used for other monitoring wells at the site. The sampling results will be compared to the groundwater VRSLs and PALs.

Because Building 14 is an active groundwater and wastewater treatment facility, water undergoing treatment could off-gas and contribute VOCs to the building indoor air, which would be unrelated to subsurface VI. Therefore, concurrent with the indoor air sampling event, water influent samples will be collected and analyzed for the VOC analytical list used for other monitoring wells at the site. For reference, the sampling results will be compared to the groundwater VRSLs and PALs; however, the primary objective of these samples is to establish whether target VOCs in Table 3-4 are present.

4.5 Sample Management and Quality Assurance

This subsection summarizes project requirements related to sampling procedures, analytical methods, field QC, sample nomenclature, equipment decontamination, and data validation. Updates to the Quality Assurance Project Plan (QAPP) (Earth Tech, Inc. 2006) are being prepared to include VI investigation samples as part of a QAPP, Addendum 5 (forthcoming), which presents the site-specific quality assurance(QA)/QC requirements to verify that environmental data collected for the site are of appropriate quality to achieve project objectives.

- **Sampling Procedures**: VI investigation data collection requirements are outlined in the SOPs provided in Appendix D.
- **Laboratory Analyses and Procedures**: Laboratory tasks will be described in the QAPP, Addendum 5 (forthcoming) and indicate the required analytical methods, sample containers, and holding times for VI investigation samples. Data quality will be evaluated based on precision, accuracy, representativeness, completeness, and comparability as described in the QAPP (Earth Tech, Inc. 2006).
- **Field QC**: Field QC samples will consist of field duplicate samples collected to monitor the precision of the field sampling process. One field duplicate will be collected for every 10 field samples per sample media (or 1 per event per media if fewer than 10 samples per media were collected).
- **Sample Nomenclature**: A sample nomenclature system will be used to identify each sample, including QA/QC samples. The sample identifier will be unique for each sample. The unique sample identifier will be used for tracking each sample within the COC, database, and subsequent reports. Regardless of analytical protocol, each sample also will be assigned a site-specific identifier that will be included on the sample label and COC record. The site-specific identifier is based on the following system:
    - Building Code or Preferential Pathway Code = BD014 (based on site building number) or PP001 (assigned in the field)

- Location Code = Vapor point identification as follows: indoor air (IA), outdoor air (OA), sub-slab (SS), crawl space (CS), sump (SP), manhole (MH), entry point (EP), background source (BS), influent for groundwater (IG), and influent for wastewater (IW) with 3-digit number following
- Date = MMDDYYYY
- Type = The type of sample will follow the date
  - N – Parent Sample for laboratory analysis
  - FD – Field Duplicate for laboratory analysis
  - QC – Quality control (used for trip blank for liquid samples) for laboratory analysis
  - H – Parent Sample for HAPSITE analysis
  - HD – Field Duplicate for HAPSITE analysis
- Matrix = “AA” for outdoor (ambient) air, “AI” for indoor air, “AS” for subslab air (SSSG), “GS” for sewer gas, “WG” for groundwater, and “WW” for wastewater

For example, an outdoor air sample from location OA-001 near Building 14 collected on January 2, 2024, is identified as follows: **BD014-OA001_01022024_N_AA**. The sample identification numbers will be affixed to each sample container before sample collection, then recorded on the COC form.

- **Field Documentation**: Field logbook entries will be completed to document activities at each sampling location. Items documented in the logbook include location identification, sample collection time, sample identification, sample collection method, associated QC field samples collected at the location, notable observations during sampling, and other pertinent field observations. The field logbook will also document deviations from the plan. The field forms included in the SOPs (Appendix D) will also be completed to document each sample collected.

4.6 Management of Investigation-Derived Waste

Investigation-derived waste generated during this field event will include miscellaneous solid waste (for example, disposable personal protective equipment such as gloves, paper towels), which will be placed in trash bags and disposed of as ordinary solid waste at the site. No soil waste is expected to be generated during this investigation program.

4.7 Health and Safety

Work will be conducted in accordance with a health and safety plan (HASP) by staff with current OSHA Hazardous Waste Operations and Emergency Response training. In general, work will be performed in Level D personal protective equipment, which includes (as needed) a reflective vest, safety glasses, hard hat, chemical-resistant gloves, and steel-toed boots. A hospital route map, driving directions, and additional health and safety information will be included in the HASP.

The field team leader or site safety coordinator will conduct a health and safety meeting daily before beginning work to discuss the work items and worker responsibilities and to familiarize workers with the HASP. Each team member will be responsible for abiding by the health and safety requirements set forth in the HASP. All site personnel will sign the HASP before conducting work. The field team leader will fill out a pre-task safety plan daily before starting any work and safe work observation forms at a minimum of once per week during the event.

A photoionization detector will be used during field activities to monitor workers’ breathing zones. If at any time hazardous concentrations are recorded, site personnel will cease work and back out of the area. Work will resume when the breathing zone is deemed safe via additional monitoring with the photoionization detector.

5. Field Schedule

Three field events will occur. The initial mobilization is tentatively scheduled for winter/early spring 2025. The follow-up conventional sampling events would follow in spring/summer 2025 and in fall 2025. This schedule is subject to review and approval of this 2025 Work Plan by the agencies, and the timing of agency approval.

6. Reporting

The findings of this assessment will be documented along with recommendations in an investigation report to be provided to EPA and WDNR. The deliverables will generally follow requirements set forth in WDNR VI guidance (Table 2b in WDNR 2018), including the following:

- Notification of sampling results to be provided to EPA and WDNR within 30 days of receipt of results, along with contact information, a map of sampling locations, a copy of the laboratory report(s), and other pertinent information (WDNR 2014, Section V). Notification of sampling results will be made within 10 business days of receipt of results for a building where an exceedance of VALs is observed and is attributable to VI.
- A site investigation report, which will include a narrative describing the methods and findings, summary figures and tabulated data, and copies of the analytical laboratory reports, sampling records, and data validation reviews. The report will be submitted within 60 days after completing the field investigation (3rd sampling event) and receipt of all laboratory data.

The site investigation report will include recommendations for additional activities, if warranted by findings, such as follow-up sampling or mitigation measures other than the planned repeat VI sampling as described in Section 4.

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Tables

Table 2-1. June and October 2024 Main Plant Contained Area Groundwater and Ground Surface Elevations

Tyco Fire Products LP, Marinette, Wisconsin

Well ID	Ground Surface Elevation	Corrected Groundwater Elevation (for equivalent fresh water)		Feet Below Ground Surface	
		June 17, 2024	October 8, 2024	June 17, 2024	October 8, 2024
MW004S	587.29	584.06	581.93	3.23	5.36
MW009S	583.35	582.64	581.06	0.71	2.29
MW012S	585.72	583.93	No Data	1.79	N/A
MW032S	586.89	583.70	581.66	3.19	5.23
MW033S	587.81	583.99	581.85	3.82	5.96
MW039S	586.57	584.12	581.98	2.45	4.59
MW041S	583.46	582.49	581.24	0.97	2.22
MW044S-R	584.45	583.75	No Data	0.70	N/A
MW045S	582.90	582.25	580.98	0.65	1.92
MW064S	586.03	583.49	581.43	2.54	4.60
MW067S	586.03	582.47	No Data	3.56	N/A
MW068S	583.33	582.48	581.09	0.85	2.24
MW103S	585.98	580.00	No Data	5.98	N/A
MW105S-R	583.34	582.06	580.86	1.28	2.49
MW106S	583.21	582.00	580.63	1.21	2.58
MW107S	583.02	582.49	No Data	0.53	N/A
MW108S	584.74	582.69	581.15	2.05	3.59
MW117S	582.85	582.33	581.09	0.52	1.76
MW118S	583.27	582.38	581.15	0.89	2.12
MW121S	583.02	582.32	581.06	0.70	1.96
MW122S	582.82	582.38	No Data	0.44	N/A
MW123S	583.66	582.37	No Data	1.29	N/A
MW124S	583.14	583.07	No Data	0.07	N/A

Notes:

Only shallow wells with surveyed ground elevations and 2024 measurements in the Main Plant contained area are shown.

Elevations are reported in feet above mean sea level (AMSL) relative top the North American Vertical Datum (NAVD) 1988.

Negative feet below ground surface result means water could be at or above the ground surface.

ID = identification

MW = Monitoring Well

N/A = not applicable

No Data = water level was not collected

Table 3-1. Variables Used for Developing VRSLs

Tyco Fire Products LP, Marinette, Wisconsin

Variable	Exposure Scenarios	
	Onsite Worker (Commercial)	**Onsite Worker (Shallow Water Table)**
Exposure Time (hours/day)	8	8
Exposure Frequency (days/year)	250	250
Exposure Duration (years)	25	25
Lifetime Duration (years)	70	70
Groundwater-to-Indoor Air Attenuation Factor	10^{-4}	10^{-3}
Groundwater Temperature	10^{o}C (50^{o}F)	10^{o}C (50^{o}F)
Target Non-Cancer Hazard Index	1	1
Target Cancer Risk	10^{-5}	10^{-5}

Notes:

These variables do not apply for the VRSL for trichloroethene (TCE) for which the Wisconsin Administrative Code § NR 140 enforcement standards (ES) of 5 micrograms per liter (µg/L) was used (WDNR 2017, Table 1).

^{o}C =degree(s) Celsius

^{o}F = degree(s) Fahrenheit

VRSL = vapor risk screening level

Table 3-2. Volatile Organic Compound Analytical Data - Shallow Groundwater

Tyco Fire Products LP, Marinette, Wisconsin

VOCs (µg/L)+	WDNR PAL	WDNR ES	WDNR Adjusted Industrial VRSL	Shallow Water Table VRSL	Max Conc	Main Plant Along River from West to East MW067S 6/27/2019	GW005S*** 9/8/2000	MW117S 6/27/2019	MW117S 6/19/2023	MW045S 5/3/2018	MW045S 6/19/2023	TW001*** 10/29/2009	MW041S 5/3/2018**	MW041S 6/19/2023	MW006S*** 10/29/2009	MW118S 6/27/2019
Benzene	**0.5**	5	1,360	136	82	**47**	**12**	**22**	**16**	**76**	**32**	51.2 U	**48** J	**3.6**	1 U	0.15 U
Chlorobenzene	**20**	100	39,300	3,930	1,800	**1,800**	**26**	**370**	**330**	**3,800**	**1,500**	51.2 U	**1,500** J	**340**	**507**	2.7
Chloroform	0.6	6	663	66.3	0.45	7.4 U	1.7 U	0.74 U	0.37 U	7.4 U	0.37 U	162 U	7.4 UJ	0.37 U	3.2 U	0.37 U
Chloroethane	80	400	623,000	62,300	4.4	10 U	7.3 U	1.0 U	0.51 U		0.51 U	121 U	10 UJ	0.51 U	2.4 U	0.51 U
Chloromethane	**3**	30	15,900	1,590	82.1	6.4 U	1.8 U	0.64 U	0.32 U		0.32 U	30 U	6.4 UJ	0.32 U	**26.1**	0.32 U
1,2-Dichlorobenzene	**60**	600	294,000	29,400	1,800	**1,100**	**130**	38		**1,800**		104 U	**170** J		**105**	1.3
1,3-Dichlorobenzene	120	600	-	-	13	8.0 U	2 U	0.80 U		13 J		109 U	8 UJ		2.2 U	0.40 U
1,4-Dichlorobenzene	**15**	75	2,990	299	84	**35**	1.9 U	3.7		**84**		119 U	**24** J		9.7	0.36 U
Dichlorodifluoromethane	200	1,000	435	43.5	19	13 U	1.7 U	1.3 U	1.9 J	13 U	0.67 U	124 U	13 UJ	0.86 J	2.5 U	0.67 U
1,2-Dichloroethane	**0.5**	5	1,990	199	16.1	7.8 U	2.1 U	0.78 U	0.39 U	**18** J	0.39 U	45 U	7.8 UJ	0.39 U	0.9 U	0.39 U
cis-1,2-Dichloroethene	**7**	70	20,000	2,000	390	**230**		1.8 J		**390**			8.2 UJ			0.41 U
trans-1,2-Dichloroethene	20	100	8,380	838	1.8	7.0 U	1.8 U	1.3 J	0.51 J	7 U	1.8	111 U	7 UJ	0.44 J	2.2 U	0.35 U
Isopropyl ether			562,000	56,200	2.5					5.5 U			5.5 UJ			
Ethylbenzene	**140**	700	3,590	359	12,600	**300**	2.6 J	7.4	2.8	**1,200**	**220**	**12,600**	**1,500** J	77	1.4 U	0.18 U
Isopropylbenzene (Cumene)			110,000	11,000	9.2					7.7 U			9.2 J			
p-Isopropyltoluene			26,000	2,600	8.5					8.5 J			7.2 UJ			
Methylene Chloride	**0.5**	5	353,000	35,300	7,400	**7,400**	**26**	3.3 U	1.6 U	**110**	**5,500**	**94.9** J	33 UJ	1.6 U	1.1 U	1.6 U
Methyl tert-butyl ether	12	60	358,000	35,800	0.64					7.9 U			7.9 UJ			
Naphthalene	**10**	100	6,010	601	351	**14** J	**13**	0.67 U		**26**		111 U	6.7 UJ		2.2 U	0.34 U
Toluene	**160**	800	1,740,000	174,000	10,700	**1,500**	25	1.1 JB	1 JB	**3,900**	**620**	**10,700**	52 J	5.4	1.7 U	0.16 JB
Trichloroethene	**0.5**	5	5	5	100	**100**	**16**	0.33 U	0.2 J	**56**	**27**	60 U	3.3 UJ	**1.3**	1.2 U	0.16 U
Vinyl chloride	**0.02**	0.2	355	35.5	30	**30**	**24**	**1.5** J	**0.95** J	**32**	**6**	22.5 U	4.1 UJ	**1.1**	0.45 U	**0.20** J
Xylenes, Total*	**400**	2,000	38,200	3,820	44,800	**2,100**	10.6 J	1.7 J	0.94 J	**7,600**	**2,200**	**44,800**	**9,100** J	**410**	4.5 U	0.22 U
Carbon disulfide	200	1,000	89,900	8,990	1.3	9.0 U	1.7 U	0.90 U	0.45 U	9 U	0.71 J	82.5 U	9 UJ	0.45 U	1.6 U	0.45 U
Acetone	1,800	9,000	-	-	1,500	1,500	55 U	3.5 U	10 UB	**3,900**	680	624 U	35 UJ	31	12.5 U	15
4-Methyl-2-pentanone (MIBK)	**50**	500	53,200,000	5,320,000	210	**62** J	**210**	4.3 U	2.2 U	**130**	32	150 U	43 J	2.2 U	3 U	2.2 U
2-Butanone (MEK)	800	4,000	190,000,000	19,000,000	38	42 U	8.9 U	4.2 U	2.1 U	130	20	538 U	42 UJ	2.1 U	10.8 U	2.1 U

Shading and Border Notes:

🟦	Blue shading or border exceeds shallow water table VRSL screening criteria (adjustment for risk to 10^{-5}, and temperature of 10°C, and modified industrial groundwater attenuation factor to account for shallow water table 10^{-3})
🟩	Green shading or border exceeds Industrial VRSL screening criteria (adjustment for risk to 10^{-5}, temperature of 10°C, and industrial groundwater attenuation factor 10^{-4})
🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

Bolded values indicate attainment or exceedance of the Wisconsin Administrative Code (WAC) NR 140 Preventative Action Limit (PAL).

Bolded and gray shaded values indicate attainment or exceedance of WAC NR 140 Enforcement Standard

Table 3-2. Volatile Organic Compound Analytical Data - Shallow Groundwater

Tyco Fire Products LP, Marinette, Wisconsin

VOCs (µg/L)+	WDNR PAL	WDNR ES	WDNR Adjusted Industrial VRSL	Shallow Water Table VRSL	Max Conc	GW008S***	GW008S (GW Grab)	MW108S		TW002***	TW002 (GW Grab)	MW010S***	MW124S	GW051S***
						9/13/2000	6/9/2019**	6/27/2019	6/19/2023	10/29/2009	6/12/2019	10/29/2009	6/26/2019	9/26/2000
Benzene	**0.5**	5	1,360	136	82	2.9 U	0.15 U	**86**	**82**	10.2 U	**6.7** J	**6.5** J	**2.2**	9.2 U
Chlorobenzene	**20**	100	39,300	3,930	1,800	**130**	**63**	**210**	**430**	**991**	**750** J	**190**	**330**	**52**
Chloroform	0.6	6	663	66.3	0.45	4.3 U	0.37 U	0.37 U	0.37 U	32.5 U	0.37 UJ	13 U	0.37 U	8.6 U
Chloroethane	80	400	623,000	62,300	4.4	11 U	0.51 U	0.51 U	0.51 U	24.2 U	0.51 UJ	9.7 U	0.51 U	37 U
Chloromethane	**3**	30	15,900	1,590	82.1	2.3 U	0.32 U	0.32 U	0.32 U	6 U	0.32 UJ	**82.1**	0.32 U	9 U
1,2-Dichlorobenzene	**60**	600	294,000	29,400	1,800	**110**	**240** J	**110**		20.8 U	4.5 J	**1,400**	**370**	**98**
1,3-Dichlorobenzene	120	600	-	-	13	2 U	1.3	0.40 U		21.8 U	0.40 UJ	8.7 U	0.76 J	10 U
1,4-Dichlorobenzene	**15**	75	2,990	299	84	**17**	**17**	0.36 U		23.8 U	0.36 UJ	**26**	8.5	9.4 U
Dichlorodifluoromethane	200	1,000	435	43.5	19	8.2 J	14.0	0.67 U	0.67 U	24.8 U	0.67 UJ	9.9 U	1.1 J	8.4 U
1,2-Dichloroethane	**0.5**	5	1,990	199	16.1	3.6 U	0.39 U	0.39 U	0.39 U	9 U	0.39 UJ	**16.1** J	**7.1**	10 U
cis-1,2-Dichloroethene	**7**	70	20,000	2,000	390		0.41 U	0.41 U			0.41 UJ		0.41 U	
trans-1,2-Dichloroethene	20	100	8,380	838	1.8	3.8 U	0.35 U	0.35 U	0.35 U	22.2 U	0.35 UJ	8.9 U	0.35 U	9.2 U
Isopropyl ether			562,000	56,200	2.5									
Ethylbenzene	**140**	700	3,590	359	12,600	2.3 U	0.18 U	16	51	**357**	10 J	133	8.5	**150**
Isopropylbenzene (Cumene)			110,000	11,000	9.2									
p-Isopropyltoluene			26,000	2,600	8.5									
Methylene Chloride	**0.5**	5	353,000	35,300	7,400	4.3 U	1.6 U	**10**	**9.3** JB	**20.3** J	1.6 UJ	**8** J	**2.0** J	9 U
Methyl tert-butyl ether	12	60	358,000	35,800	0.64									
Naphthalene	**10**	100	6,010	601	351	**16** J	0.34 U	**180**		22.2 U	0.34 UJ	**351**	**63**	14 U
Toluene	**160**	800	1,740,000	174,000	10,700	3.6 U	28	5.8	5.3	16.8 U	6.0 J	131	2.8 JB	**230**
Trichloroethene	**0.5**	5	5	5	100	3.2 U	0.16 U	0.16 U	**1.8**	12 U	0.16 UJ	4.8 U	0.16 U	8.4 U
Vinyl chloride	**0.02**	0.2	355	35.5	30	2.8 U	0.20 U	0.20 U	0.2 U	4.5 U	0.20 UJ	1.8 U	**0.75** J	7.7 U
Xylenes, Total*	**400**	2,000	38,200	3,820	44,800	4.6 U	0.22 U	46	53	**3,430**	9.4 J	**1,258**	160	**1,780**
Carbon disulfide	200	1,000	89,900	8,990	1.3	3.7 U	0.45 U	0.97 J	1.3 J	16.5 U	0.45 UJ	6.6 U	0.57 J	8.6 U
Acetone	1,800	9,000	-	-	1,500	110 U	190 J	110	13 JB	125 U	80 J	668	1.7 U	500
4-Methyl-2-pentanone (MIBK)	**50**	500	53,200,000	5,320,000	210	12 U	2.2 U	3.4 J	2.2 U	30 U	2.2 UJ	12 U	2.9 J	**140**
2-Butanone (MEK)	800	4,000	190,000,000	19,000,000	38	23 UR	2.1 U	2.6 J	2.1 U	108 U	5.4 J	43 U	2.1 U	44 U

Shading and Border Notes:

🟦	Blue shading or border exceeds shallow water table VRSL screening criteria (adjustment for risk to 10^{-5}, and temperature of 10°C, and modified industrial groundwater attenuation factor to account for shallow water table 10^{-3})
🟩	Green shading or border exceeds Industrial VRSL screening criteria (adjustment for risk to 10^{-5}, temperature of 10°C, and industrial groundwater attenuation factor 10^{-4})
🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

Bolded values indicate attainment or exceedance of the Wisconsin Administrative Code (WAC) NR 140 Preventative Action Limit (PAL).

Bolded and gray shaded values indicate attainment or exceedance of WAC NR 140 Enforcement Standard

Table 3-2. Volatile Organic Compound Analytical Data - Shallow Groundwater

Tyco Fire Products LP, Marinette, Wisconsin

						Main Plant Western Boundary			Main Plant Southern Boundary and Interior Locations from West to East							
VOCs (µg/L)+	WDNR PAL	WDNR ES	WDNR Adjusted Industrial VRSL	Shallow Water Table VRSL	Max Conc	MW003S	MW009S	GW040S	MW042S	MW043S	MW011S	MW114S	MW044S	MW054S	MW064S	MW065S
						6/26/2019**	10/27/2009	9/20/2000	10/28/2009	6/25/2019	6/26/2019	6/30/2021	10/29/2009	6/30/2021**	10/28/2009	10/28/2009
Benzene	**0.5**	5	1,360	136	82	**3.3**	0.41 U	**0.36** J	0.41 U	0.15 U	**1.1**	**0.85**	0.41 U	**4.1**	**0.5** J	0.41 U
Chlorobenzene	**20**	100	39,300	3,930	1,800	**29**	0.41 U	0.13 U	0.41 U	0.39 U	**150**	**23**	0.41 U	0.39 U	0.41 U	0.41 U
Chloroform	0.6	6	663	66.3	0.45	0.37 U	1.3 U	0.21 U	1.3 U	0.37 U	0.37 U	0.37 U	1.3 U	0.37 U	1.3 U	1.3 U
Chloroethane	80	400	623,000	62,300	4.4	0.51 U	0.97 U	0.75 J	0.97 U	0.51 U	0.51 U	4.4	0.97 U	0.51 U	0.97 U	0.97 U
Chloromethane	**3**	30	15,900	1,590	82.1	0.32 U	0.24 U	0.12 U	0.24 U	0.32 U	0.32 U	0.32 U	**3.5**	0.32 U	0.24 U	0.24 U
1,2-Dichlorobenzene	**60**	600	294,000	29,400	1,800	1.4	0.83 U	0.2 UJ	0.83 U	0.33 U	25	1.6	0.83 U	0.33 U	0.83 U	0.83 U
1,3-Dichlorobenzene	120	600	-	-	13	0.40 U	0.87 U	0.1 U	0.87 U	0.40 U	1.8	0.40 U	0.87 U	0.40 U	0.87 U	0.87 U
1,4-Dichlorobenzene	**15**	75	2,990	299	84	0.36 U	0.95 U	0.13 U	0.95 U	0.36 U	**21**	0.36 U	0.95 U	0.36 U	0.95 U	0.95 U
Dichlorodifluoromethane	200	1,000	435	43.5	19	0.67 U	0.99 U	0.13 U	0.99 U	0.67 U	0.67 U	0.67 U	0.99 U	1.2 J	0.99 U	0.99 U
1,2-Dichloroethane	**0.5**	5	1,990	199	16.1	**1.4**	0.36 U	0.18 U	0.36 U	0.39 U	0.39 U	0.39 U	0.36 U	0.39 U	0.36 U	0.36 U
cis-1,2-Dichloroethene	**7**	70	20,000	2,000	390	2.4				0.41 U	0.41 U	0.41 U		0.41 U		
trans-1,2-Dichloroethene	20	100	8,380	838	1.8	0.35 U	0.89 U	0.19 U	0.89 U	0.35 U	0.35 U	0.35 U	0.89 U	0.35 U	0.89 U	0.89 U
Isopropyl ether			562,000	56,200	2.5							2.5		0.28 U		
Ethylbenzene	**140**	700	3,590	359	12,600	0.97	0.54 U	0.12 U	0.54 U	0.18 U	0.18 U	0.19 J	0.54 U	0.18 U	0.54 U	0.54 U
Isopropylbenzene (Cumene)			110,000	11,000	9.2							0.39 U		0.39 U		
p-Isopropyltoluene			26,000	2,600	8.5							0.90 J		0.36 U		
Methylene Chloride	**0.5**	5	353,000	35,300	7,400	1.6 U	0.43 U	0.22 U	0.43 U	1.6 U	1.6 U	**2.8** J	0.43 U	1.6 U	0.43 U	0.43 U
Methyl tert-butyl ether	12	60	358,000	35,800	0.64							0.64 J		0.39 U		
Naphthalene	**10**	100	6,010	601	351	0.37 J	0.89 U	0.34 J	0.89 U	0.34 U	0.34 U	0.34 U	0.89 U	0.34 U	0.89 U	0.89 U
Toluene	**160**	800	1,740,000	174,000	10,700	0.39 JB	0.67 U	0.3 UJ	0.67 U	0.15 U	0.38 JB	1.1	0.67 U	0.15 U	0.67 U	0.67 U
Trichloroethene	**0.5**	5	5	5	100	0.16 U	0.48 U	0.16 U	0.48 U	0.16 U	0.16 U	0.16 U	0.48 U	0.16 U	0.48 U	0.48 U
Vinyl chloride	**0.02**	0.2	355	35.5	30	**1.3**	0.18 U	0.14 U	0.18 U	0.20 U	0.20 U	0.20 U	0.18 U	0.20 U	0.18 U	0.18 U
Xylenes, Total*	**400**	2,000	38,200	3,820	44,800	0.33 JB	1.8 U	0.41 J	1.8 U	0.22 U	0.23 JB	0.67 J	1.8 U	0.29 J	1.8 U	1.8 U
Carbon disulfide	200	1,000	89,900	8,990	1.3	0.45 U	0.66 U	0.18 U	0.66 U	0.45 U	0.45 U		0.66 U		0.66 U	0.66 U
Acetone	1,800	9,000	-	-	1,500	14 J	5 U	5.5 U	5 U	1.7 U	1.7 U		5 U		5 U	5 U
4-Methyl-2-pentanone (MIBK)	**50**	500	53,200,000	5,320,000	210	2.2 U	1.2 U	0.58 U	1.2 U	2.2 U	2.2 U		1.2 U		1.2 U	1.2 U
2-Butanone (MEK)	800	4,000	190,000,000	19,000,000	38	2.1 U	4.3 U	1.1 UR	4.3 U	2.1 U	2.1 U		4.3 U		4.3 U	4.3 U

Shading and Border Notes:

🟦	Blue shading or border exceeds shallow water table VRSL screening criteria (adjustment for risk to 10^{-5}, and temperature of 10°C, and modified industrial groundwater attenuation factor to account for shallow water table 10^{-3})
🟩	Green shading or border exceeds Industrial VRSL screening criteria (adjustment for risk to 10^{-5}, temperature of 10°C, and industrial groundwater attenuation factor 10^{-4})
🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

Bolded values indicate attainment or exceedance of the Wisconsin Administrative Code (WAC) NR 140 Preventative Action Limit (PAL).

Bolded and gray shaded values indicate attainment or exceedance of WAC NR 140 Enforcement Standard

Table 3-2. Volatile Organic Compound Analytical Data - Shallow Groundwater

Tyco Fire Products LP, Marinette, Wisconsin

VOCs (µg/L)+	WDNR PAL	WDNR ES	WDNR Adjusted Industrial VRSL	Shallow Water Table VRSL	Max Conc													Background	
						GW012S		GW032S		GW050S		GW033S		GW004S		MW039S		MW013S	
						6/25/2019		9/18/2000		9/22/2000**		9/18/2000		6/27/2019		10/30/2009		10/27/2009	
Benzene	**0.5**	5	1,360	136	82	0.29	J	**2.1**	J	**1.5**		**0.25**	J	0.15	U	0.41	U	0.41	U
Chlorobenzene	**20**	100	39,300	3,930	1,800	0.77	J	**43**		0.74	UJ	0.13	U	6.5		13.4		0.41	U
Chloroform	0.6	6	663	66.3	0.45	0.37	U	2.1	U	0.45	J	0.21	U	0.37	U	1.3	U	1.3	U
Chloroethane	80	400	623,000	62,300	4.4	0.51	U	5.7	U	0.57	U	0.57	U	0.51	U	0.97	U	0.97	U
Chloromethane	**3**	30	15,900	1,590	82.1	0.32	U	1.2	U	0.12	U	0.12	U	0.32	U	0.24	U	0.24	U
1,2-Dichlorobenzene	**60**	600	294,000	29,400	1,800	9.6		**250**		0.27	UJ	20		0.43	J	1.4		0.83	U
1,3-Dichlorobenzene	120	600	-	-	13	0.40	U	1.5	J	0.1	U	1.5		0.40	U	0.87	U	0.87	U
1,4-Dichlorobenzene	**15**	75	2,990	299	84	0.36	U	4.9		0.13	U	7.2		0.80	J	0.95	U	0.95	U
Dichlorodifluoromethane	200	1,000	435	43.5	19	19		2.7	J	0.13	U	0.13	U	0.67	U	0.99	U	0.99	U
1,2-Dichloroethane	**0.5**	5	1,990	199	16.1	0.39	U	1.8	U	0.18	U	0.18	U	0.39	U	0.36	U	0.36	U
cis-1,2-Dichloroethene	**7**	70	20,000	2,000	390	0.43	J							0.41	U				
trans-1,2-Dichloroethene	20	100	8,380	838	1.8	0.35	U	1.9	U	0.19	U	0.19	U	0.35	U	0.89	U	0.89	U
Isopropyl ether			562,000	56,200	2.5														
Ethylbenzene	**140**	700	3,590	359	12,600	0.18	U	2.6	J	0.78		0.14	J	0.18	U	0.54	U	0.54	U
Isopropylbenzene (Cumene)			110,000	11,000	9.2														
p-Isopropyltoluene			26,000	2,600	8.5														
Methylene Chloride	**0.5**	5	353,000	35,300	7,400	1.6	U	2.2	U	**2,700**		**1.4**		1.6	U	0.43	U	0.43	U
Methyl tert-butyl ether	12	60	358,000	35,800	0.64														
Naphthalene	**10**	100	6,010	601	351	0.34	U	2.3	U	0.23	U	2.7		0.50	JB	0.89	U	0.89	U
Toluene	**160**	800	1,740,000	174,000	10,700	0.15	U	1.8	U	1.6		65		0.15	U	0.67	U	0.67	U
Trichloroethene	**0.5**	5	5	5	100	0.16	U	1.6	U	0.16	U	0.16	U	0.16	U	0.48	U	0.48	U
Vinyl chloride	**0.02**	0.2	355	35.5	30	0.20	U	1.4	U	0.14	U	0.14	U	0.20	U	0.18	U	0.18	U
Xylenes, Total*	**400**	2,000	38,200	3,820	44,800	0.22	U	2.3	U	0.23	U	0.32	J	0.22	U	1.8	U	1.8	U
Carbon disulfide	200	1,000	89,900	8,990	1.3	0.45	U	1.8	U	0.18	U	0.18	U	0.45	U	0.66	U	0.66	U
Acetone	1,800	9,000	-	-	1,500	1.7	U	160		330		21		1.7	U	5	U	5	U
4-Methyl-2-pentanone (MIBK)	**50**	500	53,200,000	5,320,000	210	2.2	U	43		0.82	J	0.58	U	2.2	U	1.2	U	1.2	U
2-Butanone (MEK)	800	4,000	190,000,000	19,000,000	38	2.1	U	11	UR	38	J	1.7	J	2.1	U	4.3	U	4.3	U

Shading and Border Notes:

🟦	Blue shading or border exceeds shallow water table VRSL screening criteria (adjustment for risk to 10^{-5}, and temperature of 10°C, and modified industrial groundwater attenuation factor to account for shallow water table 10^{-3})
🟩	Green shading or border exceeds Industrial VRSL screening criteria (adjustment for risk to 10^{-5}, temperature of 10°C, and industrial groundwater attenuation factor 10^{-4})
🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

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Table 3-2. Volatile Organic Compound Analytical Data - Shallow Groundwater

Tyco Fire Products LP, Marinette, Wisconsin

						Former Salt Vault						Former 8th Street Slip		Wetlands Area											
						MW020S* **		**GW029S*** **		**MW115S**		**MW034S**		**GW021S**		**MW046S**		**GW047S**		**GW049S**		**MW022S**		**MW048S**	
VOCs (µg/L)+	**WDNR PAL**	**WDNR ES**	**WDNR Adjusted Industrial VRSL**	**Shallow Water Table VRSL**	**Max Conc**	**10/30/2009****		**9/19/2000**		**6/26/2019**		**10/30/2009**		**9/20/2000**		**10/28/2009**		**9/25/2000**		**9/26/2000**		**10/28/2009**		**10/27/2009**	
Benzene	**0.5**	5	1,360	136	82	**2.1**		9.2	U	**0.97**		0.41	U	**0.42**	J	0.41	U	**2**		0.18	U	0.41	U	0.41	U
Chlorobenzene	**20**	100	39,300	3,930	1,800	**27.9**		**140**		16		0.41	U	0.13	U	0.41	U	0.19	U	0.19	U	0.41	U	0.41	U
Chloroform	0.6	6	663	66.3	0.45	1.3	U	8.6	U	0.37	U	1.3	U	0.21	U	1.3	U	0.17	U	0.17	U	1.3	U	1.3	U
Chloroethane	80	400	623,000	62,300	4.4	0.97	U	37	U	0.51	U	0.97	U	0.57	U	0.97	U	0.73	U	0.73	U	0.97	U	0.97	U
Chloromethane	**3**	30	15,900	1,590	82.1	0.24	U	9	U	0.32	U	0.24	U	0.12	U	0.98	J	0.18	U	0.18	U	0.24	U	0.24	U
1,2-Dichlorobenzene	**60**	600	294,000	29,400	1,800	33		**220**		36		0.83	U	0.15	UJ	0.83	U	0.18	U	0.18	U	0.83	U	0.83	U
1,3-Dichlorobenzene	120	600	-	-	13	0.87	U	10	U	0.40	U	0.87	U	0.1	U	0.87	U	0.2	U	0.2	U	0.87	U	0.87	U
1,4-Dichlorobenzene	**15**	75	2,990	299	84	0.95	U	9.4	U	0.36	U	0.95	U	0.13	U	0.95	U	0.19	U	0.19	U	0.95	U	0.95	U
Dichlorodifluoromethane	200	1,000	435	43.5	19	5.2		8.4	U	0.67	U	0.99	U	0.13	U	0.99	U	0.17	U	0.17	U	0.99	U	0.99	U
1,2-Dichloroethane	**0.5**	5	1,990	199	16.1	0.36	U	10	U	0.39	U	0.36	U	0.18	U	0.36	U	0.21	U	0.21	U	0.36	U	0.36	U
cis-1,2-Dichloroethene	**7**	70	20,000	2,000	390					0.41	U														
trans-1,2-Dichloroethene	20	100	8,380	838	1.8	0.89	U	9.2	U	0.35	U	0.89	U	0.19	U	0.89	U	0.18	U	0.18	U	0.89	U	0.89	U
Isopropyl ether			562,000	56,200	2.5																				
Ethylbenzene	**140**	700	3,590	359	12,600	2.5		**240**		1.3		0.54	U	0.12	U	0.54	U	1.2		0.21	U	0.54	U	0.54	U
Isopropylbenzene (Cumene)			110,000	11,000	9.2																				
p-Isopropyltoluene			26,000	2,600	8.5																				
Methylene Chloride	**0.5**	5	353,000	35,300	7,400	**0.5**	J	9	U	1.6	U	**0.51**	J	0.22	U	0.43	U	0.18	U	0.18	U	0.43	U	0.43	U
Methyl tert-butyl ether	12	60	358,000	35,800	0.64																				
Naphthalene	**10**	100	6,010	601	351	**10.9**		14	U	0.58	J	0.89	U	0.23	U	0.89	U	0.29	U	0.29	U	0.89	U	0.89	U
Toluene	**160**	800	1,740,000	174,000	10,700	2.2		**200**		1.0	JB	0.67	U	0.23	U	0.67	U	0.35	UJ	0.35	UJ	0.67	U	0.67	U
Trichloroethene	**0.5**	5	5	5	100	0.48	U	8.4	U	0.16	U	0.48	U	0.16	U	0.48	U	0.17	U	0.17	U	0.48	U	0.48	U
Vinyl chloride	**0.02**	0.2	355	35.5	30	0.18	U	7.7	U	0.20	U	0.18	U	0.14	U	0.18	U	0.15	U	0.15	U	0.18	U	0.18	U
Xylenes, Total*	**400**	2,000	38,200	3,820	44,800	1.8	U	**1,950**		0.22	U	1.8	U	0.23	U	1.8	U	0.58	J	0.39	U	1.8	U	1.8	U
Carbon disulfide	200	1,000	89,900	8,990	1.3	0.66	U	8.6	U	0.45	U	0.66	U	0.18	U	0.66	U	0.17	U	0.17	U	0.66	U	0.66	U
Acetone	1,800	9,000	-	-	1,500	35.1	U	470		28	J	5	U	5.5	U	5	U	5.5	U	5.5	U	5	U	5	U
4-Methyl-2-pentanone (MIBK)	**50**	500	53,200,000	5,320,000	210	1.2	U	20	J	2.2	U	1.2	U	0.58	U	1.2	U	0.19	U	0.19	U	1.2	U	1.2	U
2-Butanone (MEK)	800	4,000	190,000,000	19,000,000	38	4.3	U	44	U	2.1	U	4.3	U	1.1	UR	4.3	U	0.89	U	0.89	U	4.3	U	4.3	U

Shading and Border Notes:

🟦	Blue shading or border exceeds shallow water table VRSL screening criteria (adjustment for risk to 10^{-5}, and temperature of 10°C, and modified industrial groundwater attenuation factor to account for shallow water table 10^{-3})
🟩	Green shading or border exceeds Industrial VRSL screening criteria (adjustment for risk to 10^{-5}, temperature of 10°C, and industrial groundwater attenuation factor 10^{-4})
🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

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Bolded and gray shaded values indicate attainment or exceedance of WAC NR 140 Enforcement Standard

Table 3-2. Volatile Organic Compound Analytical Data - Shallow Groundwater

Tyco Fire Products LP, Marinette, Wisconsin

Notes:
µg/L = microgram(s) per liter
VOC = volatile organic compound
VRSL = vapor risk screening level
WDNR = Wisconsin Department of Natural Resources
WDNR ES = Wisconsin Administrative Code (WAC) NR 140 Enforcement Standard
WDNR PAL = Wisconsin Administrative Code (WAC) NR 140 Preventative Action Limit
Max Conc = maximum detected concentration based on most recent data from each monitoring well location
J indicates the analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
U indicates the analyte was analyzed for but was not detected above the method detection limit.
R indicates rejected data. The presence or absence of the analyte cannot be verified.
Bolded values indicate attainment or exceedance of the Wisconsin Administrative Code (WAC) NR 140 Preventative Action Limit (PAL).
Bolded and gray shaded values indicate attainment or exceedance of WAC NR 140 Enforcement Standard
Blank cells indicate the well was not sampled for that compound
2009 data is from the "baseline" event
2000 data was collected by URS Corporation (URS) as part of the 2000 *RCRA Facility Investigation* (URS 2001)
+Only VOCs with at least one detection in the data set are listed
*Xylenes, Total data for 2000 and 2009 are the sum of the meta–, ortho–, and para–xylene combined or the result of the detected result if the others were non-detect or the highest non-detect result if all were non-detect
**Max value between primary and duplicate samples was reported

***Well abandoned or not viable, alternative nearby well or groundwater grab sample collected to replace older data:
GW005S - nearby replacement MW067S; TW001 - nearby replacement MW041S and MW045S;
MW006S - nearby replacement MW118S; GW008S - groundwater grab sample;
TW002 - TW002 groundwater grab; MW010S - TW002 groundwater grab and MW124S;
MW051S - nearby replacement MW124S; MW020S and GW029S - nearby replacement MW115S

🟦	Blue shading or border exceeds shallow water table VRSL screening criteria (adjustment for risk to 10^{-5}, and temperature of 10°C, and modified industrial groundwater attenuation factor to account for shallow water table 10^{-3})
🟩	Green shading or border exceeds Industrial VRSL screening criteria (adjustment for risk to 10^{-5}, temperature of 10°C, and industrial groundwater attenuation factor 10^{-4})
🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

Table 3-3. VOCs in Groundwater Exceeding PALs

Tyco Fire Products LP, Marinette, Wisconsin

VOCs	PAL (µg/L)	VRSL (µg/L)	Max GW (µg/L)	IA VAL* (10^{-5}, HQ=1) (µg/m^3)	Comments
Petroleum VOCs					
Benzene	0.5	136	82	15.7	Common background contaminant
Ethylbenzene	140	359	12,600	49.1	Common background contaminant
Naphthalene	10	601	351	3.61	Common background contaminant
Toluene	160	174,000	10,700	21,900	Actively used at facility by ChemDesign
Xylenes (Total)	400	3,820	44,800	438	Actively used at facility by ChemDesign
Chlorinated VOCs					
Chlorobenzene	20	3,930	1,800	219	Actively used at facility by ChemDesign
Chloromethane	0.3	1,590	82.1	394	Potential background contaminant
1,2-Dichlorobenzene	60	29,400	1,800	876	Previously used at facility by ChemDesign (~5-6 years ago)
1,4-Dichlorobenzene	15	299	84	11.1	Previously used at facility by ChemDesign (~5-6 years ago)
1,2-Dichloroethane	0.5	199	16.1	4.72	Common background contaminant (plastic products)
cis-1,2-Dichloroethene	7	2,000	390	175	Breakdown compound of TCE (northwest corner of facility only)
Methylene Chloride	0.5	35,300	7,400	2,630	Actively used at facility by ChemDesign
Trichloroethene (TCE)	0.5	5 (ES)	100	8.76	Northwest corner of facility only
Vinyl chloride	0.02	35.5	30	27.9	Breakdown compound of TCE (northwest corner of facility only)
Other					
4-Methyl-2-pentanone (MIBK)	50	5,320,000	210	13,100	Not included in analyte list, see Table 3-4

Notes:

🟧 Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the Wisconsin Department of Natural Resources Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

VRSL - Shallow water table vapor risk screening level criteria (adjustment for risk to 10^{-5}, temperature, and modified industrial groundwater attenuation factor to account for shallow water table 10^{-3})

*For reference, the site is an active manufacturing site; for chemicals that remain actively used, indoor air samples will also be compared to applicable OSHA standards per WDNR RR-800 2018 VI guidance Section 6.1.

µg/m^3 = microgram(s) per cubic meter

µg/L = microgram(s) per liter

°C = degree(s) Celsius

ES = Enforcement Standard, Wisconsin Administrative Code (WAC) NR 140

HQ = hazard quotient

IA = indoor air

Max GW = maximum detected concentration based on most recent data from each monitoring well location

MIBK = methyl isobutyl ketone

PAL = Preventive Action Limit, Wisconsin Administrative Code (WAC) NR 140

TCE = trichloroethene

VAL = vapor action level

VOC = volatile organic compound

Table 3-4. Vapor Intrusion VOC Analyte List

Tyco Fire Products LP, Marinette, Wisconsin

Volatile Organic Compounds
Petroleum VOCs in Groundwater
Benzene
Ethylbenzene
Naphthalene
Toluene
Xylenes (o-xylene and m- & p-xylene)
Chlorinated VOCs in Groundwater
Chlorobenzene
Chloromethane
1,2-Dichlorobenzene
1,4-Dichlorobenzene
1,2-Dichloroethane
cis-1,2-Dichloroethene
Methylene Chloride
Trichloroethene (TCE)
Vinyl chloride
VOCs in Soil
Tetrachloroethylene (PCE)
1,2,4-Trichlorobenzene (1,2,4-TCB)
Freon-12 (dichlorodifluoromethane)
Styrene

Notes:

Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the Wisconsin Department of Natural Resources Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web

VOC = volatile organic compound

Table 3-5. VOCs with Low PAL Compared to VAL

Tyco Fire Products LP, Marinette, Wisconsin

VOC	PAL (µg/L)	Maximum Concentration in Shallow Groundwater (µg/L)	Henry’s Constant (25°C)	Air Concentration Assuming Full Volatilization* (µg/m^3)	Vapor Action Level** (µg/m^3)
4-Methyl-2-pentanone (MIBK)	50	210	0.0056	1,176	13,000

Notes

MIBK = methyl isobutyl ketone

µg/m^3 = microgram(s) per cubic meter

µg/L = microgram(s) per liter

°C = degree(s) Celsius

VOC = volatile organic compound

PAL = Preventive Action Limit, Wisconsin Administrative Code (WAC) NR 140

*The air concentration assuming full volatilization is the product of the maximum groundwater concentration by Henry's constant

**For reference, the site is an active manufacturing site; for chemicals that remain actively used, indoor air samples will also be compared to applicable OSHA standards per WDNR RR-800 2018 VI guidance Section 6.1.

Table 3-6. Summary of VOCs in Soil with Limited Groundwater Detections or PAL Exceedances

Tyco Fire Products LP, Marinette, Wisconsin

VOCs in Soils (2000)	%Detection	Max Soil Conc. (µg/kg)	2000 Shallow GW Max (µg/L)	Last (2018 to 2023) Shallow GW Max (µg/L)	PAL (µg/L)	Indust. VALs* (10^{-5}, HQ=1) (µg/m^3)	Comment
1,2,4-TRICHLOROBENZENE	29.9%	270	ND	ND	14	8.8	Add to analyte list
1,3-DICHLOROBENZENE	3.2%	68 J	20	13	120	--	No VAL -- do not include
ACROLEIN	0.5%	630	ND	ND	--	0.088	One detect in soil, none in GW -- do not include
CARBON DISULFIDE	3.2%	440	0.23	1.3 J	200	3,100	Very limited in soil or GW -- do not include
CHLOROETHANE	0.5%	100 J	0.75	4.4	80	44,000	Very limited in soil or GW -- do not include
CHLOROFORM	0.5%	25	0.45	ND	0.6	5.3	Very limited in soil or GW -- do not include
DICHLORODIFLUOROMETHANE	6.4%	1500 J	140	19	200	440	Add to analyte list
HEXACHLOROBUTADIENE	0.5%	26 J	ND	ND	--	5.6	One det. in soil, none in GW -- do not include
ISOBUTANOL	7.5%	1,800,000 J	ND	ND	--	--	Isopropyl alcohol, no VAL -- do not include
STYRENE	12.3%	210,000	ND	ND	10	4,400	Add to analyte list
TETRACHLOROETHENE	5.3%	62 J	ND	ND	0.5	180	Add to analyte list
TRANS-1,2-DICHLOROETHENE	0.5%	180 J	ND	1.8	20	--	No VAL -- do not include
(187 samples collected)							

Notes:
VOC = volatile organic compound
Shaded blue rows indicate VOC is proposed for inclusion on the vapor intrusion analyte list
GW = groundwater
µg/m^3 = microgram(s) per cubic meter
µg/L = microgram(s) per liter
µg/kg = microgram(s) per kilogram
VAL = vapor action level
PAL = Preventive Action Limit, Wisconsin Administrative Code (WAC) NR 140
ND - indicates the analyte was analyzed for but was not detected above the method detection limit
J - indicates the analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample
HQ = hazard quotient
-- - not available
*For reference, the site is an active manufacturing site; for chemicals that remain actively used, indoor air samples will also be compared to applicable OSHA standards per WDNR RR-800 2018 VI guidance Section 6.1.

Table 3-7. Building Details
Tyco Fire Products LP, Marinette, Wisconsin

Entry No.	Building No.	Occupant	Building Type	Approx. Year Built	General Usage	Type of Work Performed within the Building	Occupancy (# of occupants, hours in the building)	General Building Information	Building Footprint	Products/Chemicals Used that Contain Contaminants of Concern	VOCs Exceeding PALs in Nearby Groundwater	VOCs Exceeding VRSLs in Nearby Groundwater	VOCs Identified in Nearby Soil Samples	Area	Other Building Considerations	Investigation Recommendation
Eight Buildings Screened in for Further VI Investigation																
1	14	Tyco/JCI	Industrial	2010, updates in 2015 and 2022	Groundwater collection and treatment system (GWCTS) and wastewater treatment plant (WWTP) for facility	Treatment system operations and maintenance (O&M)	3 staff, 1 per shift to cover 24 hours/5 to 7 days per week, other maintenance staff as needed.	Concrete floor serving as secondary containment, six sumps present for treatment system O&M, steel framing, metal siding, 1 level, made of office, bathroom, 2 treatment areas and an electrical room. VSEP room addition was enclosed and updated in 2015 and effluent building added in 2022. Building height varies some with max of 23 feet. One HVAC zone in main building, one zone in office space, one zone in electrical room, one in VSEP and one in effluent building addition.	15,840 SF total (174 ft X 82 ft + 48 ft x 26 ft + 28 ft x 30 ft) ~5,840 SF GWCTS ~10,000 SF WWTP break room is 11 ft x11 ft, control room is 25 ft x 11 ft	Aerosol cans, including spray paint cans, are punctured and empty cans are stored near the control room, groundwater and wastewater influent from treatment operations	Benzene, Chlorobenzene, 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, cis-1,2-Dichloroethene, Ethylbenzene, Methylene Chloride, Naphthalene, Toluene, TCE, Vinyl Chloride, Xylenes, MIBK	TCE	1,2-Dichlorobenzene, Benzene, Chloromethane, Ethylbenzene, Naphthalene, Xylenes, Toluene, PCE, TCE	Main Plant	·No TCE found in indoor air (2 sampling events) in 2020 ·Drago® vapor barrier in place where new addition was installed in 2022 ·The floor serves as secondary containment for the GWCTS and facility WWTP ·Subslab sampling should be conducted only in areas where there is no secondary containement that will be impacted	Yes, VI sampling recommended at building due to: ·Relative proximity to known TCE in subsurface ·Potential utility preferential pathways ·Relative proximity to ethylbenzene and xylenes VRSL exceedances ·Focus subslab sampling in office/bathroom/lunchroom area
2	36	Tyco/JCI	Industrial	1960	Small parts manufacturing - fire extinguishers	Manufacturing two processes: century and red line (both are fire extinguishers)	60 to 70 people per 8 hour shift. 5 days a week, 3 shifts a day.	One manufacturing floor. Original brick building on east side. Three additions on building. Crawl space under men's locker room that had previously been flooded was filled in with concrete in April 2024. Multiple offices and bathrooms. Building height approx. 31 ft.	80,000 SF	General lubricants, painting booth area reportedly does not utilize VOCs	Non-detect near SW corner of building, no other nearby groundwater		1,4-Dichlorobenzene, 1,2,4-Trichlorobenzene, Benzene, Chlorobenzene, Ethylbenzene, Styrene, Toluene, Xylenes, Methylene Chloride, Naphthalene	Main Plant	·Large building (80,000 SF) is mitigating factor ·Manufacturing nature of building	Yes, VI sampling recommended at this building due to: ·Relative proximity to known TCE in subsurface ·Potential utility preferential pathways ·Absence of nearby groundwater data ·Focus sampling in office areas and bathroom/locker rooms
3	38	ChemDesign	Industrial	Around 1951	Dryer, centrifuge and reaction vessel	Chemical processing	9 people per shift, two 12 hour shifts	North and South sides separated by firewall. North side has mezzanine style 3 levels in height (35 ft). South side uses methylene chloride 3 months out of the year (Dec. to Feb.).	~4,200 SF	Yes	No nearby groundwater		Benzene, Ethylbenzene, Xylenes, Methylene Chloride, Styrene, Toluene	Main Plant	·Manufacturing use of building (specialty chemicals) ·Solvent/chemical usage in building, including methylene chloride, indicative of VOC indoor sources ·No TCE or PCE identified in nearby soil	Yes, VI sampling recommended at this building due to: ·Relative proximity to known TCE in subsurface ·Potential utility preferential pathways ·Absence of nearby groundwater data
4	41/42	ChemDesign	Industrial	NA	Industrial, chemical storage	Storage of chemical drums, totes and other chemical containers - 50 pound bags, 300 gallon totes, etc.	0 staff (<1 hour per day), used as storage location	Structural steel framing with sheet metal walls, concrete floor, B41 a large covered storage with open lean-to (open walls), B42 enclosed cold storage with refrigeration and half dry storage with no ventilation/HVAC.	B41 - 4,250 SF (100 ft x 42.5 ft) B42 - 4,250 SF (100 ft x 42.5 ft)	B41 chemical (acid) storage, COCs could have been stored in the past, B42 cold storage	Benzene, Chlorobenzene, 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, 1,2-Dichloroethane, cis-1,2-Dichloroethene, Ethylbenzene, Methylene Chloride, Naphthalene, Toluene, TCE, Vinyl Chloride, Xylenes	TCE, Ethylbenzene, Xylenes	Benzene, Chlorobenzene, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, Ethylbenzene, Methylene Chloride, Xylenes, Naphthalene, Styrene, Toluene, TCE, Trans-1,2-Dichloroethene	Main Plant	·Building is not routinely occupied and is not suitable for continued occupancy (cold storage)	Yes, VI sampling recommended at Building 42 (enclosed area) due to: ·Relative proximity to known TCE in subsurface ·Potential utility preferential pathways ·Relative proximity to ethylbenzene and xylenes VRSL exceedances
5	61	ChemDesign	Small commercial	NA	Supervisor office and training supplies storage	Offices and storage (not chemical storage)	1 person during office hours	Trailer with skirting, offices and bathroom. Trailer is about 3 to 4 ft above grade.	~1,000 SF		No nearby groundwater		Benzene, Ethylbenzene, Xylenes, Methylene Chloride, Styrene, Toluene in soil samples to the north-northwest	Main Plant	·Building is a trailer (sample to be collected in area behind the skirting / crawl space) ·Not a large building	Yes, VI sampling recommended at this building due to: ·Relative proximity to known TCE in subsurface ·Absence of nearby groundwater data ·Conduct sampling of air under trailer within the skirt enclosed area (crawl space) as well as indoor air sampling
6	62	ChemDesign	Industrial	NA	Manufacturing - recycling solvents	Transfer of solvents and distillations	1 staff, < 6 hours/day	Structural steel with sheet metal siding, concrete floor, 3 floors, 1st and 2nd floors are enclosed 3rd is open, partial wall and fencing.	~1,300 SF (27 ft x 48 ft)	Methylene chloride process. Distilled xylene, toluene, and IPA (not benzene) in B62 in the past.	Benzene, Chlorobenzene, 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, Ethylbenzene, Methylene Chloride, Toluene, TCE, Vinyl Chloride, Xylenes	Ethylbenzene, Xylenes	Benzene, Ethylbenzene, Xylenes, Methylene Chloride, Styrene, Toluene, Isobutanol, MIBK	Main Plant	·Manufacturing use of building (solvent transfer and distillation) ·Solvent/chemical usage in building, including methylene chloride, xylenes, and toluene, indicative of VOC indoor sources ·Building is large (tall) and open to the exterior, with limited staff occupancy	Yes, VI sampling recommended at this building due to: ·Relative proximity to known TCE in subsurface ·Relative proximity to ethylbenzene and xylenes VRSL exceedances
7	71	Tyco/JCI	Large commercial / industrial	1959/1973	Administrative and maintenance	1/3 mailroom, 1/3 office space, 1/3 maintenance shop. Spray painting in maintenance shop.	10 staff, 8 hours in the building Monday through Friday.	Mix of structural steel framing with sheet metal walls and concrete block walls, concrete floor. 2 stories in mailroom. Height approx. 18 ft. Garage doors in mechanical shop that are open in the summer.	15,600 SF (120 ft x 130 ft)	Possible	Benzene, Chlorobenzene, 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, TCE, Vinyl Chloride, Xylenes	Ethylbenzene, Xylenes	Benzene, Xylenes, Ethylbenzene, Methylene Chloride, Toluene, Isobutanol, Styrene, MIBK	Main Plant	·Part of building is for maintenance ·The building also has a QC lab ·Non-manufacturing nature of building (except maintenance) ·Other VOCs in nearby soil and groundwater	Yes, VI sampling recommended at building due to: ·Relative proximity to known TCE in subsurface ·Potential utility preferential pathways ·Relative proximity to ethylbenzene and xylenes VRSL exceedances ·Focus sampling to office and mailroom areas
8	86	Tyco/JCI	Industrial	NA	Former pump house for pumping river water to fire sprinkler system and other buildings, currently houses the booster pump for the fire system (all city water now) with a diesel pump that will be abandoned in the future	Two rooms: fire system booster pump and diesel backup generator	None, occasional maintenance only. No offices or bathrooms.	Concrete block walls, concrete floor. Building height approx. 12 ft. Two separate rooms in building. Located adjacent to river. A floor grate is present and open to the river.	1,200 SF (40 ft x 30 ft)	No	Benzene, Chlorobenzene,1,2-Dichloroethane, Vinyl Chloride		Toluene, Xylenes	Outside VBW in northwest corner of the Main Plant	·Building is only occupied for maintenance and is not suitable for continued occupancy ·No TCE or PCE identified in nearby soil, and building is outside the vertical barrier wall (slurry wall)	Yes, VI sampling recommended at this building due to: ·Relative proximity to known TCE in subsurface ·Potential utility preferential pathways
Buildings Where No VI Investigation is Proposed																
9	1	ChemDesign	Industrial	2020	Office, Labs, employee locker rooms and lunch room	Office and 2 lab (QA/QC lab and the other a process lab)	30 people in the offices/labs, locker room/lunch areas vary throughout the day - lab is occupied 24 hours by 2 people, other areas are occupied during normal working hours	On a concrete slab with a vapor barrier and passive venting system, pre-cast concrete structure for the walls, concrete blocks in some areas (locker room and stairwells), 2 floors on 1 half of the building, labs are single story	25,000 SF	lab procedures and housekeeping	Non-detect		1,2-Dichlorobenzene, Ethylbenzene, Methylene Chloride, Naphthalene, Toluene, Xylenes	Main Plant	·No TCE or PCE identified in nearby soil, and building away from area of known TCE groundwater presence ·No VOC detections in nearby groundwater ·Building is built with a vapor barrier and a passive venting system	No VI sampling recommended at this building
10	9	Tyco/JCI	Small commercial	NA	Guard Shack	Office/security, storage and bathroom	At least 3 staff to cover 24 hours/7 days per week		~225 SF	No	No nearby groundwater, however, outside VOC area of concern		No nearby soil	Outside VBW in southwest corner of the Main Plant	·Outside area of VOC concerns ·Building away from area of known TCE presence in groundwater	No VI sampling recommended at this building
11	18	Tyco/JCI	Industrial	NA	Manufacture products for fire extinguishers	Manufacturing, offices, bathrooms, storage	Approximately 17 people per day, 3 shifts. Future plans to only use portion of the building for manufacturing and the remainder of the building for storage.	Concrete, western side is manufacturing. Eastern side is storage. Approx. building height is 25 ft. NW corner has elevated 1st floor.	10,000 SF		Chloromethane		1,2-Dichlorobenzene, Naphthalene, Xylenes, Toluene, Benzene, Carbon Disulfide, Chlorobenzene, Ethylbenzene, Methylene Chloride	Main Plant	·Manufacturing use of building ·Chemical usage and manufacturing in building indicative of potential VOC usage and indoor sources ·Only chloromethane in exceedance of PAL in nearby groundwater (3.5 ug/L), which is unlikely to result in indoor air VAL exceedance ·No TCE or PCE identified in nearby soil, and building away from area of known TCE groundwater presence	No VI sampling recommended at this building
12	29	Tyco/JCI	Industrial / large commercial	1956	Industrial fire extinguishers manufacturing	Manufacturing, QC lab, offices, bathrooms, maintenance office	40 people per shift, up to 3 shifts, 5 to 6 days a week. 2 shifts for engineering offices.	2nd floor office area separated from manufacturing floor. Western side is lower than eastern side. The southwestern corner has an addition used for dry chemical manufacturing. Building height varies 17 to 21 ft. Painting area is powder based process.	88,000 SF	General lubricants, painting booth area reportedly does not utilize VOCs	Benzene		1,2,4-Trichlorobenzene, Methylene Chloride, Naphthalene, Toluene	Main Plant	·Manufacturing use of building (fire extinguishers) ·Potential manufacturing related chemical usage in building ·Only benzene in exceedance of PAL in nearby groundwater (0.36 ug/L), which is very unlikely to result in indoor air VAL exceedance ·No TCE or PCE identified in nearby soil, and building away from area of known TCE groundwater presence	No VI sampling recommended at this building
13	40	Tyco/JCI	Industrial	1936	Boiler house (gas-fired)	Boiler house - steam used and sold to ChemDesign. Provides energy to other buildings.	1 operator per shift; operated 24 hours a day, 7 days a week. 4 people total.	Old brick building, drafty and open to the exterior. Offices in western corner and lab enclosure. Building height approx. 43 ft. Concrete floor with trenches for water.	5,100 SF	No	Chlorobenzene, 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, Naphthalene		Benzene, Chlorobenzene, Chloroethane, Chloromethane, 1,4-Dichlorobenzene, 1,2-Dichlorobenzene, Dichlorodifluoromethane, Ethylbenzene, Naphthalene, Methylene Chloride, PCE, Toluene, Xylenes	Main Plant	·Building height and size (43 ft and 5,100 SF) ·Limited potential for indoor air issues (building is open and drafty) ·Industrial nature of building (boiler house) and potential for VOC indoor sources ·No TCE in soil and building away from area of known TCE groundwater presence ·Limited PCE identified in nearby soil (not directly adjacent to the building) and not in nearby groundwater	No VI sampling recommended at this building
14	43	Tyco/JCI	Industrial	1970s	Former Outfall 001 sampling building	Previously sampling for combined Outfall 001 waste water (WWTP discharge, non-contact cooling water, boiler water and stormwater) before outfall discharge to river. Is now an unoccupied building.	None, occasional maintenance only.	Concrete block walls, concrete floor. The outfall sampling was eliminated at the end of December 2022. Propane tank onsite is using electrical from the building.	500 SF	Less than 5 gallons of sulfuric acid present	No nearby groundwater. However, Building 43 is outside the VOC area of concern, and closest surrounding wells show no VRSL exceedances.		No nearby soil; however, Building 43 is outside the VOC area of concern.	Main Plant	·Building is no longer used as a pump house, houses some electrical equipment used to operate other site equipment, not routinely occupied and is not suitable for continued occupancy	No VI sampling recommended at this building

Table 3-7. Building Details
Tyco Fire Products LP, Marinette, Wisconsin

Entry No.	Building No.	Occupant	Building Type	Approx. Year Built	General Usage	Type of Work Performed within the Building	Occupancy (# of occupants, hours in the building)	General Building Information	Building Footprint	Products/Chemicals Used that Contain Contaminants of Concern	VOCs Exceeding PALs in Nearby Groundwater	VOCs Exceeding VRSLs in Nearby Groundwater	VOCs Identified in Nearby Soil Samples	Area	Other Building Considerations	Investigation Recommendation
15	52	ChemDesign	Industrial	NA	Production area	Chemical production area	24 hours/ 7 days a week / 365 days per year - 7 employees; 2 shifts of 12 hours each.	Structural steel with metal sheeting/roof – 2 floors with mezzanine levels. Building height approx. 40 ft. No bathrooms. Floor is chemical resistant bricks with trenches.	~4,200 SF	VOCs being used in building. Chlorobenzene and PSA Nitrogen generation currently in use and stored immediately adjacent (west) of building 52	Benzene, Chlorobenzene, Ethylbenzene, Methylene Chloride, Xylenes		Benzene, 1,4-Dichlorobenzene, 1,2-Dichlorobenzene, Xylenes, Naphthalene, Toluene, Methylene Chloride, 1,2,4-Trichlorobenzene, Chlorobenzene, Chloromethane, Ethylbenzene, MIBK, PCE, TCE	Main Plant	•Manufacturing use of building (specialty chemicals) •Solvent/chemical usage in building, including chlorobenzene, indicative of VOC indoor sources •Limited TCE and PCE identified in soil just under 100 feet away (not adjacent to building), not in nearby groundwater, and building away from area of known TCE groundwater presence	No VI sampling recommended at this building
16	54	ChemDesign	Small commercial	1952 - Demolished in 2022	Former locker room and showers - men and women	-	-	-	-	-	-	-	-	-	-	None. Building was demolished in May 2022 and locker room moved to the new ChemDesign building B1 in November 2021. The former building footprint is now occupied by ChemDesign's regenerative thermal oxidizer equipment.
17	59	Tyco/JCI	Industrial	1979	Large storage warehouse	No work, only storage	None, staff temporarily in building to retrieve or move materials	No offices, no bathrooms. Non-hazardous waste storage, non-regulated storage. Building height approx. 35 ft.	43,000 SF		Benzene, Methylene Chloride to the north and west, no exceedances to the east		Naphthalene, Toluene, Xylenes, Carbon Disulfide	Main Plant	•Building is not routinely occupied and is not suitable for continued occupancy •Some exceedances of PALs in nearby groundwater; however, these are unlikely to result in indoor air VAL exceedance •No TCE or PCE identified in nearby soil and away from area of known TCE groundwater presence	No VI sampling recommended at this building
18	67	ChemDesign	Industrial	2022 demolished and rebuilt with expanded footprint	Chemical storage	Chemical storage for combustible materials only, including some that may be toxic	0 staff (<1 hour per day), used as storage location	1 floor. Structural steel with sheet metal siding, concrete floor, 40 ft high, sprinkler, heated.	~10,000 SF in 2022	Products and raws for agricultural materials	Benzene, Chlorobenzene, 1,4-Dichlorobenzene		PCE, 1,2,4-Trichlorobenzene, Benzene, Ethylbenzene, Xylenes, Methylene Chloride, Naphthalene, Toluene	Main Plant	•Building is not routinely occupied •Some exceedances of PALs in nearby groundwater; however, these are unlikely to result in indoor air VAL exceedance •No TCE identified in nearby soil and away from area of known TCE groundwater presence •PCE identified in nearby soil but no PCE detected in groundwater	No VI sampling recommended at this building
19	68	ChemDesign	Industrial	Demolished in ~2022	Near original Building 69, small electrical room	Electrical room	-	-	-		-		-	-	-	None. Building was demolished around 2022. Former building footprint is beneath upgraded Building 69.
20	69	ChemDesign	Industrial	1957 - building addition over existing B68/B69 footprint in 2022	Specialty chemical manufacturing	Four batches of chemicals made here that also use VOCs in the process. No office.	2 shifts of 4 people (12 hour shifts)	There are four levels in mezzanine type style on one side of the building. Approximate building height is 50 ft. One side is the production side and the other side is for material handling. In the southwest corner is a smaller area broken out with a utility door and man door on the west wall. A tank farm was also added.	~6,000 SF	Chemicals used in the manufacturing process include: Acetic acid Chlorine Isopropanol Ethyl Bromide Tetrabutylammonium Bromide	Benzene, Chlorobenzene, 1,4-Dichlorobenzene, Methylene Chloride		Toluene, Methylene Chloride, PCE, 1,2,4-Trichlorobenzene, Ethylbenzene, Xylenes, Naphthalene, Benzene, Carbon Disulfide, Chlorobenzene, 1,2-Dichlorobenzene	Main Plant	•Part of building is for manufacturing use (specialty chemicals) •Chemical usage and manufacturing in building indicative of potential VOC usage and indoor sources •Some exceedances of PALs in nearby groundwater; however, these are unlikely to result in indoor air VAL exceedance •PCE identified in a nearby soil sample but no PCE detected in groundwater •Other VOCs in nearby soil	No VI sampling recommended at this building
21	70	ChemDesign	Industrial	Around 1954	Production area, dryer room	Western half of building used to dry agricultural products like starch and powders. Other half is locker rooms/compressor room.	24 hours a day / 7 days a week / 365 days per year - 2 employees, 2 shifts of 12 hours	Structural steel with metal sheeting/roof – 2 floors, 1st floor split into two areas, one for production, one employee locker room, 2nd floor split into 2 separate areas both for production purposes. Foundation slab 3 feet above grade. Dryer room building height is 23 ft.	~4,300 SF	No	Benzene, Chlorobenzene, Ethylbenzene, Methylene Chloride, Xylenes		Benzene, 1,4-Dichlorobenzene, 1,2-Dichlorobenzene, Xylenes, Naphthalene, Toluene, Methylene Chloride, PCB 1260, Chlorobenzene, Chloromethane, Ethylbenzene, MIBK	Main Plant	•Manufacturing use of building (starch/powders) •No TCE or PCE identified in nearby soil, and building away from area of known TCE groundwater presence	No VI sampling recommended at this building
22	74	Tyco/JCI	Industrial	2021	Pump down program building	Groundwater pumping and conveyance system operations and maintenance and truck bay for loading disposal trucks with groundwater or reject water for offsite disposal	1 staff, a few hours per day, 5 days per week, other maintenance staff as needed.	Concrete floor serving as secondary containment, steel framing, metal siding, 1 level, building height varies and is 14 to 18 plus feet. Two unit heaters in building.	~2,600 SF, including the truck bay	Groundwater from pump down program area sent to GWCTS building for treatment, reject water sent back to building for sending offsite for disposal	Benzene, Chlorobenzene, 1,2-Dichlorobenzene, Methylene Chloride		1,2,4-Trichlorobenzene, Benzene, Ethylbenzene, Xylenes, Naphthalene, Toluene,	Former Salt Vault	•The floor serves as secondary containment for the GWCTS operations •Building away from area of known TCE presence in groundwater	No VI sampling recommended at this building
23	83	ChemDesign	Industrial	NA	Compressor area, maintenance shop, lunchroom (and former scrubber)	Maintenance, electrical maintenance, work benches, tools and parts storage, washer tank for decontamination and cleanup (non-solvent), break/lunchroom area, empty/ clean totes and drums	Maintenance shop and compressor area – 12 hours per day week days only, 12 employees. Lunchroom intermittent.	Cinder block, wood roof, no basement – 3 main areas. Areas are compressor area, lunch room (single story), maintenance shop (single story). Building height 30 ft . Mezzanine style in some areas.	~8,500 SF	No	Chlorobenzene, 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, Naphthalene		Benzene, Chlorobenzene, Chloroethane, Chloromethane, 1,4-Dichlorobenzene, 1,2-Dichlorobenzene, Dichlorodifluoromethane, Ethylbenzene, Naphthalene, PCE, Toluene, Xylenes	Main Plant	•Manufacturing use of building (maintenance) •Potential VOC-containing chemical usage in building •No TCE in soil and building away from area of known TCE presence in groundwater •Limited PCE identified in nearby soil (not directly adjacent to building) and not in nearby groundwater	No VI sampling recommended at this building
24	84	ChemDesign	Industrial	1966	Shipping and receiving area	98% is finished products	6 operators; 2 12 hour shifts plus 1 office staff	1 office. Building height 18 ft. Chemical storage, some chlorobenzene storage (drums and bulk)	~5,600 SF	Yes	No nearby groundwater		No nearby soil with VOC analysis	Main Plant	•Solvent/chemicals present in building, including chlorobenzene in drums and bulk, indicative of VOC indoor sources •Building away from area of known TCE presence in groundwater	No VI sampling recommended at this building
25	90 (former balloon bldg.)	ChemDesign	Industrial	~2011	Non Hazardous chemical storage	Storage of raw materials	None - occasional people coming and going	1 large warehouse. Building height about 23 ft. Structural steel with sheet metal siding and roof, appears based on design drawings that old balloon building foundation and concrete flooring were utilized as part of the new building construction.	~12,000 SF	No	Non-detect and no exceedances east of building, benzene west and south of building		1,2,4-Trichlorobenzene, Benzene, Chloromethane, Ethylbenzene, Xylenes, Toluene, Methylene Chloride, Naphthalene, PCE	Main Plant	•Building is not routinely occupied and is not suitable for continued occupancy	No VI sampling recommended at this building
26	91	ChemDesign	Industrial	NA	Hazardous waste storage	Storage	None	All open, has sheet metal roof. Drums are on a concrete slab.	~3,300 SF		Benzene, Chlorobenzene, 1,2-Dichlorobenzene		Benzene, Ethylbenzene, Xylenes, Naphthalene, Toluene, 1,4-Dichlorobenzene, Chloromethane,	Main Plant	•Building is a covered storage area with open walls (not enclosed) •Building is not routinely occupied and is not suitable for continued occupancy •No TCE or PCE identified in nearby soil, and building away from area of known TCE groundwater presence •Only exceedance of PAL in nearby groundwater, which are unlikely to result in indoor air VAL exceedance	No VI sampling recommended at this building
27	Sprung Structure	ChemDesign	Industrial	NA	Storage	Storage - chemicals, non-flammable	None	Temporary storage structure (tent like) - tubular steel and plastic sheeting - may get replaced in the future with longer term storage	NA	Overflow - final product in cylinders (2500 lb., like a propane tank) non haz, product cannot touch air	Chloromethane		1,2-Dichlorobenzene, Naphthalene, Xylenes, Toluene, Benzene, Carbon Disulfide, Chlorobenzene, Ethylbenzene, Methylene Chloride	Main Plant	•Building is not routinely occupied and is not suitable for continued occupancy	No VI sampling recommended at this building
28	OPS Trailer	ChemDesign	Industrial	Demolished in 2022	Laboratory	-	-	-	-	-	-	-	-	-	-	None. Building demolished in May 2022 and office moved to the new ChemDesign building B1 in November 2021. The area was paved with asphalt and is being used for tote and drum storage. No replacement building is planned at this location.

Notes:
Jacobs conducted an initial field survey of the site buildings in February 2020 to better understand building use, occupancy, and configuration. A follow-up review was conducted in 2024 with facility personnel to identify changes since this initial field survey. Before commencing the VI investigation, a building survey will be conducted in the eight buildings to be further evaluated and will be compared to the initial information obtained during the February 2020 survey and 2024 update.

ft = feet
GWCTS = groundwater collection and treatment system
MIBK = methyl isobutyl ketone (4-Methyl-2-pentanone)
NA = not available
PCE = tetrachloroethylene
SF = square feet
TCE = trichloroethene
VOC = volatile organic compound
VRSL = vapor risk screening level
WWTP = waste water treatment plant
VI = vapor intrusion

Table 3-8. Summary of Buildings and Proposed Sampling to Include in Vapor Intrusion Investigation

Tyco Fire Products LP, Marinette, Wisconsin

Building No.	General Usage	Type of Work Performed within the Building	Occupancy (# of occupants, hours in the building)	Approximate Building Footprint	VOCs Exceeding VRSLs or TCE PAL in Nearby Shallow Groundwater?*	Include in VI Investigation?	Conduct Real-Time Preferential Pathway and Utility Conduits HAPSITE Assessment?	Number of Proposed Indoor Air Samples	Number of Proposed Subslab Vapor Samples	June to October 2024 Range of Groundwater Depth Below Ground Surface (feet)
14	Groundwater collection and treatment system and wastewater treatment plant for facility	Treatment system operations and maintenance.	3 staff, 1 per shift to cover 24 hours/5 to 7 days per week, other maintenance staff as needed. Women of child bearing age.	15,000 SF	Yes	Yes	Yes	5	1**	1.2 to 4.1
36	Small parts manufacturing - fire extinguishers	Manufacturing two processes: century and red line (both are fire extinguishers)	60 to 70 people per 8 hour shift. 5 days a week, 3 shifts a day. Includes women of child bearing age.	80,000 SF	Potentially	Yes	Yes	6	6	0.7 to 2.6
38	Dryer, centrifuge and reaction vessel	Chemical processing	9 people per shift, two 12 hour shifts	4,250 SF	Potentially	Yes	Yes	2	2	0.9 to 2.2
41/42	Industrial, chemical storage - B41 is an open air structure, and B42 is a refrigeration unit	Storage of chemical drums, totes and other chemical containers - 50 pound bags, 300 gallon totes, etc.	0 staff (<1 hour per day), used as storage location	B41 - 4,250 SF B42 - 4,250 SF	Yes	Yes	Yes	2	2	0.7 to 2.2
61	Engineering building - Trailer	Offices, no chemical storage - supply room of safety supplies	1 person during office hours	1,000 SF	Potentially	Yes	Yes	1	1***	0.9 to 2.2
62	Manufacturing - recycling solvents	Transfer of solvents and distillations	1 staff, < 6 hours/day	1,300 SF	Yes	Yes	Yes	2	2	0.9 to 2.2
71	Administrative and maintenance	1/3 mailroom, 1/3 office space, 1/3 maintenance shop. Spray painting in maintenance shop.	10 staff, 8 hours in the building Monday through Friday. Women of child bearing age.	15,600 SF	Yes	Yes	Yes	4	4	0.9 to 2.2
86	Former pump house for pumping river water to fire sprinkler system and other buildings, currently houses the booster pump for the fire system (all city water now) with a diesel pump that will be abandoned in the future	Two rooms: pump house and diesel backup generator	None, occasional maintenance only. No offices or bathrooms.	1,200 SF	Potentially	Yes	Yes	2	2	3.9 to 5

* = Yes — Building is within 100 feet of a shallow groundwater well with VOCs > VRSLs or TCE PAL; Potentially — Building is in an area of the site where VRSLs or TCE PAL could potentially be exceeded, but no groundwater data are available

** = Sample in office area only, other areas serve as secondary containment for groundwater and facility treatment system operations

*** = Sample from Building 61 skirt/crawl space

VOC = volatile organic compound

TCE = trichloroethene

PAL = Wisconsin Administrative Code NR 140 Preventative Action Limit

VI = vapor intrusion

VRSL = vapor risk screening level

SF = square feet (ft^2)

Notes:

- Conventional VI sampling will be repeated for two sampling events, including one heating season event, per EPA and WDNR request (number of events to be adjusted based on results and consistent with WDNR guidance).
- The air analyte list will include the analytes identified in groundwater samples at concentrations exceeding PALs (Section 3.3) and the four analytes identified in soil, which were not detected in groundwater (Sections 3.3 and 3.4) (Table 3-4).
- In general accordance with WDNR RR-649 (WDNR 2021), sewer gas sampling will be conducted in a phased approach with real-time HAPSITE GC/MS assessment followed by conventional VI sampling. These activities are described in Sections 3.6, 4.2 and 4.3.3.
- Standard Operating Procedures for each sampling methodology are located in Appendix D including: Indoor, Outdoor, and Crawlspace Air Sampling Using Canisters; Indoor, Outdoor, and Crawlspace Air Sampling Using Passive Samplers; Analytical Method for the Determination of Volatile Organics in Soil Vapor or Air Using the HAPSITE Field GC/MS; Sewer Gas Sampling; Utility Clearance for Intrusive Operations; Installation and Abandonment of Vapor Pins as Subslab Soil Vapor Probes; Subslab Soil Vapor Sampling from Vapor Pins.
- One duplicate air sample per 10 samples.
- Each building will have an outdoor (ambient) air sample collected at the same time as the indoor air samples, either upgradient of the building relative to the prevalent wind direction or near the building air intake, if readily accessible.

Table 4-1. Vapor Intrusion VOC HAPSITE Analyte List

Tyco Fire Products LP, Marinette, Wisconsin

Volatile Organic Compounds	Indoor Air VAL* (µg/m^3)	Sewer Gas Screening Level (µg/m^3)	10% of Sanitary Sewer Gas Screening Level (µg/m^3)	HAPSITE Reporting Limit (µg/m^3)	Does the analyte's maximum concentration in shallow GW exceed its GW VRSLs?	Is the analyte actively used at the facility by ChemDesign?	Is the analyte a breakdown compound of TCE?	Retain as HAPSITE analyte?**
Petroleum VOCs in Groundwater								
Benzene	15.7	524	52.4	0.16	No	No	No	No
Ethylbenzene	49.1	1,640	164	0.22	Yes	No	No	Yes
Naphthalene	3.61	120	12	0.53	No	No	No	No
Toluene	21,900	730,000	73,000	0.19	No	Yes	No	Yes
Xylenes (o-xylene and m- & p-xylene)	438	14,600	1,460	0.44	Yes	Yes	No	Yes
Chlorinated VOCs in Groundwater								
Chlorobenzene	219	7,300	730	0.23	No	Yes	No	Yes
Chloromethane	394	13,100	1,310	May not be detectable	No	No	No	No
1,2-Dichlorobenzene	876	29,200	2,920	0.31	No	No	No	No
1,4-Dichlorobenzene	11.1	372	37.2	0.31	No	No	No	No
1,2-Dichloroethane	4.72	157	15.7	0.21	No	No	No	No
cis-1,2-Dichloroethene	175	5,840	584	0.20	No	No	Yes	Yes
Methylene Chloride	2,630	87,600	8,760	0.18	No	Yes	No	Yes
Trichloroethene (TCE)	8.76	292	29.2	0.27	Yes	No	No	Yes
Vinyl chloride	27.9	929	92.9	0.26	No	No	Yes	Yes

Notes:

🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web
▨	Not proposed for HAPSITE

VAL = vapor action level
VOC = volatile organic compound
VRSLs = vapor risk screening levels
GW = groundwater
µg/m^3 = microgram(s) per cubic meter
VAL Source
https://widnr.widen.net/s/fvhcjvxrfs
Sewer gas screening level based on the indoor air VAL and an attenuation factor of 0.03
* For reference, the site is an active manufacturing site; for chemicals that remain actively used, indoor air samples will also be compared to applicable OSHA standards per WDNR RR-800 2018 VI guidance Section 6.1
** Analytes in the HAPSITE list include the following: (1) analytes for which groundwater concentrations exceed GW VRSLs, (2) analytes that are chemical currently used at the facility, or (3) analytes that are a breakdown of TCE

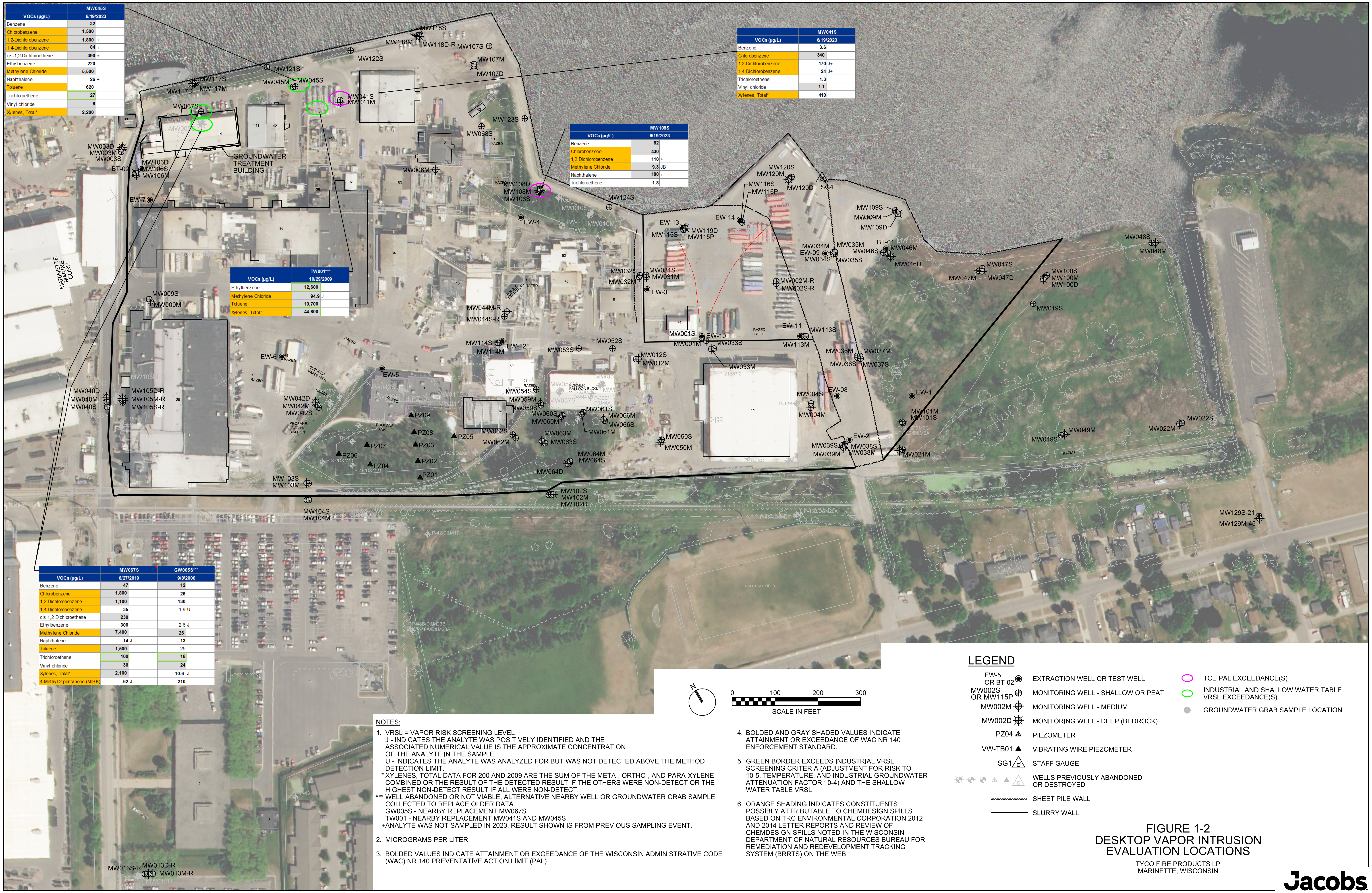
Figures

Note:
1. Imagery Source: Pléiades Neo (PNEO) Satellite Acquisition Date: 6/7/2023

Figure 1-1. Site Map
Tyco Fire Products LP
Marinette, WI

Jacobs

\\DC1VS01\GISPROJ\T\TYCO\TYCO\MAPFILES\2023\QUARTERLYREPORT\FIGURE 1 - SITE MAP.MXD JHANSEN1 1/12/2024 1:53:12 PM



VOCs (µg/L)	MW045S 6/19/2023	
Benzene	**32**	
Chlorobenzene	**1,500**	
1,2-Dichlorobenzene	**1,800**	+
1,4-Dichlorobenzene	**84**	+
cis-1,2-Dichloroethene	**390**	+
Ethylbenzene	**220**	
Methylene Chloride	**5,500**	
Naphthalene	**26**	+
Toluene	**620**	
Trichloroethene	**27**	
Vinyl chloride	**6**	
Xylenes, Total*	**2,200**	

VOCs (µg/L)	MW041S 6/19/2023	
Benzene	**3.6**	
Chlorobenzene	**340**	
1,2-Dichlorobenzene	**170**	J+
1,4-Dichlorobenzene	**24**	J+
Trichloroethene	**1.3**	
Vinyl chloride	**1.1**	
Xylenes, Total*	**410**	

VOCs (µg/L)	MW108S 6/19/2023	
Benzene	**82**	
Chlorobenzene	**430**	
1,2-Dichlorobenzene	**110**	+
Methylene Chloride	**9.3**	JB
Naphthalene	**180**	+
Trichloroethene	**1.8**	

VOCs (µg/L)	TW001*** 10/29/2009	
Ethylbenzene	**12,600**	
Methylene Chloride	**94.9**	J
Toluene	**10,700**	
Xylenes, Total*	**44,800**	

VOCs (µg/L)	MW067S 6/27/2019		GW005S*** 9/8/2000	
Benzene	**47**		**12**	
Chlorobenzene	**1,800**		**26**	
1,2-Dichlorobenzene	**1,100**		**130**	
1,4-Dichlorobenzene	**35**		1.9	U
cis-1,2-Dichloroethene	**230**			
Ethylbenzene	**300**		2.6	J
Methylene Chloride	**7,400**		**26**	
Naphthalene	**14**	J	**13**	
Toluene	**1,500**		25	
Trichloroethene	**100**		**16**	
Vinyl chloride	**30**		**24**	
Xylenes, Total*	**2,100**		**10.6**	J
4-Methyl-2-pentanone (MIBK)	**62**	J	**210**	

NOTES:

1. VRSL = VAPOR RISK SCREENING LEVEL
   J - INDICATES THE ANALYTE WAS POSITIVELY IDENTIFIED AND THE ASSOCIATED NUMERICAL VALUE IS THE APPROXIMATE CONCENTRATION OF THE ANALYTE IN THE SAMPLE.
   U - INDICATES THE ANALYTE WAS ANALYZED FOR BUT WAS NOT DETECTED ABOVE THE METHOD DETECTION LIMIT.
   * XYLENES, TOTAL DATA FOR 200 AND 2009 ARE THE SUM OF THE META-, ORTHO-, AND PARA-XYLENE COMBINED OR THE RESULT OF THE DETECTED RESULT IF THE OTHERS WERE NON-DETECT OR THE HIGHEST NON-DETECT RESULT IF ALL WERE NON-DETECT.
   *** WELL ABANDONED OR NOT VIABLE, ALTERNATIVE NEARBY WELL OR GROUNDWATER GRAB SAMPLE COLLECTED TO REPLACE OLDER DATA.
   GW005S - NEARBY REPLACEMENT MW067S
   TW001 - NEARBY REPLACEMENT MW041S AND MW045S
   +ANALYTE WAS NOT SAMPLED IN 2023, RESULT SHOWN IS FROM PREVIOUS SAMPLING EVENT.

2. MICROGRAMS PER LITER.

3. BOLDED VALUES INDICATE ATTAINMENT OR EXCEEDANCE OF THE WISCONSIN ADMINISTRATIVE CODE (WAC) NR 140 PREVENTATIVE ACTION LIMIT (PAL).

4. BOLDED AND GRAY SHADED VALUES INDICATE ATTAINMENT OR EXCEEDANCE OF WAC NR 140 ENFORCEMENT STANDARD.

5. GREEN BORDER EXCEEDS INDUSTRIAL VRSL SCREENING CRITERIA (ADJUSTMENT FOR RISK TO 10-5, TEMPERATURE, AND INDUSTRIAL GROUNDWATER ATTENUATION FACTOR 10-4) AND THE SHALLOW WATER TABLE VRSL.

6. ORANGE SHADING INDICATES CONSTITUENTS POSSIBLY ATTRIBUTABLE TO CHEMDESIGN SPILLS BASED ON TRC ENVIRONMENTAL CORPORATION 2012 AND 2014 LETTER REPORTS AND REVIEW OF CHEMDESIGN SPILLS NOTED IN THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES BUREAU FOR REMEDIATION AND REDEVELOPMENT TRACKING SYSTEM (BRRTS) ON THE WEB.

LEGEND

EW-5 OR BT-02 ◉	EXTRACTION WELL OR TEST WELL
MW002S OR MW115P ⊕	MONITORING WELL - SHALLOW OR PEAT
MW002M ⊕	MONITORING WELL - MEDIUM
MW002D ⊕	MONITORING WELL - DEEP (BEDROCK)
PZ04 ▲	PIEZOMETER
VW-TB01 ▲	VIBRATING WIRE PIEZOMETER
SG1 △	STAFF GAUGE
⊕ ⊕ ● ▲ ▲ △	WELLS PREVIOUSLY ABANDONED OR DESTROYED
~~	SHEET PILE WALL
──	SLURRY WALL
○	TCE PAL EXCEEDANCE(S)
○	INDUSTRIAL AND SHALLOW WATER TABLE VRSL EXCEEDANCE(S)
●	GROUNDWATER GRAB SAMPLE LOCATION

FIGURE 1-2
DESKTOP VAPOR INTRUSION EVALUATION LOCATIONS

TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

Jacobs

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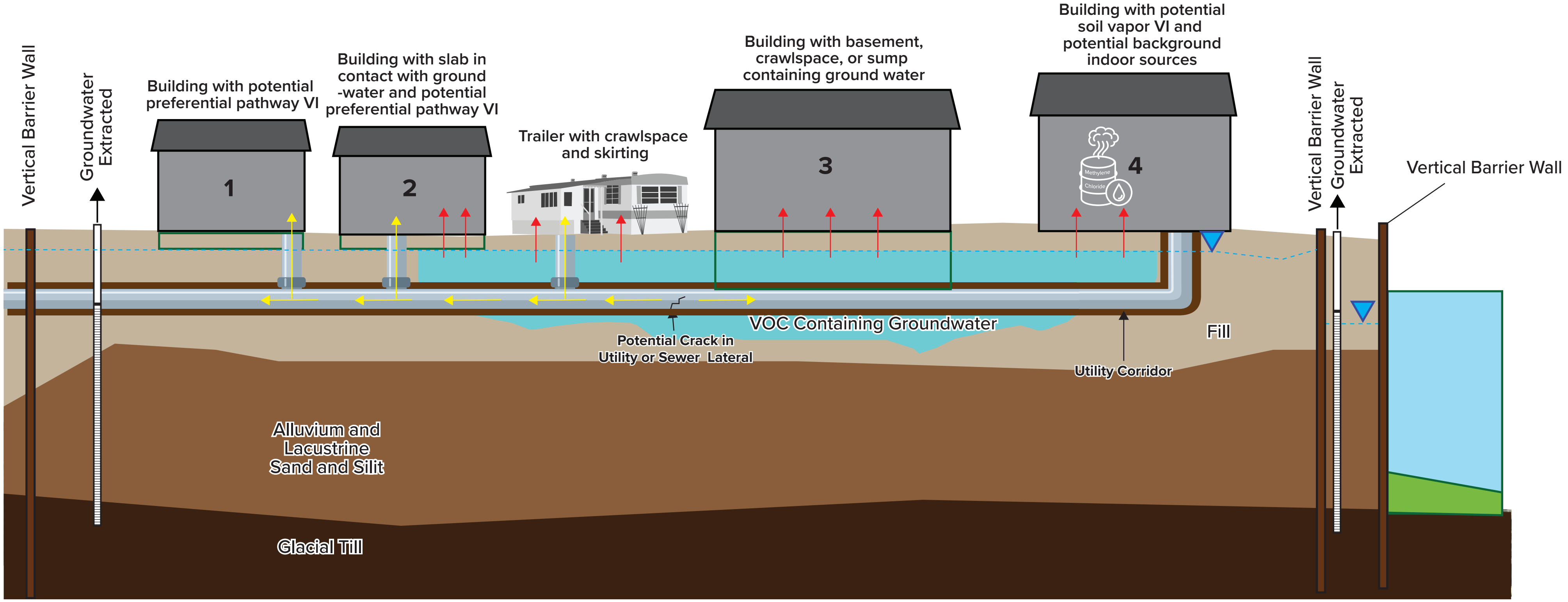
Legend

Potential Preferential Pathway Vapor Transport →

Potential Vapor Transport from Soil and Groundwater →

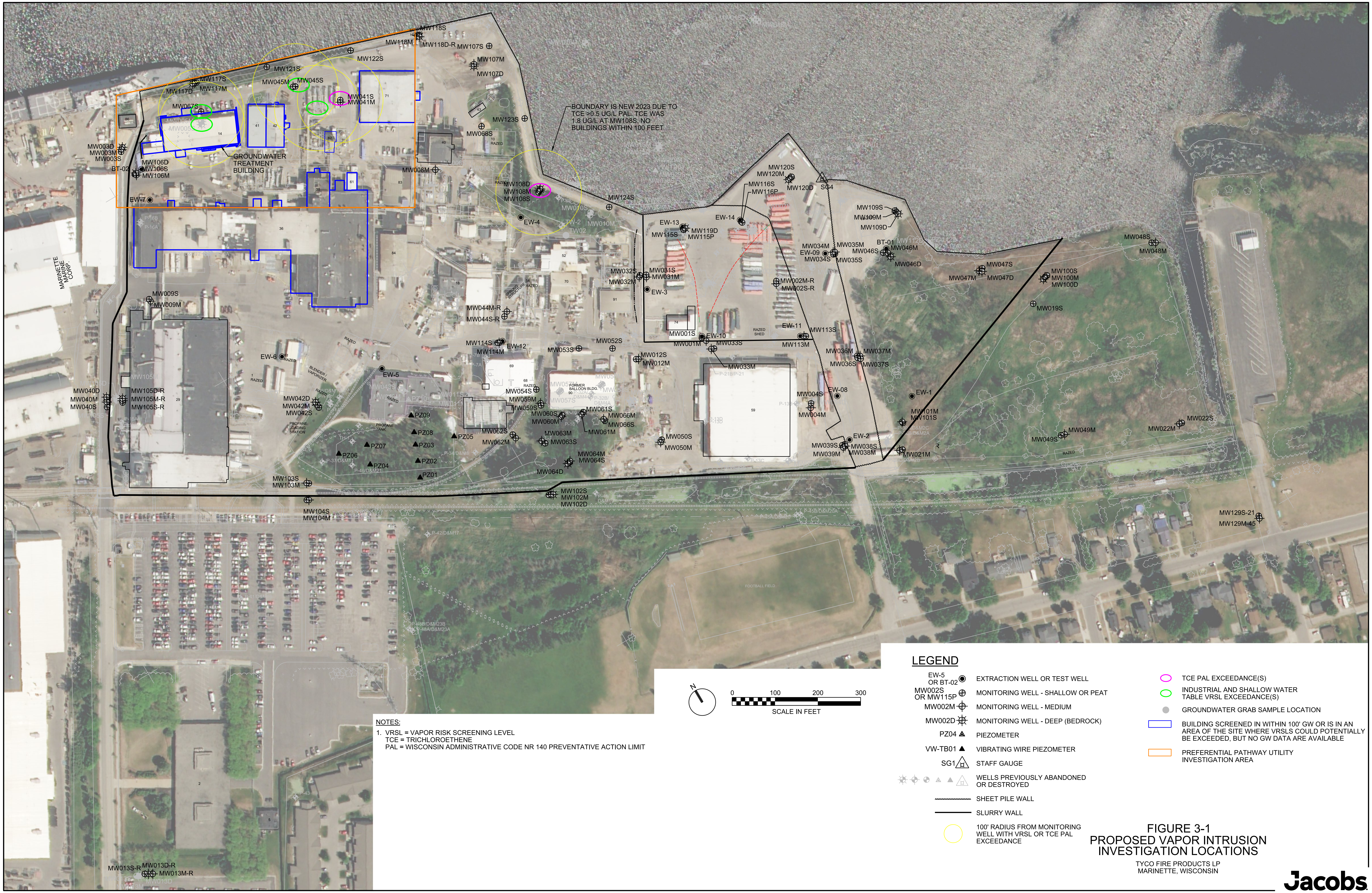
Groundwater Level ▽

Potential Preferential Pathway Vapor Transport, to be Assessed



Notes:
See definitions in Wisconsin Department of Natural Resources RR-649 for preferential pathway, utility lateral, and utility corridor
VI = vapor intrusion
VOC = volatile organic compound

Figure 2-1. Potential Vapor Intrusion Conceptual Site Model
Tyco Fire Products LP
Marinette, WI



NOTES:

1. VRSL = VAPOR RISK SCREENING LEVEL
TCE = TRICHLOROETHENE
PAL = WISCONSIN ADMINISTRATIVE CODE NR 140 PREVENTATIVE ACTION LIMIT

LEGEND

EW-5 OR BT-02 ●	EXTRACTION WELL OR TEST WELL
MW002S OR MW115P ⊕	MONITORING WELL - SHALLOW OR PEAT
MW002M ⊕	MONITORING WELL - MEDIUM
MW002D ⊕	MONITORING WELL - DEEP (BEDROCK)
PZ04 ▲	PIEZOMETER
VW-TB01 ▲	VIBRATING WIRE PIEZOMETER
SG1 △	STAFF GAUGE
⊕ ⊕ ● ▲ △	WELLS PREVIOUSLY ABANDONED OR DESTROYED
	SHEET PILE WALL
	SLURRY WALL
○	100' RADIUS FROM MONITORING WELL WITH VRSL OR TCE PAL EXCEEDANCE
○	TCE PAL EXCEEDANCE(S)
○	INDUSTRIAL AND SHALLOW WATER TABLE VRSL EXCEEDANCE(S)
●	GROUNDWATER GRAB SAMPLE LOCATION
▭	BUILDING SCREENED IN WITHIN 100' GW OR IS IN AN AREA OF THE SITE WHERE VRSLS COULD POTENTIALLY BE EXCEEDED, BUT NO GW DATA ARE AVAILABLE
▭	PREFERENTIAL PATHWAY UTILITY INVESTIGATION AREA

FIGURE 3-1
PROPOSED VAPOR INTRUSION INVESTIGATION LOCATIONS

TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

Jacobs

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Appendix A
2020 Building 14 Indoor Air Sampling Results

Appendix A. 2020 Building 14 Indoor Air Sampling Results

On December 18, 2019, EPA provided comments on the 2019 Work Plan (EPA 2019b). EPA's comments included a request for indoor air sampling at Building 14 in consideration of the presence of trichloroethylene (TCE) in nearby shallow groundwater monitoring wells. Building 14 houses the groundwater collection and treatment system for the site. TCE in groundwater is generally limited to the northwestern corner of the site and was found present in two groundwater wells in the area of Building 14 (MW045S and MW067S, which is a replacement well for abandoned well GW005S). The maximum TCE concentration in shallow groundwater measured during the most recent sampling events was 100 micrograms per liter (MW067S, June 2019).

WDNR RR-800 vapor intrusion (VI) guidance recommends that when TCE is one of the volatile organic compounds (VOCs) of interest, the demographics of potential receptors be determined (WDNR 2018, Section 3.4). Review of potential receptors at Building 14 indicated at least one receptor was present in the sensitive population for TCE (women of child-bearing years [age range of 14 to 44]). As of January 2021, this sensitive population is no longer present in the building. However, because of the presence of the receptor at the time of this initial evaluation, Jacobs, on behalf of Tyco, conducted two indoor air sampling events on February 11 and April 9, 2020, as follows:

- Five indoor air samples, including one duplicate, and one outdoor air sample were collected at Building 14 from the following locations (Figure A-1):
    - One indoor air sample and a duplicate were collected from the office/lunchroom area in the central portion of the building.
    - One indoor air sample was collected from the wastewater treatment area in the eastern portion of the building.
    - One indoor air sample was collected from the groundwater treatment area in the western portion of the building.
    - One indoor air sample was collected in the extended western portion of the building where the vibratory shear-enhanced processing units are located.
    - One outdoor (ambient) air sample was collected on the northern side of the building near the air intake of the building heating, ventilation, and air conditioning system.
- The indoor and outdoor air samples were collected at breathing zone height into pre-evacuated, individually certified, 6-liter Summa canisters equipped with flow controllers set for a sampling duration of 8 hours, as is typical in non-residential settings (WDNR 2018, Section 5.4.3).
- The samples were submitted to a laboratory under typical chain-of-custody protocol for gas chromatography-mass spectrometry analysis of TCE and its common degradation products, cis-1,2-dichloroethylene (cDCE) and vinyl chloride (VC), using EPA TO-15 analytical method.

Sampling to date indicates TCE does not pose a VI concern at the site. Results from both air sampling events were non-detect for the analyzed parameters (TCE, cDCE, and VC) with detection limits that were more than one order of magnitude below applicable indoor air screening levels. Specifically:

- The TCE indoor air vapor action level (VAL) used by WDNR for commercial/industrial setting is 8.8 micrograms per cubic meter (µg/m^3) and is equal to the EPA vapor intrusion screening level (VISL) for TCE in indoor air on the basis of cancer and noncancer risk targets of 10^{-5} and 1.0, respectively, whichever is smaller (WDNR 2018, Section 6.2.1; EPA 2024a).

- The TCE method detection limit (MDL) for indoor air samples collected as part of the two sampling events is 0.32 µg/m^3 or less, that is, more than one order of magnitude below the VAL.[31]
- Even assuming temporal variability of indoor air concentrations at Building 14, it is unlikely that the VAL for TCE could be exceeded in the future.

Because Building 14 is an active groundwater and wastewater treatment facility, water undergoing treatment could off-gas and contribute VOCs to the building indoor air, which would be unrelated to subsurface VI. Therefore, concurrent with the indoor air sampling event, water influent samples also were collected and analyzed for TCE and its common degradation products, cDCE and VC. The groundwater and wastewater treatment facility influent samples were non-detect for the same analyzed parameters.

Emails were sent to the agencies on March 3, May 4, and May 20, 2020, with the results and non-residential building indoor air evaluation form for Building 14. The results are summarized in Table A-1.

After submittal of the 2021 Work Plan, upgrades to the treatment system were made in 2022 and 2023, including constructing a new building addition that had a Drago vapor barrier installed (which was inspected and smoke tested during installation according to the design drawings). Building 14 will be re-evaluated as part of the 2025 Work Plan because of the changes to the building and the treatment system operations.

---

[31] Note that the MDLs are lower than the reporting limits (RLs), which are provided in the data summary in Table A-1. Results reported down to the MDL are qualified as estimated values (with a J qualifier). For the two sampling events, there were no J-qualified detections between the MDL and RL. The maximum RL for the TCE in the indoor air samples was 0.94 µg/m^3 (Table A-1) and is close to one order of magnitude below the VAL of 8.8 µg/m^3.

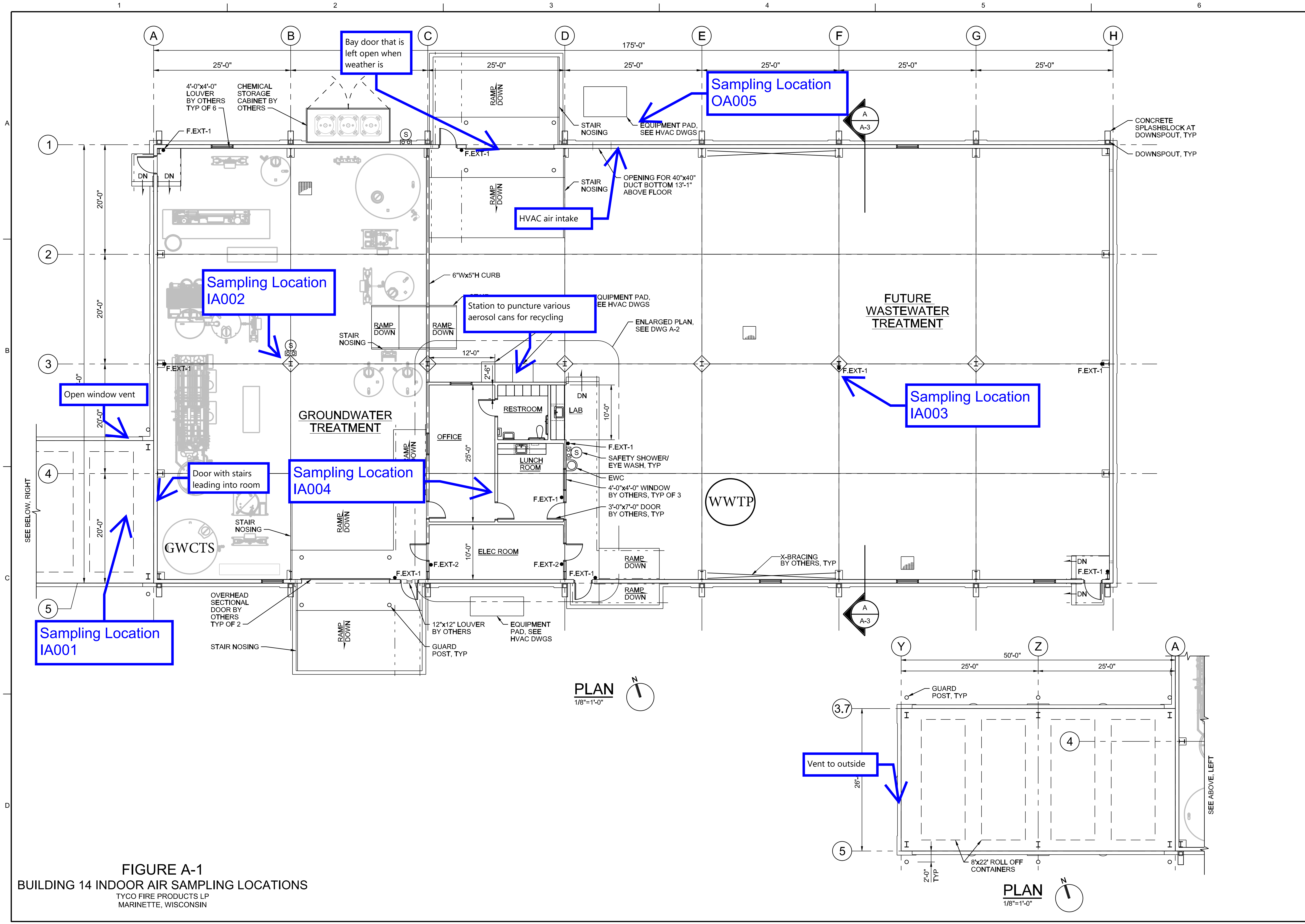

FIGURE A-1
BUILDING 14 INDOOR AIR SAMPLING LOCATIONS
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

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DSGN R. SIEBERS DR G. BURLEY CHK T. GLAWTSCHEW APVD M. JURY

NO. DATE REVISION BY APVD

TYCO FIRE PRODUCTS LP
GWCT SYSTEM
PHASE II: TREATMENT BUILDING DESIGN
MARINETTE, WISCONSIN

CH2MHILL

ARCHITECTURAL
FLOOR PLAN

1/8"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	JUNE 2010
PROJ	388522
DWG	A-1
SHEET	22

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Table A-1. Building 14 Indoor Air Sampling Results

Tyco Fire Products LP, Marinette, Wisconsin

	SAMPLE IDENTIFICATION													
	B14-IA001	**B14-IA001**	**B14-IA002**	**B14-IA002**	**B14-IA003**	**B14-IA003**	**B14-IA004**	**B14-IA004**	**B14-OA005**	**B14-OA005**	**BW14-INGWCTS**	**BW14-INGWCTS**	**BW14-INWWTP**	**BW14-INWWTP**
	2/11/2020	**4/9/2020**	**2/11/2020**	**4/9/2020**	**2/11/2020**	**4/9/2020**	**2/11/2020**	**4/9/2020**	**2/11/2020**	**4/9/2020**	**2/11/2020**	**4/9/2020**	**2/11/2020**	**4/9/2020**
VOCs	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**
cis-1,2-Dichloroethene	0.69 U	0.68 U	0.68 U	0.69 U	0.69 U	0.64 U	0.68 U	0.69 U	0.58 U	0.65 U	0.41 U	0.41 U	0.41 U	0.41 U
Trichloroethene	0.94 U	0.92 U	0.92 U	0.94 U	0.94 U	0.86 U	0.93 U	0.94 U	0.79 U	0.88 U	0.16 U	0.16 U	0.16 U	0.16 U
Vinyl chloride	0.45 U	0.44 U	0.44 U	0.44 U	0.45 U	0.41 U	0.44 U	0.45 U	0.38 U	0.42 U	0.20 U	0.20 U	0.20 U	0.20 U

Notes:

µg/m^3 = microgram(s) per cubic meter

µg/L = microgram(s) per liter

VOC = volatile organic compound

U indicates the analyte was analyzed for but was not detected above the method detection limit.

Bolded values indicate attainment or exceedance of the Wisconsin Administrative Code (WAC) NR 140 Preventative Action Limit (PAL).

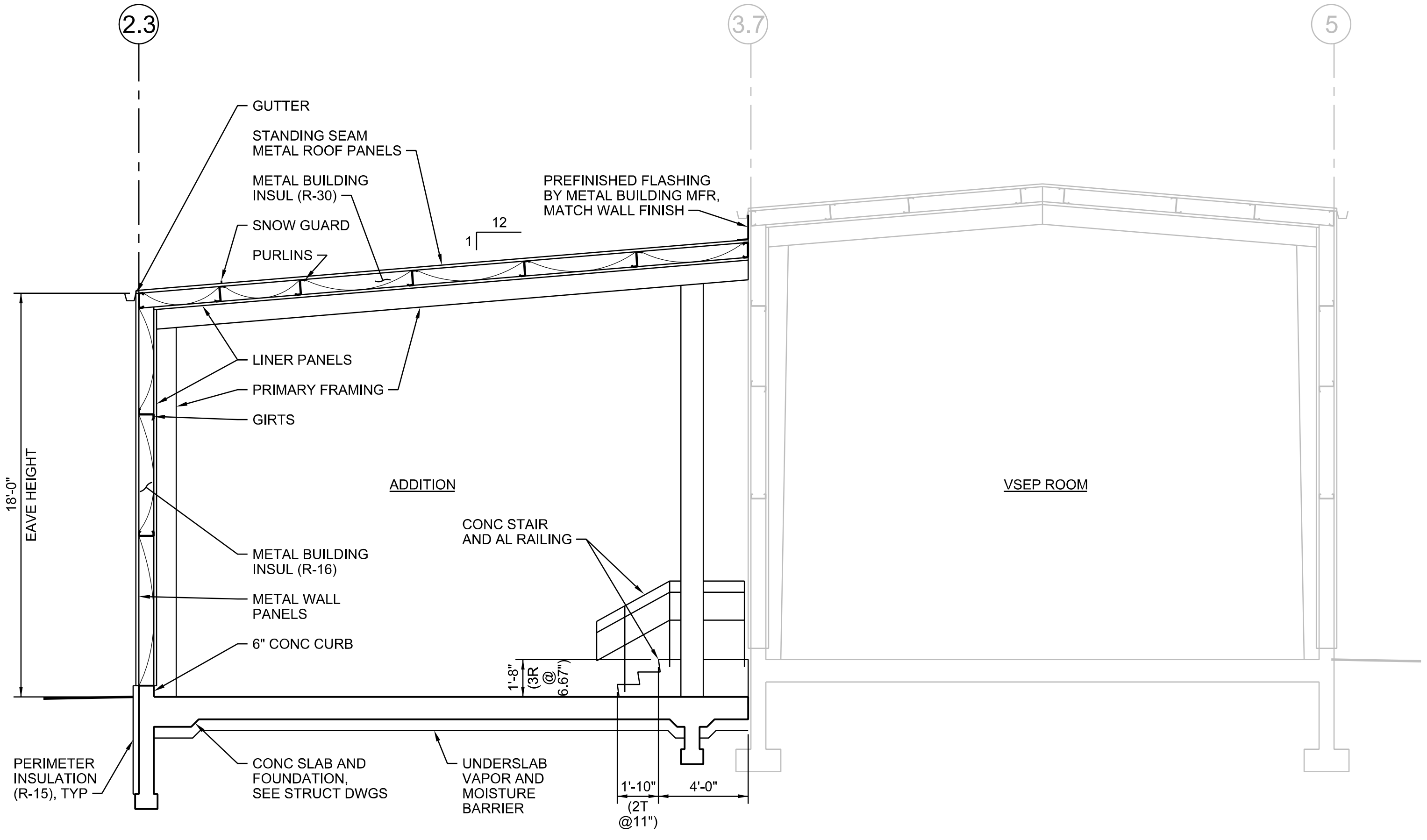
Bolded and shaded values indicate attainment or exceedance of WAC NR 140 Enforcement Standard.

Max value between primary and duplicate samples was reported.

Appendix B
Building 14 Addition Vapor Barrier Details

GENERAL SHEET NOTES

1. VAPOR/MOISTURE BARRIER SHALL BE STEGO INDUSTRIES, LLC DRAGO WRAP OR EQUIVALENT, INSTALLED AS COMPLETE SYSTEM USING DRAGO WRAP PRODUCTS.
2. INSTALL DRAGO WRAP PRODUCTS PER MANUFACTURER INSTRUCTIONS.
3. QUALITY CONTROL TESTING IS TO BE PERFORMED AND SHALL INCLUDE SMOKE TESTING BENEATH THE COMPLETED BARRIER PRIOR TO CONCRETE PLACEMENT. ANY HOLES, SEPARATION, OR OTHER PENETRATIONS SHALL BE REPAIRED PER MANUFACTURER'S INSTRUCTIONS AND RE-TESTED UNTIL THE BARRIER PASSES THE TESTING.
4. FOR THE FINAL DETAILS, SEE THE TYCO TREATMENT BUILDING FOR CONSTRUCTION DESIGN DRAWINGS BY AMERICAN BUILDINGS (SEALED 7/27/2022).



A SECTION

1/4"=1'-0"

020-A-202

RECORD DRAWINGS

Revisions Drawn By DL MICHALEK Date JULY 2024

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

DSGN	R. SIEBERS
DR	D. MICHALEK
CHK	V. MILEWSKI
APVD	W. ANDRAE

TYCO FIRE PRODUCTS LP
MODIFIED GROUND WATER
TREATMENT SYSTEM DESIGN
MARINETTE, WISCONSIN

Jacobs

ARCHITECTURAL
TREATMENT BUILDING
SECTION

1/4"=1'-0"

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	FEBRUARY 2022
PROJ	D3526500
DWG	A-004
SHEET	17OF98

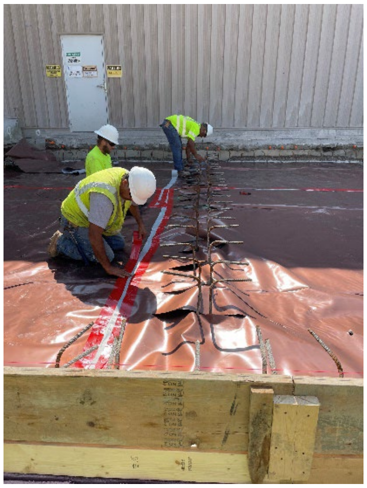
Project Title: **Groundwater Collection and Treatment System Building Addition Vapor Barrier Installation and Testing Photolog**

Location: Tyco Fire Products LP, Marinette, Wisconsin

Date: September 2022

Photolog

Photograph 1: Vapor Barrier Installation



Taken by: Jacobs *Date taken: September 14, 2022*

Photograph 2: Vapor Barrier Installation

Taken by: Jacobs *Date taken: September 14, 2022*

Photograph 3: Overview of Vapor Barrier Installation with Rebar

Taken by: Arrowhead Contracting, Inc. *Date taken: September 15, 2022*

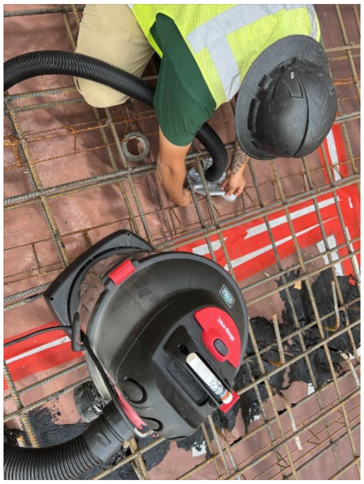
Photograph 4: Close up of Vapor Barrier Installation Along Concrete Foundation

Taken by: Arrowhead Contracting, Inc. *Date taken: September 15, 2022*

Photograph 5: Overview of Vapor Barrier Installation with Rebar

Taken by: Arrowhead Contracting, Inc. *Date taken: September 15, 2022*

Photograph 6: Vapor Barrier Testing



Taken by: Arrowhead Contracting, Inc. *Date taken: September 15, 2022*

Photograph 7: Smoke Used for Vapor Barrier Testing

Taken by: Arrowhead Contracting, Inc. *Date taken: September 15, 2022*

Appendix C
Site Utilities Reference Figures

NOTE:

1. THE UTILITIES SHOWN ARE INDICATED IN ACCORDANCE WITH PAST RECORDS/DRAWINGS. EXACT UTILITY LOCATION AND CURRENT STATUS SHOULD BE CONFIRMED PRIOR TO ANY WORK.

LEGEND

EW-5 OR BT-02 ◉	EXTRACTION WELL OR TEST WELL	— OH–E —	OVERHEAD ELECTRIC	— T —	OVERHEAD TELEPHONE WIRE
〰〰〰	SHEET PILE WALL	— OH–STEAM —	OVERHEAD STEAM	— ? —	UNKOWN UTILITY
— — —	SLURRY WALL	— OH–WIRE —	OVERHEAD WIRE	-WASTE–W-	WASTE WATER
—•—•—	ABANDONED LINE	- PIPE–GROUP-	PIPE GROUP	━━━	WELL CONVEYANCE LINE
— E —	BURIED ELECTRIC	— RAW–W —	RAW WATER	- WELL–W -	WELL WATER
- CITY–W —	CITY WATER	- RE–USE–W —	REUSE WATER		
— FO–T —	FIBER AND TELEPHONE	— RINSE–W —	RINSE WATER		
— FO —	FIBER OPTIC	—RIVER–W —	ABANDONED RIVER WATER		
— GS —	NATURAL GAS (ANSUL & WPS) (SEE LABLES FOR OWNER)	— S —	SANITARY SEWER		
○	WATER HYDRANT	— SEWER —	SEWER LINE		
-HST-SEW	ABANDONED HISTORICAL SEWER	— STEAM —	STEAM LINE		
— IW —	INDUSTRIAL WASTE LINE	— SS —	STORM WATER		
— LS —	LAWN WATER	— — — — — —	SUPPORT WIRE		
— MISC —	MISC				

FIGURE 1
SITE PLAN WITH UTILITY LOCATIONS

TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

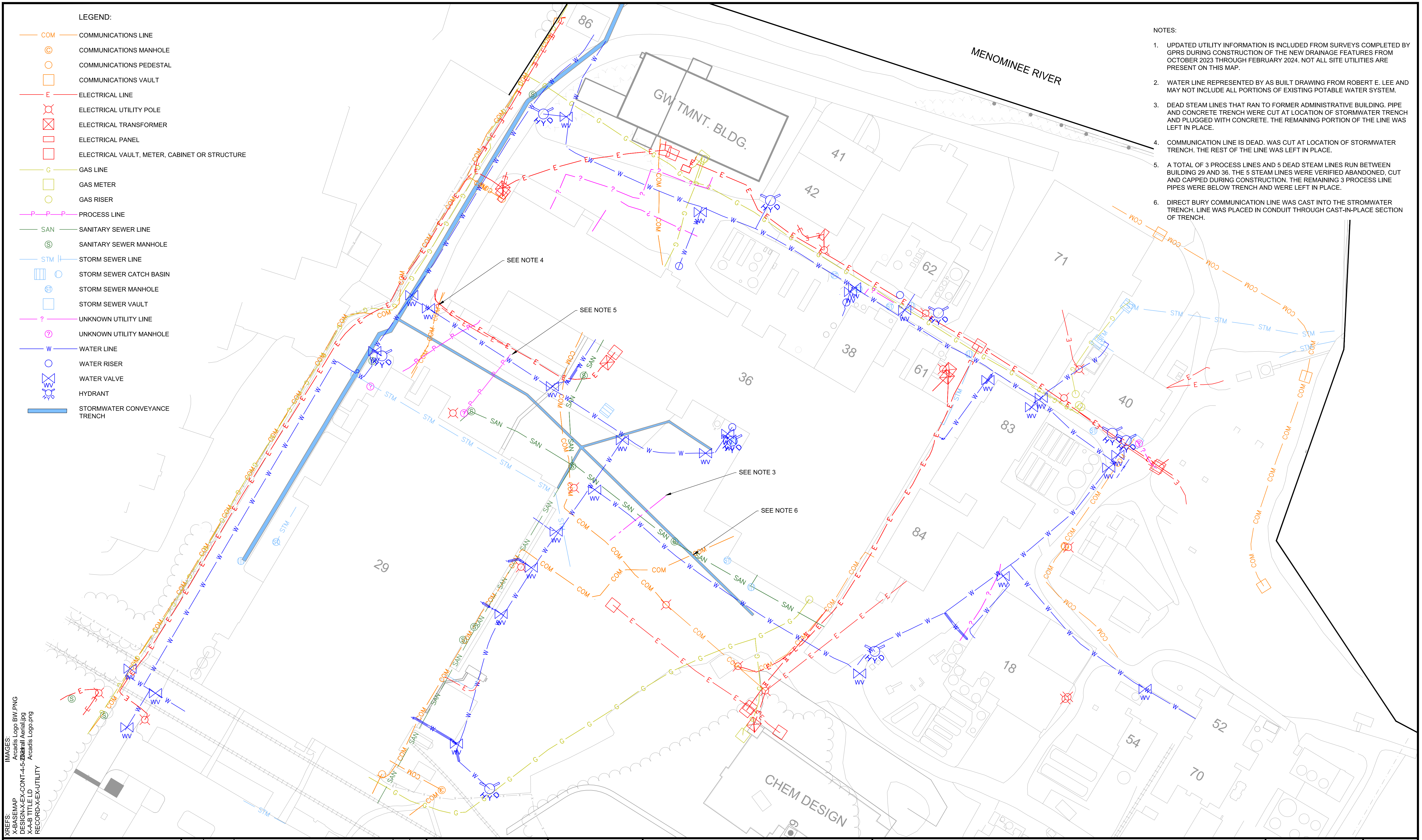
Jacobs

FILENAME: FigureUM_AppC_D3235600.dgn PLOT DATE: 1/30/2025 PLOT TIME: 11:40:53 AM

C:\Users\wdberndg.ARCADIS-US\DC\ACCDocs\Arcadis ACC US\AUS-99999999-TYCO_FT CTR_MARINETTE_WI\Project Files\10_WIP\10T_ARC_ENV\2024\01-DWG\RECORD-F02-UTILITY LOC.dwg LAYOUT: 2 CONST SAVED: 11/13/2024 6:54 PM ACADVER: 23.0S (LMS TECH) PAGESETUP: ----
PLOTSTYLETABLE: PLTFULLRED.CTB PLOTTED: 11/13/2024 7:13 PM BY: BERNDGEN, WENDY DARLENE

XREFS:
X-BASEMAP
DESIGN-X-EX-CONT-4-5-2024
X-A-B TITLE LD
RECORD-X-EX-UTILITY

IMAGES:
Arcadis Logo BW.PNG
Overall Aerial.jpg
Arcadis Logo.png



LEGEND:

— COM —	COMMUNICATIONS LINE
Ⓒ	COMMUNICATIONS MANHOLE
○	COMMUNICATIONS PEDESTAL
□	COMMUNICATIONS VAULT
— E —	ELECTRICAL LINE
☒	ELECTRICAL UTILITY POLE
☒	ELECTRICAL TRANSFORMER
▭	ELECTRICAL PANEL
□	ELECTRICAL VAULT, METER, CABINET OR STRUCTURE
— G —	GAS LINE
□	GAS METER
○	GAS RISER
—P—P—P—	PROCESS LINE
— SAN —	SANITARY SEWER LINE
Ⓢ	SANITARY SEWER MANHOLE
— STM —	STORM SEWER LINE
▥ ○	STORM SEWER CATCH BASIN
Ⓢ	STORM SEWER MANHOLE
□	STORM SEWER VAULT
— ? —	UNKNOWN UTILITY LINE
ⓘ	UNKNOWN UTILITY MANHOLE
— W —	WATER LINE
○	WATER RISER
⋈ WV	WATER VALVE
✧	HYDRANT
▬	STORMWATER CONVEYANCE TRENCH

NOTES:

1. UPDATED UTILITY INFORMATION IS INCLUDED FROM SURVEYS COMPLETED BY GPRS DURING CONSTRUCTION OF THE NEW DRAINAGE FEATURES FROM OCTOBER 2023 THROUGH FEBRUARY 2024. NOT ALL SITE UTILITIES ARE PRESENT ON THIS MAP.
2. WATER LINE REPRESENTED BY AS BUILT DRAWING FROM ROBERT E. LEE AND MAY NOT INCLUDE ALL PORTIONS OF EXISTING POTABLE WATER SYSTEM.
3. DEAD STEAM LINES THAT RAN TO FORMER ADMINISTRATIVE BUILDING. PIPE AND CONCRETE TRENCH WERE CUT AT LOCATION OF STORMWATER TRENCH AND PLUGGED WITH CONCRETE. THE REMAINING PORTION OF THE LINE WAS LEFT IN PLACE.
4. COMMUNICATION LINE IS DEAD. WAS CUT AT LOCATION OF STORMWATER TRENCH. THE REST OF THE LINE WAS LEFT IN PLACE.
5. A TOTAL OF 3 PROCESS LINES AND 5 DEAD STEAM LINES RUN BETWEEN BUILDING 29 AND 36. THE 5 STEAM LINES WERE VERIFIED ABANDONED, CUT AND CAPPED DURING CONSTRUCTION. THE REMAINING 3 PROCESS LINE PIPES WERE BELOW TRENCH AND WERE LEFT IN PLACE.
6. DIRECT BURY COMMUNICATION LINE WAS CAST INTO THE STROMWATER TRENCH. LINE WAS PLACED IN CONDUIT THROUGH CAST-IN-PLACE SECTION OF TRENCH.

0 50' 100'
SCALE

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
WESLEY MAY
Professional Engineer's No.
35887

State	Date Signed	Project Mgr.
WI		BMS

Designed by	Drawn by	Checked by
BMS	PPH	BMS

ARCADIS U.S., INC.

TYCO FIRE PROTECTION PRODUCTS • ONE STANTON STREET MARINETTE, WI 54143-2542

UTILITY LOCATIONS

ARCADIS Project No.
30178504.0001

Date
NOVEMBER 2024

ARCADIS NA
126 NORTH JEFFERSON STREET
SUITE 400
MILWAUKEE, WISCONSIN 53202
TEL. 414.276.7742

Appendix D
Standard Operating Procedures

Conducting Building Surveys for Vapor Intrusion Investigations

Purpose

This Standard Operating Procedure (SOP) presents general guidelines for conducting building surveys for vapor intrusion (VI) investigations. A building survey is performed as part of a VI investigation to obtain information for development of the building-specific aspects of a conceptual site model (CSM) and to prepare for VI sampling (for example, select optimal sampling locations and determine if there are potential confounding indoor sources of volatile organic compounds [VOCs]).

A CSM for VI pathway investigation describes potential VOC subsurface sources, migration pathways, and potential human receptors under current and/or future land uses at the site. The important building characteristics for VI pathway investigation include the following:

- Building use and occupancy
- Condition of the building envelope
- Presence of a basement or crawlspace
- Presence of preferential pathways for VI
- Dimensions of the building and interior compartments
- Condition of the slab and basement walls and presence of potential VI pathways
- Type, zoning, and typical operational settings of the heating, ventilation, and air conditioning (HVAC) system
- Presence of potential indoor sources of VOCs, and sources that may have been sored or used in the past, if known
- Evidence of groundwater infiltration into the structure

This SOP can be used to perform building surveys in residential, commercial, or industrial buildings.

Scope

This SOP provides a general description of the information that should be observed and documented during building surveys. Sources of information about the building can include conversations with the owners or occupants, visual observations, and possibly building plans or building inspection reports the owner may be willing to share. The level of detail to which each building characteristic is evaluated will depend on the data quality objectives for each project.

Equipment and Materials

- Electronic or paper format Building Survey Form – to record survey information
- Figure showing the footprint of the building (if available) – to mark up during the building survey
- Flashlight

- Laser measuring tool, walking wheel, or measuring tape – to measure building and room dimensions
- Camera – to photograph the building (interior and exterior)
- *Recommended* – field instrument such as a MultiRAE photoionization detector (PID) to measure total VOC and carbon monoxide concentrations in the breathing zone for health and safety monitoring
- *Optional* – ppbRAE PID to assist with identifying indoor VOC sources

Procedures and Guidelines

- **Gain access to the building**. Field staff should be trained for their role in courteous public interaction and risk communication and be aware of common safety hazards that may exist in buildings.
- **Obtain occupant information**. The building occupants are the potential receptors in the VI CSM. Is the building use residential, commercial, or industrial? How many people typically occupy the building? Are there sensitive receptors (children, elderly, pregnant women, or immune-impaired) in the building? How much time do occupants spend in the building? What areas of the building do the occupants typically use (that is, where do they spend the most time)? If there is a basement, it is helpful to understand the amount of time people spend in the basement – for example, is there a family room in it or is it just storage or laundry?
- **Obtain building information.** How old is the building? What was its original use? Have there been additions or other significant modifications? Additions will likely have slabs that are separate from the original building. Differing shingles or roof pitches can sometimes indicate additions as well. How many floors does the building have? Does the building have a basement? If so, how far does it extend below grade? Is the slab on grade? Is the slab elevated above the ground surface? Is there a crawlspace? If so, where is the crawlspace access?
- **Survey the building envelope**. Walk around the inside and outside of the building and record information on the building construction and condition. How many doors/windows/loading docks are there, what condition are they in, and are they typically left open or closed? Are there obvious cracks in the walls or at the eaves that provide ventilation? What are the building construction materials? Look up at the roof for signs of a whole-house fan or other exhaust ventilation. Observe any exhaust fans that may be present in the walls or ceilings.
- **Determine the indoor air volume and the location and volume of separate indoor air compartments within the building**. Measure the building dimensions (length, width, and height). Measure the dimensions of compartments or rooms within the building. How are rooms connected? Are interior doors typically kept open or shut? Are there separate compartments within the building (that is, areas that are not connected to other areas such that the indoor air does not mix)?
- **Observe the slab condition**. How thick is the slab? What is the general condition of the slab? What is the floor covering in each room of the lowest floor (carpet, tile, or wood)?
- **Identify potential VI pathways.** Any openings, cracks, or penetrations in the slab or basement walls may be entryways for subslab soil vapor. Are there utilities that penetrate the slab or basement walls? Are they sealed properly? It may be helpful to inventory utilities systematically by asking where the water line comes in, and where the sewage line goes out. Ask if the building has central utility services for water and sewer or uses septic and/or well. Similarly, telecommunications, cable TV, and power lines can come into the building overhead or underground. Overhead services can frequently be identified on the exterior of the structure and are unimportant for VI. Underground services can either be directly buried wire/cable or installed in a conduit.

Are there cracks in the slab or basement walls? If so, note where these cracks are and their approximate size. Are there sumps? If so, note the dimensions of each and their typical operating conditions (is pump present? Is the top of the sump sealed? Where does the sump discharge?). Is the wall/floor juncture sealed well? Is there a french drain? Is there an open drain provided in the laundry room or for draining water from the furnace or gas fired hot water heater? Has the basement been waterproofed? Are there expansion joints in the slab? If so, note their condition.

- **Evaluate the HVAC system**. Record the type and model of the systems and the typical operating conditions. Is there one air conditioning zone or multiple zones (look for multiple thermostats)? Does the HVAC system use radiant heat or forced air? If the HVAC system is forced air, where are the heating and cooling and return air vents? Where is the HVAC system's fresh air intake? What is the heating fuel source (that is, natural gas, oil, or propane)? Are there ventilation fans (such as bathroom exhaust, kitchen exhaust and/or whole house fans)? If so, note where and their typical operating conditions. Are there window air conditioning units? Is a heat recovery ventilator in use? Is there a fireplace or woodstove, and if so, how frequently is it used?
- **Identify any existing vapor mitigation systems.** Is there a radon mitigation system or other subslab depressurization system? Is there sealant on any cracks or crevices? Is there a sealant coat on the floor or basement walls for vapor or water mitigation?
- **Identify if the building experiences seasonal flooding**. Ask the building owner and/or occupants if seasonal flooding in the building is experienced. If so under what conditions/how frequently/how bad? If the building experiences flooding, document the condition of gutters/downspouts and whether the lot is graded away from the foundation. This will help assess the source of the water.
- **Sketch the building floor plan**. Include building dimensions, locations of windows/doors/loading docks, outdoor surface cover (such as, grass and asphalt), and locations of potential indoor or outdoor VOC sources. Attached garages or attached storage sheds can be important sources of VOCs. Fully detached garages or storage buildings do not normally need to be surveyed unless they are routinely occupied.
- **Identify potential indoor VOC sources within the building**. Record the location of the potential sources and determine if they can be removed before indoor air sampling is performed. Potential indoor sources of VOCs may include cleaning products, paint, dry-cleaned clothes, craft glues, air fresheners, gasoline, cosmetics, or cigarette smoke. Recent remodeling activities, including painting, installing new carpeting or flooring, and moving in new furniture should be identified, because they could be potential sources of VOCs. A field instrument can also be used to pinpoint potential indoor VOC sources. In situations with numerous products such as numerous cleaning supplies, it can be efficient to photograph both the front and back of the containers lined up. In addition, information on historical usage of VOC-containing chemicals will also be evaluated, if known.
- **Identify potential outdoor contaminant sources**. These may include gas stations, major roadways, dry cleaners, repair shops, industries, outdoor cooking areas, or landfills.
- **Identify possible indoor air, outdoor air, crawl space air, and subslab soil vapor sample locations** that meet the project-specific data quality objectives and are acceptable to building occupants.

Quality Control and Quality Assurance

Adequate time should be reserved for performing building surveys and detailed notes should be recorded at the time of the building survey. Verify that indoor air samples are collected no less than 24-hours after chemical products that may contain VOCs are temporarily removed from the building.

Attachments

- Jacobs Building Survey Form
- U.S. Environmental Protection Agency Non-Residential Indoor Air Quality Evaluation Form

References

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. 2015. *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. June.

Building Survey Form for Vapor Intrusion Investigations

Property ID: ______________________________

Site/Project Name: ______________________________

____

Date of Survey: ______________________________

Preparer(s): ____

Building Occupancy and Use

1. What is the estimated number of building occupants?

____

____

(Make general observations about age range and percentage of male to female ratio)

2. Are there any sensitive receptors in the building? (elderly, children, immuno-compromised, women of child bearing age, etc.)

____

3. How long have the current occupants occupied the building? ______________________________

4. What is the building type/use? Circle all that apply and describe.

Residential (single family, duplex, apartments) / Office / Strip Mall / Commercial / Industrial / Other:

____

Describe building use (circle all that apply):

Residential / Manufacturing / Storage / Chemical Storage / Administrative / Instrumentation / Other:

____

____

5. What are the historical activities within the building (if different than above)?

____

____

Building Occupancy and Use - continued

Questions 6 - 8 are applicable to non-residential buildings only.

6. What type of work is performed within the building?

7. How many hours per day or week do workers spend in the building?

8. Is the building accessed by the public? (Describe approximate number of persons, frequency of visits, and duration of visits.)

Building Construction

1. What year was the building constructed?

2. Have there been additions to the building? If so, when? (Identify on building sketch)

3. What are the approximate dimensions of the building?

4. What are the construction materials of the exterior of the building?

5. How many floors does the building have?

Does the main floor sit on, below, or above grade?

(How many feet above or below grade?)

Number of floors at or above grade?

Number of floors below grade?

(How many feet below grade?)

Building Construction - continued

6. Describe the basement (if present):

Does the building have a basement and/or crawl space? ______________________

Does the basement have access to outside (windows or doors)? ______________________

How many feet below grade? ______________________

Approximate square footage: ______________________

Approximate ceiling height (give range if varying height): ______________________

Is the basement separated into multiple rooms? Describe (note use, if space is finished/unfinished):

____

____

Construction materials of walls (i.e. poured concrete, cinderblock, brick, etc.; are the walls covered with epoxy?):

____

Are significant cracks present in the walls? ______________________

7. Describe the main floor:

Approximate square footage: ______________________

Approximate ceiling height (give range if varying height): ______________________

Is the main floor separated into multiple rooms? ______________________

____

Is there access to a floor above ground level? ______________________

Construction materials of walls (i.e. framing, siding, cinderblock, etc.):

____

____

Building Construction - continued

8. Describe the building slab:

Construction materials of floor/slab: ______________________

____

Describe the floor coverings (epoxy paint, carpet, tile, etc.) ______________________

____

If concrete slab, are expansion joints present? ______________________

Are they sealed/showing deterioration? ______________________

Are significant cracks present in the slab? ______________________

Are there any penetrations in the slab? (utility conduits, etc.) ______________________

____

Is there a subslab vapor/moisture barrier in place? ______________________

Are any floor drains or sumps present? Is there standing water in them? ______________________

____

Are there any subsurface vaults present? (if so describe and add locations to building sketch)

____

9. Does the building have a moisture/dampness problem?

No / Rarely (less than 1 time per year) / Occasionally (1-2 times per year) / Frequently

10. Does the building ever flood?

No / Rarely (less than 1 time per year) / Occasionally (1-2 times per year) / Frequently

11. Is there a septic system? ☐ Yes ☐ Yes, but not in use ☐ No

12. Is there irrigation or a private well? ☐ Yes ☐ Yes, but not in use ☐ No

13. Type of ground cover outside: Grass / Concrete / Gravel / Asphalt / Other ______________________

14. Additional notes on building construction or moisture/dampness:

____

____

____

Existing Vapor Mitigation Systems

1. Has a radon or vapor mitigation system been installed in this building? (Show location on building sketch)

____

If yes: Installation Date: ____________________

Type of System: Passive Venting / Active Subslab Depressurization
Crack and Crevice Sealing / Dilution Ventilation Control / Other

Notes: ____

Air Flow Within the Building and Outdoor Air Exchange

1. Are there any areas of the building that are positively or negatively pressurized (look for doors not opening and/or closing properly, perceptible air flow, audible fan noises)?

____

____

____

2. Is there one HVAC zone or multiple zones? How many zones? Add thermostat locations to building floorplan, if available.

____

____

____

3. Type of ventilation system (circle all that apply):

Central Air Condition / Mechanical Fans / Bathroom Ventilation Fans / Individual Air Condition Units
Kitchen Range Hood Fan / Outside Air Intake / Industrial Floor Fans
Whole-Building Attic Exhaust Fan / Other: ____________________

4. Type of heating system (circle all that apply):

Forced Hot Air / Hot Air Radiation / Wood / Steam Radiation / Heat Pump / Individual Heater / Hot Water Radiation
Kerosene Heater / Fireplace / Electric Baseboard / Other: ____________________

5. Type of fuel utilized (circle all that apply):

Natural Gas / Electric / Fuel Oil / Wood / Coal / Solar / Kerosene / Other: ____________________

6. Are there any sources of outdoor air?

☐ Mechanical (AHU)
☐ Access Doors
☐ Garage/Bay Doors
☐ Windows
☐ Other

Are windows/doors left open routinely (seasonal differences)? ____________________

____

Evaluation of Potential Indoor VOC Sources

1. Are SDSs available for chemicals used with in the building? If possible, obtain a copy of the Table of Contents. List items in additional notes section (include approximate quantities and frequency).

☐ Yes ☐ No

2. Do any of the products stored in the building contain VOCs?

☐ Yes ☐ No ☐ Unknown (record products for later review by Vapor Intrusion Senior Technical Consultant)

3. Are any of the target analytes used in the building?

☐ Yes ☐ No ☐ Unknown (record products)

If yes, is the usage confined to a specific room/area?

☐ Yes ☐ No

____

____

4. Are pesticides used for indoor pest control?

☐ Yes ☐ No ☐ Unknown

If yes: Name of product or company: ____________________

Frequency of use: ____________________

Has there been an application within the last 6 months? __________

5. Is smoking permitted inside the building?

☐ Yes ☐ No

If yes, does smoking typically occur within a specific room/area?

☐ Yes ☐ No Notes: ____________________

How often? ____________________

Last time someone smoked in the building? ____________________

6. Has there been any remodeling or construction within the past 6 months (i.e. new carpeting/tiling, painting, additions, new furniture, etc.)

☐ Yes ☐ No *(Provide pictures, if possible)*

____

____

____

Is there any planned for the near future?

☐ Yes ☐ No ☐ Unknown

If yes, describe: ____

____

Evaluation of Potential Indoor VOC Sources - continued

7. Does the building have an attached garage or do vehicles regularly enter the space (example: a vehicle repair shop)?

☐ Yes ☐ No

8. Are gas-powered equipment or cans of gasoline/fuels stored in the building or attached garage?

☐ Yes ☐ No ☐ Unknown

9. Do building occupants dry clean their clothes? ☐ Yes ☐ No ☐ Unknown

If yes, how often? Weekly / Monthly / Infrequently (3-4 times a year)

10. Has there ever been a fire in the building? ☐ Yes ☐ No ☐ Unknown

11. Has there ever been a known chemical spill immediately outside or inside the building?

☐ Yes ☐ No ☐ Unknown

12. Was the building screened with a ppbRAE to identify indoor VOC sources? If yes, describe the results:

☐ Yes ☐ No

Evaluation of Potential Outside VOC Sources

1. Are there stationary sources nearby (i.e. gas stations, emission stacks, hazardous waste storage, etc.):

☐ Yes ☐ No

2. Is there heavy vehicular traffic nearby (or other mobile sources)?

☐ Yes ☐ No

Building Survey Form for Vapor Intrusion Investigations

Attachment 1 - Confidential Information

Building Type: Government ☐ Residential (rental) ☐ Commercial ☐
Residential (non-rental) ☐ Industrial ☐

Building Location:

Property ID: ____________________

Address: ____________________

Business name (if applicable): ____________________

Contact information, as applicable and available:

Client:

Name(s): ____________________

E-mail Address: ____________________

Phone Number (mobile): ____________________

Phone Number (home/office): ____________________

Property Owner or Rental Agency:

Name(s): ____________________

E-mail Address: ____________________

Phone Number (mobile): ____________________

Phone Number (home/office): ____________________

Renter/Additional Contact:

Name(s): ____________________

E-mail Address: ____________________

Phone Number (mobile): ____________________

Phone Number (home/office): ____________________

Building Survey Form for Vapor Intrusion Investigations

Attachment 2 - Room-Specific Information

Questions from the generic building survey may apply to individual rooms if the building is partitioned into separate work spaces, especially if work spaces differ in daily activities. Please include room name and any applicable details below. If available, add room names to building floor plan for future reference.

Important room-specific features to capture: Room dimensions; HVAC or fan operation; potential background sources typically stored in the space; utility penetrations; employee/resident usage; general construction of room (walls, ceiling, floor); window and door usage; new furniture and/or renovation notes; condition of observable slab

Building Survey Form for Vapor Intrusion Investigations

Attachment 3 - Additional Notes

If additional room is needed for capturing information collected during the building survey, include all notes here:

Instructions: Non-Residential Indoor Air Evaluation Form

Introduction

This form was developed to aid in the evaluation of volatile organic compound (VOC) vapor intrusion into non-residential buildings. Portions of this form may also be applicable to radon intrusion. It is assumed that the user of this form has a basic knowledge of environmental sampling, building ventilation, and building construction. For building evaluations, it is important that the building maintenance staff be present. For more complicated buildings, the HVAC specialist or contractor may need to be present.

It is recommended that two staff be present to conduct evaluations. The staff should have appropriate health and safety training for the hazards that may be present in non-residential buildings. During the building evaluation, there are certain activities that should only be performed if the staff has the appropriate training and clearance. For example; viewing ventilation and other equipment on roofs, or entering building structures dedicated to mechanical equipment and HVAC systems that may require specific confined space and lockout tagout procedures and training for ladder safety. The staff activities should follow the guidelines from their health and safety specialist and those from the facility being evaluated.

How to use this form

The form has been broken into four parts that should be completed to the best extent possible. Supplemental information, such as HVAC test and balance, commissioning, and sequence of operations, may also need to be provided by the building operator. For large buildings or campuses, it is recommended that a kick off meeting be conducted and documented. This meeting should be used to discuss the purpose of the evaluation, gather information and documentation, and to gain insight into building operations.

Evaluation of ventilation for large warehouse spaces and hangers is not covered here. In addition, if there are structures built inside these spaces, they should be evaluated as individual buildings using this form.

It is recommended that the staff evaluating the building be familiar with this form contents and document information when it is observed or is raised during conversation.

Part 1

The intention of Part 1 is to document contact, building size, and building construction and occupant information.

Part 2

Part 2 includes initial observations of conditions that could impact vapor intrusion and evaluations of potential indoor air sources. General ventilation observations, a pathway evaluation, and pressure and temperature evaluations should be documented in this part. Sampling should be focused in areas where there are pathways, driving forces, or stagnant conditions. Areas where there is greater outdoor air exchange and/or potential VOC sources should be a lower priority for sampling.

Where pathways are identified, they should be used to help target locations to collect indoor air samples. It is also recommended that VOC samples be collected in the identified pathways to help understand vapor intrusion potential.

Part 3

List items/products in the building or the adjacent structures that may contain site specific compounds of concern. These should be removed prior to sampling. List items/products/operations that give off significant volatiles as these may interfere with chemical analysis. The use of a portable instrument, such as a photo-ionization detector (PID), can help locate volatile chemicals.

Most businesses should have Safety Data Sheets (SDSs), these should be evaluated. A physical inventory should also be conducted, there may be products present that are not represented by SDSs.

Examples of products that may contain trichloroethene (TCE) are gun cleaner, rubber cement, solvent degreasers, spot removers, correction fluid, and electrical motor cleaner. Be aware that older products are more likely to contain TCE.

Part 4

Part 4 is a voluntary evaluation of building ventilation systems. Because most non-residential buildings are intended to be actively ventilated, the form focuses on active ventilation systems. Where there are non-residential buildings that are designed and constructed like residential buildings (or are converted residential buildings) the residential evaluation form should be used for ventilation evaluations.

If there is a building management system, it is critical to review the system operations, set points, and the sequence of operations for each ventilation zone. Information from the management system should also be verified during the walkthrough of the building.

For more information on this form please contact EPA’s Project Manager.

Non-Residential Indoor Air Quality Evaluation Form

Date: ____________________ **Facility Name:** ___________________ **EPA ID No.:** ___________________

PART 1: General Information

Business Name: ____

Address: ____

Contact Name: ____

Phone: ____________________________ **Email:** __________________________________

Facility Owner/Landlord Information (If different from above)

Name: ____

Phone: ____________________________ **Email:** __________________________________

Other Building Contacts ____

Building/Business Type and Uses (Check appropriate boxes)

☐ Office Space ☐ Warehouse ☐ Manufacturing ☐ Multi-story ☐ Multi-tenant ☐ Warehouse

☐ Single level Office/Warehouse ☐ Other ____

Building Occupancy

Number of Occupants: _______ Adults: Gender M/F _____/_____ General Age ranges:_______________

Days/Hours of occupancy __________ Duration of work shifts _____________

Days/Hours of ventilation system operation _________________________________

Building Characteristics
Year/Decade Built: ________________ Number of Stories: _______________________

Approximate Building Area (square feet): Total ______________ First Floor ________________

Is there an attached warehouse/shop space? (Y/N) ____ describe its use: _____________________________

Is there a basement or underground garage? (Y/N) ____ describe its use: _____________________________

Foundation Type (Check appropriate boxes)

☐ Slab-on-Grade ☐ Slab-above-Grade (elevated/cap-slab on fill) ☐ Crawl Space ☐ Basement ☐ None

Describe ____

Survey Preparation Information

Preparer's Name: ____ Date Prepared: ________________

Affiliation: _______________________ Phone: _________________ Email: ___________________________

Non-Residential Indoor Air Quality Evaluation Form

Date: ____________________ **Facility Name:** ___________________ **EPA ID No.:** ___________________

PART 2: Factors Impacting Indoor Air Quality and Sampling

Questions

Describe renovation activities over the last 6 months (what was done, what area, and when):

____

____

____

Describe any open combustion in the building. (smoking/incense/candles/cooking/burning)

____

____

____

Have site-specific contaminants of concern been used or stored in the building or nearby? ☐ Yes ☐ No

Please list the general types of chemicals______________________________________

Have any significant amounts of volatile chemicals been used recently? ☐ Yes ☐ No

Please list the chemicals____

Describe any instance of water/groundwater present in the basement/crawlspace (including sumps):

____

Are there conduits for sewer gases to enter the building (dry p-traps, open clean-outs, abandoned hook-ups, poorly installed/sealed/seated plumbing)? Describe:

____

Observations

What is the temperature relative to outside? ___________________________

VI is promoted when the interior is warmer than the exterior.

Were windows/doors/roll-up doors kept open? _____________________________

Increased ventilation from the outside will dilute vapors from the subsurface and may mitigate areas of negative pressure.

Mechanical ventilation system status and condition? _________________________

Are intake or exhaust fans being used? __________________________

Are there ventilation hoods in use? _____________________________

Is there evidence of negative pressure? _____________________

Indicated by air moving from the outside in. Negative pressure is the main driving force that moves vapors into a building.

Do parts of the indoor environment appear stagnant? _________________________

Vapors may build up in areas with poor ventilation.

Describe any strong odors. _______________________________________

Strong odors may indicate poor ventilation or an indoor air source that may interfere with analysis.

Building Construction

Building Construction Materials?

☐ Concrete ☐ Concrete Block ☐ Steel ☐ Wood ☐ Other _______________

Does the building have an at-grade or below-grade garage? ______ How is it ventilated? _________________

Non-Residential Indoor Air Quality Evaluation Form

Date: ____________________ **Facility Name:** ___________________ **EPA ID No.:** ___________________

Does the building have an attached mechanical room? ________________________

Does the building have footers distinct from the slab or integrated footers? ____________________

Is the building slab constructed with post-tension concrete? ____________________

What are the ceiling heights? ____

Pathway Analysis

Does the building have a basement or sub-surface structures that are/have:
☐ Unfinished ☐ Exposed soil ☐ Damp or flooded ☐ Unsealed utility lines ☐ Other _________________

Are there utilities that penetrate the slab that may be conduits for soil vapor? ☐ Yes ☐ No

Are these:

Connected to subsurface vaults? ☐ Yes ☐ No

Connected to utilities closer to potential VI sources? ☐ Yes ☐ No

In areas where pressure differential would cause air to flow through them? ☐ Yes ☐ No

Is there non-ventilated spaces in the building (maintenance /electrical / server rooms)? ☐ Yes ☐ No

If Yes, describe: ____

Are these spaces occupied? ☐ Yes ☐ No

At what frequency/duration? ________________

Are there potential pathways in these spaces? ☐ Yes ☐ No

If Yes, describe: ____

Are there heat sources in these spaces (servers, transformers, etc.? ☐ Yes ☐ No

If Yes, describe: ____

Are there heat sources or other systems that may generate a negative pressure near the floor/slab?
☐ Yes ☐ No
If Yes, Describe: ____

Are there elevators in the building? ☐ Yes ☐ No
If the elevators are hydraulic how deep do the pistons penetrate below the slab? _____________

Are there utilities penetrating the floor/slab? ☐ Yes ☐ No

Are there sumps, either interior or outside and adjacent? ☐ Yes ☐ No

What is the condition of the foundation/slab? ____

Non-Residential Indoor Air Quality Evaluation Form

Date: ______________________ **Facility Name:** _____________________ **EPA ID No.:** _____________________

Was the building constructed with a subslab system or barrier? ☐ Yes ☐ No

If Yes, describe: ____

____

____

Are there floor drains? ☐ Yes ☐ No

If Yes, describe: ____

____

____

If the foundation design specifications and/or as-built drawings are available, please attach.

Other Information (that may be of importance in understanding the indoor air quality):

____

____

____

Potential Sampling Locations

General notes on potential sample locations and type. Tentative sampling date(s) and preferred times.

____

____

____

On a separate page, draw/attach the general floor plan of the building and denote potential locations of sample collection. Indicate locations of doors, windows, ventilation system components, indoor air contaminant sources and field instrument readings.

Non-Residential Indoor Air Quality Evaluation Form

Date: ______________________ **Facility Name:** _____________________ **EPA ID No.:** _____________________

PART 3: Inventory of Potential Indoor Contaminant Sources:

List items/products in the building or the attached warehouse/shop that may contain site-specific contaminants of concern. Attach Safety Data Sheets (SDSs).

Potential contaminant source	Location of Product Source	Photograph, ingredients, PID reading	Remove? Y/N

Non-Residential Indoor Air Quality Evaluation Form

Date: ____________________ **Facility Name:** ____________________ **EPA ID No.:** ____________________

PART 4: Building Heating/Cooling/Ventilation Systems

(Note: Complete this section as much as possible. Not all facility personnel or their contractors will readily have access to information in this section. Information from this section will help determine characteristics of some systems and it's impacts on vapor intrusion)

Systems Present

What types of systems are used for heating, cooling and ventilation? Check all that apply.

☐ Air Handler(s) ☐ Package Units ☐ Window/Wall systems ☐ Split System

☐ Radiant heating (electric or water/steam) ☐ Evaporative Coolers ☐ Heat pump ☐ Built-up ☐ None

Comments ____

Do the systems present provide make-up/fresh air? ☐ Yes ☐ No

Fresh air should be supplied in all commercial/industrial/institutional settings. ASHRAE Standard 62, *Ventilation for Acceptable Indoor Air Quality*, has guidelines on how much air should be supplied. Meeting these requirements generally helps to mitigate VI impacts.

Have the systems been evaluated for ASHRAE Standard 62 compliance? ☐ Yes ☐ No

Is a system commissioning report available? ☐ Yes ☐ No (attach)

When was the system last tested and balanced? __________________ (attach report if available)

Is the ventilation system automated (building automation system)? ☐ Yes ☐ No

Automation systems can be used to record settings during sampling and to verify HVAC operation where an HVAC remedy is required

If yes is the data recorded or can it be recorded? ☐ Yes ☐ No

(*Note that the ventilation settings should be evaluated in the automation system and verified manually where possible.)*

System operations

For each of the ventilation systems describe how is outdoor air supplied?

- Economizers: ______________________
    - minimum and maximum settings cfm or %_______________________________
- Manual adjustable outdoor air intakes _____________________
    - Settings _____________________________________
- Fixed outdoor air intakes? ____
- Unused outdoor air intake (blank panel)? _____________________________________
- Outdoor air intake not easily installed (e.g., split system, radiant heating) __________________

How frequently are the ventilation systems serviced? _____________________________

Generally, systems should be serviced quarterly to verify performance.

Days and hours of operation for each ventilation system ______________________________________

Do any of the ventilation systems operate during nights and weekends? ☐ Yes ☐ No

Non-Residential Indoor Air Quality Evaluation Form

Date: ____________________ **Facility Name:** ___________________ **EPA ID No.:** ___________________

If yes, are they operating on reduced settings? ☐ Yes ☐ No

Are the temperature / ventilation settings locked or routinely adjusted by the occupants? _________________

What are the temperature settings? (note if seasonally variable) Days _____________ Nights ___________
Weekends _____________

If there is an economizer, does the system control outdoor air supply using: (check all that apply)
☐ Outdoor air temperature/enthalpy ☐ CO_2 concentration ☐ Other ______________

Is there power exhaust? ☐ Yes ☐ No

Is the power exhaust setting dependent on ☐ economizer damper position ☐ static pressure

Does the system use variable or constant air volume distribution (VAV/CAV)? _________

Is there a dedicated outdoor air system installed? ☐ Yes ☐ No

If Yes, describe: ____

Other Ventilation Issues impacting vapor intrusion potential.

Does the ventilation system have any underground components? __________________

Having air flow on or below the building floor can draw in vapors from the subsurface.

Is ventilation being supplied or returned under a false floor above the building slab? ___________

This is common in server rooms

Are ducting components routed through a basement, crawlspace, or utility vault area? _______________

Is a boiler or heater present in a basement or crawlspace? ______ describe_________________

Is the make-up air balanced with the exhaust fans in kitchens, laboratories and similar spaces? ___________

Are there spaces of the building that are inherently at a negative pressure? __________________

Certain rooms such as kitchens are generally kept at negative pressure other rooms may be negative due to system design/use

Outdoor air intakes

Where are the outdoor air intakes located? ____

Are any intakes near sources of contaminants / sewer vents? _______________________________________

Are there carbon filters present in the ventilation system? _______

What make and model of filters are present and how often are they changed? ___________________

Non-Residential Indoor Air Quality Evaluation Form

Date: ______________________ **Facility Name:** _____________________ **EPA ID No.:** _____________________

Ventilation zones and settings

Zone/ Room	System Type	Supply Air Total cfm (range if VAV)	Supply Air % outdoor (range)	Ducted y/n	Return Air cfm	Ducted y/n

Non-Residential Indoor Air Quality Evaluation Form

Date: ______________________ **Facility Name:** _____________________ **EPA ID No.:** _____________________

Additional Notes:

STANDARD OPERATING PROCEDURE SOP-2

Analytical Method for the Determination of Volatile Organics in Soil Vapor or Air Using the HAPSITE Field GC/MS

Purpose

This standard operating procedure (SOP) presents general guidelines for using a HAPSITE gas chromatograph (GC)/mass spectrometer (MS) to analyze soil vapor or air samples in the field using U.S. Environmental Protection Agency (EPA) Method TO-15 as guidance.

Scope

This SOP provides a general description of how to analyze soil vapor or air samples in the field with a HAPSITE GC/MS. This SOP is intended to be used by GC/MS chemists with proper training and experience. These procedures are based upon EPA Method TO-15, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, *Second Edition* (1999), and the HAPSITE user manual. This method is applicable to specific volatile organic compounds (VOCs) in soil vapor or air. Table 1 presents a list of VOCs with reporting limits (RLs) that can be analyzed with this procedure.

Equipment and Materials

HAPSITE GC/MS sampling materials:

- Inficon HAPSITE Smart, Smart Plus, or ER GC/MS
- GC Column – VOC (Standard)
- Gas sampling bags (such as Tedlar brand) in varying sizes as needed (including canister-to-bag adapter for calibration standards).
- Gastite syringes in various sizes from 25 microliters (µl) to 100 milliliters (mL) with Teflon plunger and rounded needle tip.
- Portable Windows-based laptop computer, equipped with HAPSITE Smart IQ software for acquisition, integration, quantitation, and storage of mass spectral data (including communication cable between HAPSITE and laptop and a transfer method for retrieving data from the vendor-supplied laptop). The HAPSITE can operate without connection to a computer, but a computer is necessary for higher-quality data reprocessing.
- Power source – either line power or an automobile power inverter. The HAPSITE has an onboard battery, but it needs to be re-charged periodically.
- Internal/Surrogate/Tuning Standard mix, provided with the HAPSITE in a disposable gas cylinder.
- Nitrogen Carrier Gas, provided with the HAPSITE in a disposable gas cylinder.
- Two-stage regulator for nitrogen cylinder (optional). CGA 580 fitting.
- Calibration standards – 6 liter (L) evacuated canisters prefilled with 5 parts per billion by volume (ppbV) and 0.5 ppbV of mixed gas standard for calibrating the HAPSITE and verifying calibration daily.

- Method blank standard – 6 L evacuated canister prefilled with high-purity nitrogen, to verify the HAPSITE is free of contamination daily.

Procedures and Guidelines

This SOP describes the general procedures and guidelines for using a HAPSITE GC/MS, to analyze soil vapor or air samples in the field.

Overview of the Analytical Process

- Soil vapor and air samples are collected through the sampling probe at ambient pressure.
- The HAPSITE can be operated in two different modes. Analytical mode for quantitative (quant) and qualitative results, or survey (sniff) mode for qualitative screening.
- Quant mode: Samples are introduced into the GC/MS system by way of a sample probe and concentrator. The concentrator traps the sample onto an adsorbent trap, which allows atmospheric gases to pass through (such as, carbon dioxide, oxygen, and nitrogen [N_2]). The trap is then heated, and the analytes are transferred to the GC column, then to the MS detector.
- Survey mode: Samples are introduced through the sample probe directly into the MS detector.
- Data are collected and stored into the HAPSITE system memory. The data can then be used by an external computer for calibration, data processing, reporting of samples, and data archiving.
- SIM and SCAN: The MS system can operate in SCAN or SIM mode, depending on analytical or specific project requirements. SCAN mode is used for more conventional TO-15 analysis or if tentatively identified compounds (TIC) are required. In this mode, the MS scans a range of ions (typically 35 to 250 atomic mass units). This range contains all ions necessary to identify and quantitate all compounds in the TO-15 list. If lower detection levels are required, SIM mode may be used. In SIM mode, the analyzer only looks at ions specific to the target compounds. Up to three ions are used per compound, 1 for quantitation and 1 or 2 for qualification. This increases the dwell time that the analyzer spends scanning for each specified ion, which increases sensitivity at the cost of selectivity. Because of this, it is not possible to produce TIC reports in SIM mode.
- After samples are analyzed, processed, and meet all acceptance criteria herein, a client report is generated and typically reviewed by a peer.

Target Analytes, Reporting Limits, and Detection Limits

Standard target analytes and RLs for the base analyte list for analysis in SIM mode are listed in Table 1. To keep the analysis time as short as possible, the analyte list should be kept to the minimum number of compounds of interest. To produce the analyte list and RLs in Table 1, it takes approximately 10 to 15 minutes from injection to injection (including sampling time, analytical run time, and post-run instrument cool down).

The RLs shall be at or above the lowest calibrated point on the initial calibration curve. RLs may increase or decrease based on the amount of time the sample is loaded onto the concentrator. Typical achievable limits for a 1-minute fill time are listed in Table 1 for SIM mode.

Table 1: Method Analytes (1-minute fill time)

Standard Analytes	Reporting limit µg/m3
1,2-DCE (cis)	2.0
1,2-DCE (trans)	2.0

Table 1: Method Analytes (1-minute fill time)	
PCE	3.5
TCE	2.8
Vinyl Chloride	1.3

*All RLs are subject to change on a client specified basis as requested by that client. Analytes listed here are referenced as the most common select list of VOCs to maintain during a HAPSITE investigation. Please check with your project-specific VI SME for the appropriate screening list.

Interferences

Contamination may occur in the sampling system if it is not properly cleaned before use. Therefore, the probe should be heated and an ambient system flush performed at the start of each day, and between samples with elevated (greater than double the highest point on the calibration curve) concentrations of VOCs.

Contamination may occur from impurities in the carrier gases and from background sources. These sources of contamination are monitored through analysis of method blanks.

Cross-contamination can occur whenever samples containing high VOC concentrations are analyzed. Therefore, whenever an unusually concentrated sample is encountered (greater than double the highest point on the calibration curve), the analyst uses professional judgment when reviewing the samples to determine whether reanalysis is necessary.

Sample Collection, Storage, Holding Times, and Preservation

Samples are collected in gas sampling bags. Analysis of gas sampling bags should be performed immediately after sample collection. Samples should be field screened with a photoionization detector before analysis to obtain an approximate dilution factor.

Standards, Gases, and Reagents

All standards are logged into the chemical inventory database upon receipt. Any standard that is prepared in the laboratory will be verified against current standards before use.

- Calibration standard—Purchase a premade standard or have a vendor prepare a calibration standard in a 6-L Summa canister. Actual concentration and composition varies by project, but typically 5 ppbV and 0.5 ppbV are good targets.
  - Stock standards—Standards are purchased as custom made mixtures in gas cylinders. Cylinders purchased from vendors are traceable to a National Institute of Standards and Technology. 62-component mixture from Scott Gases (catalog number 41973-U). Stock standard is 1,000 ppbV.
  - Primary Field Standard (5 ppbV)—Dilute the 1,000-ppbV primary standard(s) 1:200. Evacuate a clean 6-L canister. Add 50 µl of DI water. Add 90 mL of 1,000-ppbV standard. Fill canister to final pressure of 2,280 torr using Ultra High Purity (UHP) N_2. This provides 12 L of usable 5-ppbV standard (16 L total).
  - Primary Field Standard (0.5 ppbV)—Dilute the 1,000-ppbV primary standard(s) 1:2000. Evacuate a clean 6-L canister. Add 50 µl of DI water. Add 9 mL of 1,000-ppbV standard. Fill canister to final pressure of 2,280 torr using UHP N_2. This provides 12 L of usable 0.5-ppbV standard (16 L total).
  - Daily Field Calibration standards—Primary Field Daily Calibration Standard—Fill a 1-L gas sampling bag with 5-ppbV primary field standard.

- Internal/Surrogate/Tuning standard—The internal/surrogate/tuning standard mix is provided with the HAPSITE in a disposable gas cylinder. Each cylinder is prepared with bromopentafluorobenzene (BPFB) and 1,3,5-tris (trifluoromethyl) benzene (TRIS) at approximately 5 ppbV, with nitrogen as the balance gas.
- Nitrogen Carrier Gas—UHP 99.999 percent or better. Either in disposable Inficon canisters or commercially provided cylinder (if HAPSITE will be used in a fixed location and large quantities are required).

Analytical Procedure

- Startup when the HAPSITE is received:
  - Unpack the HAPSITE. It is usually shipped with the power off and the MS pumped down. Be sure that it has a significant amount of time (at least an hour or overnight if possible) to warm up and equilibrate before use.
  - Insert the carrier gas (or attach external supply) and internal standard gas cylinders. Visually verify that the sample trap has not broken during shipment.
  - Plug the HAPSITE into an external power source.
  - Attach the computer (turn on and start software). Then push the power button on the HAPSITE. The HAPSITE will go through a warm up routine, then a tune. When prompted for a trap clean out, press ‘yes’ on the HAPSITE screen.
  - Load the desired method on the HAPSITE screen and then denote this method as the default method. This is important because otherwise it will default to a different method at the end of each run and change zone temperature settings. Note: All files (method, tune, data) reside on the HAPSITE, not the laptop computer.
- Create a new subdirectory each day. This can be done in the method editor (Data page).
  - Startup from extended standby:
    - Press power button
    - Insert internal standard and carrier gas.
    - Wait for instrument to warm up and run tune.
  - Analytical standards and/or diluted samples in gas sampling bags are attached to the sample probe manifold with a compression fitting. Ambient air samples are simply drawn directly into the probe. Pressurized or evacuated sample or standard sources cannot be used as they will significantly change instrument response.
- Quantitation Mode
  - Using the method editor on the PC, verify that the desired sample time is set correctly in the method to be used for analysis. Typically, this will be 1 minute, but may differ depending on project requirements or dilutions. Save the method.
  - Load the appropriate quantitation method onto the HAPSITE. This can either be done from the touch screen or the PC. Be sure that the method is appropriate for the target compounds. If necessary, sensitivity can be increased by using SIM to target the most important ions of interest.
  - Run the quality control (QC) (either an initial calibration [ICAL] or calibration verification [CV] and blank). Attach a gas sampling bag containing the standard or UHP blank gas to the sample

  probe. Open the bag and press run on the HAPSITE. Once QC has passed criteria, then sample analysis can begin.

  - Attach a gas sampling bag containing the sample to the sample probe and press the run button on the HAPSITE. Once the desired sample time has been completed, the gas sampling bag can be removed.
  - Once the analysis is complete, allow the GC oven to cool, then inject the next sample.
  - All the sample and QC information for an analytical run, such as laboratory and client sample identifications (IDs), injection volumes, standard IDs, and run methods, are added to the field log.
- Sample Dilution
  - Any sample that has target analytes over the calibrated range of the instrument should be diluted if possible. The subsequent dilution should be run such that the final value of the maximum concentration analyte recovers within the calibrated range on the instrument (before dilution factors are applied).
  - Required dilutions for HAPSITE analysis can be achieved in two different ways:
    - Concentrator fill time: Inject a smaller sample volume. Record all dilutions in the field form. For example, normalized to a 1 minute fill time (100 mL), a dilution of 5 times can be performed by only sampling for 0.2 minute (20 mL). Using the method editor on the PC, set the desired sample time in the method to be used for analysis. Save the method. Then load the appropriate quantitation method onto the HAPSITE. This can either be done from the touch screen or the PC
    - Gas sampling bag dilution: Take a sample with a syringe and inject it into a gas sampling bag with a known volume of clean air. Attach the bag to the instrument sampling port and withdraw an aliquot. The aliquot can be less than the normalized value (as in the section before). Both the gas sampling bag dilution factor and concentrator fill injection factors are applied to the final instrument result.
- At the end of the day, put the HAPSITE into external standby and remove carrier gas and internal standard (ISTD) if the instrument is going to be used again next day. Otherwise, the HAPSITE can be powered off.

Quality Control and Quality Assurance

All RLs, QC frequency, and QC acceptance criteria are subject to change on a project specific basis.

- The instrument is tuned using BPFB and TRIS. This is performed before analysis each day. The HAPSITE software runs a tuning program set to optimize its instrument parameters for analysis. This program optimizes sensitivity and enables library matching of the spectra.
  - There are short- and long-tune algorithms. Typically, the short tune is performed. A long tune is performed only after major instrument maintenance.
  - After running a successful tune (tune passes internal instrument criteria), it is saved to the default tune file.
  - The HAPSITE is not designed to pass the TO-15 bromofluorobenzene (BFB) tune criteria to operate at its highest potential. Therefore, BFB tune criteria are not relevant for this SOP.
- Initial Calibration—An initial calibration curve is required to demonstrate adequate instrument performance for sensitivity, linearity, resolution, and absence of active sites.

- A valid initial calibration curve must be established before samples can be analyzed. The GC/MS is calibrated following the outline herein. Variations from this standard calibration scheme are sometimes necessary because of project RL requirements.
- As the RL is driven by the lowest calibration point, any lowering of the RL will require either (A) calibrating to a lower level or (B) injection of more sample volume.
- Calibration schemes.
- The following calibration schemes have been successfully used, the actual scheme used should be tailored to the instrument and project requirements. It is based on a 1-minute sampling period (1 minutes at 100 mL/min = 100 mL)

  Cal Levels (1-minute sampling time normalization)

  Table 2. Calibration Levels

Cal level	Std Concentration, ppbV	Sampling time, min.	Concentration, ppbV
Level 1	0.5	0.2	0.1
Level 2	0.5	1.0	0.5
Level 3	0.5	2.0	1.0
Level 4	5.0	1.0	5.0
Level 5	5.0	5.0	25.0

- The curve can be shifted to be more or less sensitive by increasing or decreasing the sampling time. Longer sampling time increases sensitivity, and vice versa.
- For the initial calibration, a response factor and a percent relative standard deviation (%RSD) are calculated for each analyte.
- After a new calibration is performed, the method needs to be saved with the correct filename. The method name should be the date followed by an identifier. For example, an ICAL performed on October 29, 2014, for client X shall be named 102914X.
- There must be at least three points to have a valid calibration curve. The lowest point will be below the quantitation limit required in the Quality Assurance Project Plan.
- The %RSD for all compounds must be less than 30 percent.
- If the %RSD greater than 30 percent, then a linear curve fit may be used if the curve fit greater than 0.995.
  - If the requirements are not met, then a new initial calibration must be performed. If this does not result in an acceptable initial calibration, then system maintenance may be necessary.
  - Calibrations are valid for 1 year (or until the end of the project, whichever occurs first) if QC continues to meet acceptance criteria.
  - In the following instances, a new calibration shall be required:

    Major instrument maintenance such as cleaning the MS.

    Repeated failure (more than 3 attempts) to pass continued calibration criteria.

- Method Blanks—Method blanks are required at a rate of one per day. Method blanks are analyzed to monitor possible instrument contamination. Laboratory method blanks are prepared with UHP nitrogen in a gas sampling bag every day samples are to be analyzed. The method blank is carried through the same analytical procedure as a field sample.

  - Method blanks are analyzed by injecting the full normalized volume of nitrogen (varies by system) into the HAPSITE and following procedures outlined in Section 9.
  - The blank must not contain any target analyte at a concentration greater than the RL and must not contain additional compounds with elution characteristics or mass spectral features that would interfere with identification and measurement of a method analyte. If target analytes are found in the method blank above the RL, the source of the contamination must be considered. Usually, rerunning the blank will resolve most problems (especially if the sample run prior to the blank was high in target analyte concentration). If blank contamination is still present, the analyst must perform system maintenance. Some common problems that cause a blank to show contamination are:
    - Cold spots—check heated zones for failure
    - Contaminated sample probe—flush the probe
    - Dirty gas sampling bag—flush and refill the bag or use new bag

- Continuing Calibration Verifications—a primary source standard analyzed at the beginning of an analytical batch to ensure that the instrument continues to meet the instrument sensitivity and linearity requirements originally established by the initial calibration.
  - The opening CV for each compound of interest shall be verified prior to sample analysis using the same introduction technique and conditions as used for samples. This is accomplished by analyzing one of the calibration standards used for initial calibration.
  - Concentrations for CV must be at or below the midpoint of the instrument calibration curve.
  - No closing calibration check is required for TO-15 analysis. However, a closing calibration check will be analyzed to increase confidence in data quality.
  - The percent difference (%D) for each compound may not exceed 30 percent.
  - Failure to pass continuing calibration criteria requires corrective action are performed. Repeated failure (more than 3 consecutive attempts) to pass response factor criteria requires the performance of a new initial calibration.

Attachments

- HAPSITE Log Sheet – Quant Mode
- HAPSITE Log Sheet – Sniff Mode

References

U.S. Environmental Protection Agency (EPA). 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*. January.

Infilcon. 2017. Operating Manual: HAPSITE ER Chemical Identification System. IPN 074-471-P1D.

Infilcon. 2008. Operating Manual: HAPSITE Smart Plus Chemical Identification System. IPN 074-472-P1D. November.

Hapsite Log Sheet
Quant Mode

Site ____________________

Date ____________________

Operator ____________________

SubDirectory ____________________

Location	Time	File ID	Fill Time	DF	Notes

Comments: ____

Hapsite Log Sheet
Sniff Mode

Site ____________________

Date ____________________

Operator ____________________

General Location ____________________

SubDirectory ____________________

File ID ____________________

Start time ____________________

Location	Time	Notes

Comments: ____________________

STANDARD OPERATING PROCEDURE SOP-3

Sewer Gas Sampling

Purpose

This Standard Operating Procedure (SOP) presents general guidelines for collecting sewer gas samples from sanitary or stormwater manholes or cleanouts in support of vapor intrusion (VI) investigations. The number, location, analytical method (including sampling container), and sampling duration of sewer gas samples should be determined on a project-specific basis.

Scope

This SOP provides a general description of how to conduct sewer gas sampling in sanitary or stormwater sewer manholes or cleanouts. This SOP includes multiple different sampling techniques:

- Grab sampling with gas sampling bags for real-time analytical intruments, such as the Inficon HAPSITE GC/MS
- Grab sampling with evacuated canisters
- Extended duration sampling (for example, 8 or 24-hour) with evacuated canisters
- Extended duration sampling with passive sampling devices

Equipment and Materials

Typical equipment required includes the following:

- Laser distance finder or water level meter to determine depth to water/wastewater.
- Teflon tubing 1/4-inch-outside-diameter (OD) tubing. Ensure there is enough tubing to use new tubing at each sample location. (Tubing may not be needed if only passive sampling devices are used and field measurements are not collected.)
- Tubing weight – A small piece of metal can be secured to the end of the Teflon tubing if it is not possible to keep the tubing straight. This is optional for correct placement of the tubing inlet.
- Wrenches, various sizes as needed for connecting fittings. A 9/16-inch wrench fits the 1/4-inch Swagelok fittings, which most canisters and flow controllers have.
- Rubbing alcohol, phosphate-free detergent, water, and paper towels to decontaminate anything that comes in contact with wastewater/sewage.
- MultiRAE five-gas meter meter with photoioization detector (PID) for health and safety to ensure breathing zone concentrations remain within levels specified by the health and safety plan. It is also optional to collect field measurements of the sewer gas.
- *Optional* (needed if work is to be performed in publically accessed or trafficked areas) – Reflective cones, “Men At Work” signs, barricades, and/or caution tape to alert others of manhole.
- *Optional* (needed if manhole cover has to be moved to sample):
    - Manhole lid lifter – various styles are available depending on manhole size and surrounding ground cover.

  - Plastic sheeting to cover the manhole opening, with sand bags or duct tape to secure the plastic to the ground (needed for grab samples).
- *Optional* (for sampling a sewer cleanout) – a cap with a pre-drilled hole for tubing to use during sampling. This cap should create an air-tight seal with the cleanout pipe. It may be a replacement PVC cap so it screws into the cleanout pipe, or it may be a flexible rubber cap that fits over the cleanout pipe.
- *Optional* – LandTec GEM landfill gas meter for field measurements of carbon dioxide, oxygen, and methane in the sewer gas prior to and/or after sampling. If field measurements indicate that the sampling canister will contain methane in excess of the lower explosive limit (LEL), five percent by volume, then the sampling canisters or bags will need to be shipped as dangerous goods.

Equipment for bag sampling:

- Bag sampler (lung box)
- Vacuum pump with rotameter capable of a flow rate set to 200 milliliters per minute (mL/min)
- Gas sampling bags (1 liter) – Enough for each sample location and a few spares for purging.

Equipment for evacuated canister sampling:

- Stainless-steel sampling canister(s), certified clean and evacuated by the analytical laboratory.
- Flow controller(s) set at desired sampling rate by the analytical laboratory.
- Analog vacuum gauge dedicated to the canister (provided by the analytical laboratory) may be permanently attached to either the canister or flow controller. This vacuum gauge will be used to monitor the canister vacuum during sampling.
- *Recommended* – Digital vacuum gauge with a -30 to 0 inch mercury (Hg) range, and 0.50 inches Hg accuracy, equipped with appropriate fitting for canister setup. Digital gauges should not be shared between soil vapor samples and air samples (indoor, outdoor, or crawlspace) to prevent cross-contamination. Analog vacuum gauges may be used instead of digital ones, but they may not be as accurate.
- T-connector (provided by the analytical laboratory) to collect simultaneous duplicate samples.
- Swagelok 1/4-inch nut and ferrule sets for connecting the tubing to the sampling canister (part #SS-400-NFSET).
- Materials to secure or hang the canister or sample tubing inside of the manhole or cleanout for extended duration samples.
- Shipping container, suitable for protection of canister(s) during shipping. Typically, strong cardboard boxes are used for canister shipment. The canisters should be shipped to the analytical laboratory in the same shipping container(s) in which they were received.

Equipment for passive sampling:

- Passive sampling devices, which typically consist of a sorbent and a diffusion rate limiting element.
- Materials, such as string or wire, to secure or hang the passive sampling device inside of the manhole or cleanout.

Procedures and Guidelines

General Guidelines

- The field team should coordinate sampling activities with the city's public works department prior to conducting the sampling. The city may also be able to supply drawings of the sewer lines.
- Traffic control may be required for sampling manholes in or next to roads.
- Sewer gas sampling should not be performed until 48 hours after a significant rain event if it is a combined sanitary and stormwater system.
- Sewer gas samples will be collected from ground surface by advancing the sampling device or sample tubing into the manhole. Under no circumstances should field personnel enter the manhole.

Sampling Setup - General

1. Block off the area where sampling will be performed if it is publicly accessible. Use cones, barricades, and/or caution tape, as necessary.
2. Gain access to the manhole or cleanout for sampling.
    2.1. If necessary (i.e., there are no holes in the lid or other access points), move the manhole lid slightly to allow just enough space to perform measurements and sampling, or remove the manhole lid. If the manhole lid is moved slightly, be sure to use a wedge to prevent the lid from sliding and pinching the sample tubing.
3. Measure and record the depth to water/wastewater in the manhole with a laser distance finder or water level meter. If sampling a sewer cleanout, measure the depth to the bottom of the pipe if there is no water/wastewater in the pipe.
4. *Optional* – document the number, location, size, and depth of influent/effluent pipes in the manhole.

Sampling Setup and Collection – Grab Samples

1. Measure and cut the Teflon tubing. The sample tubing inlet should be placed approximately 1 – 2 feet above the top of the water surface or bottom of the pipe if dry, and a weight may be used to ensure correct placement of the tubing.
2. Insert the tubing inlet into the manhole or cleanout using the one of the following approaches:
    2.1. If the manhole cover has openings large enough to slip the tubing through or can be moved slightly to create a space, lower the tubing into the manhole through the opening, and secure it with the tubing inlet set at the appropriate depth. Plastic sheeting and/or tape may be used to cover openings in the manhole cover. If the manhole cover was moved or if openings were covered up, then wait 30 minutes for the sewer gas to equilibrate to ensure the sample isn't diluted by outdoor air.
    2.2. If the manhole cover needs to be removed temporarily, place polyethylene sheeting over the manhole and secure it around the manhole using tape and/or sandbags. Make a small hole in the sheet, lower the tubing into the manhole through the hole, and secure it with the tubing inlet set at the appropriate depth. Wait 30 minutes for the sewer gas to equilibrate to ensure the sample isn't diluted by outdoor air.

    2.3. If sampling a sewer cleanout, remove the cover and place a cover on the pipe with a hole for the tubing. Insert the tubing into the hole and secure it with the tubing inlet set at the appropriate depth. Wait 30 minutes for the sewer gas to equilibrate to ensure the sample isn't diluted by outdoor air.

3. Connect the MultiRAE to the tubing to perform field measurements of the sewer gas. Record the field measurements on the form. It is optional to collect field measurement with a LandTec GEM landfill gas meter also.
4. Performing the field measurements will purge the sample tubing of ambient air. At least 3 times the tubing volume should be purged. (One foot of tubing is approximately 10 mL. The MultiRAE pumps at approximately 550 mL/min.)
5. Detach the MultiRAE and immediately attach the tubing to either the bag sampler or evacuated canister.
6. Sample collection with gas sampling bags
    6.1. Connect the bag sampler to the tubing. Attach a gas sampling bag to the fitting inside the box and open the bag. Close the bag sampler. Attach the vacuum pump to the bag sampler if necessary.

    6.2. To begin sampling, turn on the vacuum pump at 200 ml/min and record the sample start time.

    6.3. At the end of the sample period, turn off the pump, open the bag sampler, close the bag, and record the sample end time.
7. Sample collection with evacuated canisters
    7.1. Measure the initial canister vacuum with the digital vacuum gauge. The initial vacuum should be between -28 and -30 inches Hg. If it is less than -26 inches Hg, do not use the canister for sampling. If it is between -28 and -26 inches Hg, only use the canister if there are no other spare canisters available. Note that altitude can affect vacuum readings and account for these differences (i.e., each additional 1,000 feet of elevation above sea level reduces the maximum vacuum measured in a canister by approximately 1-inch Hg).

    7.2. In the field log, record the canister identification (ID), flow controller ID, initial vacuum, desired flow rate, sample location information, and all other information pertinent to the sampling effort.

    7.3. If using a canister with a valve, connect the flow controller and analog vacuum gauge to the canister. When the flow controller and vacuum gauge are attached correctly, they will not move separately from the canister (they will not spin around). If the canister is equipped with a quick-connect fitting and it is not equipped with a valve, do not attach the flow controller until it is time to initiate sample collection.

    7.4. Connect the canister via the flow controller to the sample tubing with a Swagelok nut and ferrule set.

    7.5. For canisters equipped with a valve, to begin sampling, open the canister valve one full turn and record the sample start time. For canisters equipped with a quick-connect fitting, sampling will initiate as soon as the canister is connected to the flow controller.

    7.6. Monitor the canister vacuum on the analog gauge (if present) several times during the sample period, to ensure the canister is filling at the desired rate and the final canister vacuum does not fall to 0 inch Hg.

   7.7. At the end of the sample period, close the canister valve, or detach the quick-connect fitting, and record the sample end time. Detach the canister and flow controller from the sample tubing.

   7.8. Measure the final canister vacuum with the digital vacuum gauge. The final vacuum should be between -10 to -2 inches Hg. If it is 0 inch Hg, do not submit the sample for analysis. If it is between -2 and 0 inch Hg, re-deploy the sample if possible; if not submit it to the analytical laboratory for analysis but make sure it is received with some residual vacuum.

   7.9. Replace the protective cap on the canister.

8. Duplicate samples should be collected simultaneously with a dedicated T-connector. Grab sample duplicates should be collected by attaching the T-connector to each canister and then connecting one flow controller to the top of the T-connector. (If there was a flow controller on each canister, then the sampling flow rate would be double that of the other samples.) The duplicate sample will take twice as long to collect.
9. Sampling information should be recorded on the Sewer Gas Sampling Log. Record any other observations pertinent to the sampling event on the sampling log. Also record the weather conditions (temperature, barometric pressure, precipitation, etc.) during sampling.
10. Remove the sample tubing and plastic sheeting. Do not reuse these materials, new tubing and plastic sheeting should be used at every manhole.
11. Replace the manhole lid if moved or removed.
12. Fill out all appropriate documentation (chain of custody, sample tags) and return samples and equipment to the analytical laboratory. Canisters are typically shipped in the same box in which they were received. Do not place sticky labels or tape on surface of the canister. Canisters and Tedlar bags should not be cooled during shipment.

Sampling Setup and Collection – Extended Duration Samples

1. The sample canister may either be placed into the manhole, or sample tubing may be used to extend into the manhole or cleanout. The canister should be carefully secured and the canister and tubing should be above the potential high water line in the manhole. Sample tubing will likely be needed for canister sampling from cleanouts because the canister probably will not fit into the cleanout. If the sample canister is left outside in a publicly accessible area, then it should be secured somehow so it isn’t stolen or tampered with.
2. Passive sampling devices will be placed into the manhole or cleanout. They should be placed and prepared as instructed by the manufacturer. Passive samplers may be hung in the manhole or cleanout from string or wire.
3. Canisters and passive samplers placed inside manholes or cleanouts should be secured at an appropriate depth that is within the target sampling zone, while making sure that the canister or passive sampler will not come in contact with water/wastewater which would ruin the sample.
4. If tubing is used, follow Steps 1 through 5 in the previous section. However, the manhole cannot be left unattended in publically accessible areas if the cover is removed (fully or partially) with only plastic sheeting covering it.
5. For canister sampling, follow Step 7 from the previous section. However, it is optional to check on the canister vacuum during the sampling period, and it should be understood that doing so will dilute the sample with outdoor air.
6. Placing the canister or passive sampling device into the manhole:

    6.1. Remove the manhole cover or slide it over enough to access the manhole.
    6.2. Collect field measurements of the sewer gas with the MultiRAE by extending tubing into the manhole. It is optional to collect field measurement with a LandTec GEM landfill gas meter also.
    6.3. Place the canister or passive sampling device into the manhole and secure it at the desired sampling depth. To begin canister sampling, open the canister valve one full turn and record the sample start time.
    6.4. Replace the manhole cover.
7. Duplicate samples should be collected simultaneously with a dedicated T-connector. Extended duration samples should be collected by attaching a flow controller to each canister and then connecting the T-connector to each flow controller. (If only one flow controller was used, then the sampling duration would be twice as long.)
8. After the planned sampling period is completed, retrieve the canister or passive sampling device from the manhole or cleanout and follow Steps 8 through 12 in the previous section.

Quality Control

- Verify implementation of traffic control plan if it was necessary.
- Verify local municipal or public works department approval to conduct sampling.
- Canisters supplied by the analytical laboratory must follow the performance criteria and quality assurance prescribed in U.S. Environmental Protection Agency (EPA) Method TO-14/15 for canister cleaning, certification of cleanliness, and leak checking.
- Flow controllers supplied by the analytical laboratory must follow the performance criteria and quality assurance prescribed in EPA Method TO-14/15 for flow controller cleaning and adjustment.
- Field duplicates and trip blanks (sorbent tube methods only) may be required.

Attachments

- Sewer Gas Sampling Log

References

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. 2015. *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. June.

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Sewer Gas Sampling Log - Canister Method

Project Info

Project Name: ……………………………………………… **Project # :** ……………………

Sampler Name: ……………………………………………… **Date:** ……………………

Structure

Identification: ………………………………………………………………

Manhole or Cleanout Location: ……………………………………………………

………………………………………………………………………………

Sewer Gas Sampling Log

Sample location	
Sample Identification	

Set up Information	Manhole removal time	
	Field Analysis time (If applicable - 30 min equilibration period)	
Optional Field Analysis MultiRAE PID	O2 (%)	
	CO (ppm)	
	H2S (ppm)	
	LEL (%)	
	Total VOCs (ppmv)	
Optional Field Analysis LandTec GEM	O2 (%)	
	CO2 (%)	
	CH4 (%)	
	CH4 (%) with carbon filter	

Canister Sampling	Canister ID	
	Flow controller ID	
	Sampling rate or period (mL/min)	
	Sample start date and time	
	Initial canister pressure (" Hg)	
	Sample completion date and time	
	Final canister pressure (" Hg)	
Passive Sampling	Sample device type or ID	
	Sample start date and time	
	Sample end date and time	

Weather conditions during sampling: ……………………………………………………

………………………………………………………………………………

Observations and Comments: ……………………………………………………

………………………………………………………………………………

………………………………………………………………………………

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Sheet ___ of ___

Soil Vapor Field Sampling Log

Diagram - Outline of Site & Location of Soil Gas Probes

N

Note:
Show the location of each soil gas probe and indicate distances from significant features at the site.

Other observations and comments: ....

STANDARD OPERATING PROCEDURE SOP-4

Indoor, Outdoor, and Crawlspace Air Sampling Using Canisters

Purpose

This Standard Operating Procedure (SOP) presents general guidelines for collecting indoor, outdoor, and crawlspace air samples using evacuated canisters. The type, number, location, and sample duration of indoor, outdoor, and/or crawlspace air samples should be determined on a project-specific basis.
A building survey should be performed before air sampling to identify potential confounding indoor sources of volatile organic compounds (VOCs) and to refine the proposed sampling locations based on building characteristics.

Equipment and Materials

- Stainless-steel sampling canister(s), certified clean and evacuated by the analytical laboratory.
- Flow controller(s) set at desired sampling rate by the analytical laboratory.
- Vacuum gauge (analog or digital) dedicated to the canister (may be permanently attached to either the canister or flow controller). This vacuum gauge will be used to monitor the canister vacuum during sampling.
- At least two (2) adjustable crescent wrenches. A 9/16-inch wrench fits the typical 0.25-inch Swagelok fittings, which most canisters and flow controllers have.
- Shipping container, suitable for protection of canister(s) during shipping. Typically, strong cardboard boxes or plastic totes are used for canister shipment. The canisters should be shipped to the analytical laboratory in the same shipping container(s) in which they were received.
- *Recommended* – Digital vacuum gauge with a -30 to 0 inches mercury (Hg) range, and 0.50 inches Hg accuracy, equipped with appropriate fitting for canister setup. To prevent cross-contamination, digital gauges should not be shared between soil vapor samples and air samples (indoor, outdoor, or crawlspace).
- *Recommended* – field instrument such as a MultiRAE photoionization detector (PID) to measure total VOC and carbon monoxide concentrations in the breathing zone for health and safety monitoring.
- *Optional* – Laminated "Do not disturb" signs identifying the canister as an air sample and providing contact information.

Additional Crawlspace Air Sampling Equipment:

- Teflon tubing (0.25-inch outer diameter [OD]) – to extend the sample inlet from the canister into the crawlspace.
- Swagelok nut and ferrule sets (part #SS-400-NFSET) – to connect the sample tubing to the canister.
- Rod for placing the crawlspace air sample tubing or the canister at the desired location in the crawlspace without having to enter the enclosed space. These can be metal, plastic, or wooden rods.

- T-connector (provided by the analytical laboratory) to collect simultaneous field duplicate samples through the same tubing.

Additional Outdoor Air Sampling Equipment:

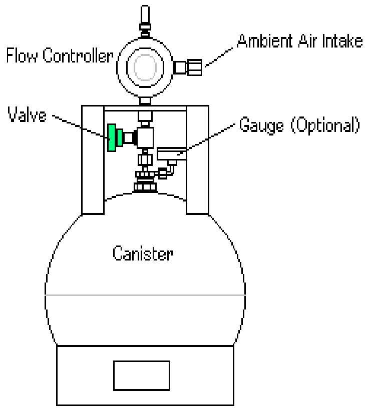
- Sampling cane, a length of Teflon tubing, or aluminum foil tent to prevent water from entering canister during sampling.
- Bike lock or chain and lock to secure the canister and prevent theft.

Procedures and Guidelines

This SOP describes the general guidelines for collecting indoor, outdoor, and crawlspace air samples using evacuated canisters. Sampling information should be recorded in the field logbook and on the attached form "Indoor, Outdoor, and Crawlspace Air Sampling Log—Canister Method".

1. Measure the initial canister vacuum with the digital vacuum gauge. The initial vacuum should be between -28 to -30 inches Hg. If it is less than -26 inches Hg, do not use the canister for sampling. If it is between -28 to -26 inches Hg, then only use the canister if there are no other spare canisters available. Note that altitude can affect vacuum readings and account for these differences (i.e., each additional 1,000 feet of elevation above sea level reduces the maximum vacuum measured in a canister by approximately 1-inch Hg).
2. In the field log, record the canister identification (ID), flow controller ID, initial vacuum, desired flow rate, sample location information, and all other information pertinent to the sampling effort.
3. If the canister has a valve to keep the sample from collecting, connect the flow controller and analog vacuum gauge to the canister (Figure 1). When the flow controller and vacuum gauge are attached correctly, they will not move separately from the canister (they will not spin around). If the canister is equipped with a quick-connect setup, do not attach the flow controller until it is time to initiate sample collection.

Figure 1. Assembled Canister



4. For outdoor samples, be sure that the inlet to the flow controller is protected from precipitation. Either place the canister and flow controller under a shelter (do not restrict air-flow to sample intake), use a sampling cane provided by the analytical laboratory, attach a length of tubing that hangs downward, or use a clean piece of aluminum foil to build a tent over the flow controller inlet. Secure the canister to an immovable structure with the bike lock or chain and lock to prevent theft.

5. For sampling crawlspace air through Teflon tubing, adjust the length of the sample tubing to be able to reach the desired sampling location, attach it to the rod with VOC-free tape or zip ties, and place the sample tubing into the crawlspace using the rod. Make sure the sample tubing influent is several inches above the ground level. Now connect the sample tubing to the inlet of the flow controller.
6. For indoor air samples, place the canister in the desired sampling location. Indoor air samples are typically collected at breathing zone height (3 to 5 feet above the floor) and a minimum of 5 feet away from exterior walls.
7. Attach the “Do not disturb” sign to the canister, as appropriate.
8. For canisters equipped with a valve, to begin sampling, open the canister valve one full turn and record the sample start time. For canisters equipped with a quick-connect setup, place the can in the desired sampling location, pull back the collar on the flow controller, push fully down onto the male end on the canister, and release the collar. The flow controller will spin freely but should not be able to lift off the can if installed correctly.
9. Monitor the canister vacuum several times during the sample period to ensure the canister is filling at the desired rate and the final canister vacuum does not fall to 0-inch Hg.
10. At the end of the sample period, close the canister valve, or remove the flow controller for a quick-connect setup, and record the sample end time.
11. Measure the final canister vacuum with the digital vacuum gauge.
    a. The final vacuum for 6-liter canisters should typically be between -10 to -2 inches Hg.
    b. The final vacuum for 1-liter or 2.7-liter canisters should typically be between -5 to -2 inches Hg.
    c. If the final vacuum is 0-inch Hg, do not analyze the sample; return the canister to the analytical laboratory marked as “Do not analyze” on the sample tag and chain of custody.
    d. If the reading is between -2 to 0 inches Hg, redeploy the sample if possible; if not, submit it to the analytical laboratory for analysis but alert the sample manager to request laboratory receipt vacuums to ensure it is received with some residual vacuum.
12. Replace the protective cap on the canister.
13. Fill out the appropriate documentation (chain of custody, sample tags) and return canisters and equipment to the analytical laboratory in the same shipping container in which they were received.
14. The samples should not be cooled during shipment. DO NOT put ice in the shipping container.
15. Do not place sticky labels or tape on any surface of the canister.

Quality Control and Quality Assurance

- Canisters supplied by the analytical laboratory must follow the performance criteria and quality assurance prescribed in U.S. Environmental Protection Agency (EPA) Method TO-14/15 for canister cleaning, certification of cleanliness, and leak checking.
- Flow controllers supplied by the analytical laboratory must follow the performance criteria and quality assurance prescribed in EPA Method TO-14/15 for flow controller cleaning and adjustment.

Attachments

- Indoor, Outdoor, and Crawlspace Air Sampling Log—Canister Method
- “Do Not Disturb” sign providing contact information.

References

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. 2015. *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.* June.

Indoor, Outdoor, Crawlspace Air Sampling Log - Canister Method

Project: ______________________________

Building: ______________________________

Field Sample ID	Location Description	Canister ID	Flow Controller ID	Initial Vacuum ("Hg)	Start Date	Start Time	Check (6/20 hr)		End Date	End Time	Final Vacuum ("Hg)
							Time	Vacuum ("Hg)			

Weather Conditions

General weather conditions: ______________________________

____

Temperature Range (indoor and outdoor): ______________________________

Was there significant precipitation within 24 hours prior to (or during) the sampling event? ______________________________

Air Testing in Progress

Please Do Not Disturb

Contact for Further Information:

Name: ______________________________

Organization:______________________

Phone:______________________________

STANDARD OPERATING PROCEDURE SOP-5

Indoor, Outdoor, and Crawlspace Air Sampling Using Passive Samplers

Purpose

This Standard Operating Procedure (SOP) presents general guidelines for collecting indoor, outdoor, and crawlspace air samples using passive samplers. The type, number, location, and sample duration of indoor, outdoor, and/or crawlspace air samples should be determined on a project-specific basis.
A building survey should be performed before air sampling to identify potential confounding indoor sources of volatile organic compounds (VOCs) and to refine the proposed sampling locations based on building characteristics.

Scope

Certified sorbent with diffusive membranes and sample base are shipped to the field. The sorbent, diffusive membrane, and base are assembled, and sampling is passively conducted (typically 1 day to 2 weeks). Temperature is recorded to inform the sampling uptake rate. At the end of the sampling period the sorbent is collected and placed inside individual airtight containers, chilled, and sent to the laboratory for analysis. This procedure is specific to Radiello type samplers. But the general procedures apply to other types of sampler as well.

Interferences

Sampling equipment should be certified clean to the method detection limit and stored in an environment with no significant background sources of VOCs. Insufficient cleaning can result in false positives for COCs. The following should also be considered:

- Sorbent uptake rates can be influenced by dirty diffusion membranes, temperature fluctuations, and air flow.
- High or low moisture environments may result in poor analyte recovery. Precipitation during sampling may also directly interfere with the sample collection process, this can occur whether or not sampling devices are directly exposed to precipitation.
- Sampling of highly polluted or reactive environments may interfere with sampling or analyte recovery.
- Background contamination in the pre-sampling and/or post-sampling procedures may result in false positive results.
- Sampling equipment generally will be left unattended for 8 hours to two weeks in an occupied space. Equipment can be inadvertently or intentionally damaged or moved.

Equipment and Materials

- Sorbent tube
- Diffusive membrane, sampler base, and sample labels
- Airtight glass vials that are verified to be free of VOCs for sorbent storage

- Small cooler and ice packs for sample shipment
- Sampling shelters (for outdoor sampling)
- Calibrated data logging thermometer/thermocouple, HVAC operation information, and/or a nearby Met station (to record ambient temperature to calculate actual uptake rate)
- PVC pipe (in 1-2 meter increments) for crawlspace deployment
- *Recommended* – field instrument such as a MultiRAE photoionization detector (PID) to measure total VOC and carbon monoxide concentrations in the breathing zone for health and safety monitoring.
- *Optional* – Laminated “Do not disturb” signs identifying the canister as an air sample and providing contact information.

Procedures and Guidelines

This SOP describes the general guidelines for collecting indoor, outdoor, and crawlspace air samples using passive samplers. Sampling information should be recorded in the field logbook and on the attached form “Indoor, Outdoor, and Crawlspace Air Sampling Log—Passive Sampler Method”.

1. If using a thermometer, turn it on at the desired sampling location.
2. Open the glass vial containing the sorbent and slide the sorbent into the diffusive body. Take care not to touch the sorbent mesh or the diffusion membrane portion of the diffusive body. The use of gloves is recommended.
3. Seat the sorbent in the diffusive body and attach the base. Do not over tighten.
4. Attach the adhesive pouch to the base.
5. Place the sampler in the selected location.
6. For outdoor samples, be sure that the sampler is protected from precipitation. Place the sampler in a shelter (do not obstruct air flow to the sampler).
7. For sampling crawlspace air, attach it to a rod or PVC pipe with VOC-free tape or zip ties, and place the sampler into the crawlspace using the rod. The sampler should be 6 inches above the ground’s surface and as far from the crawlspace walls as possible.
8. For sampling indoor air, samples are typically collected at breathing zone height (3 to 5 feet above the floor) and a minimum of 5 feet away from exterior walls.
9. The sampler is now beginning to collect VOCs.
10. Fill out the start dates and times onto the labels and the field forms.
11. Do not remove the adhesive from the label, and insert the label into the pouch. The label will be attached to the sorbent vial after sampling.
12. To retrieve the samples, reverse the process. Unscrew the diffusive body from the base and slide the mesh-enclosed sorbent back into the glass vial. Fill out the end date and time on the barcode label. Affix the label to the glass vial with the bar code in line with the long axis of the tube.
13. Place the sample vials into a secure container and/or plastic bag and place in a cool ice chest for shipping to the laboratory.
14. Download temperature data from the thermometer, get the temperature from the HVAC controller, and/or download the data from a met station. Record the average temperature on the Chain of Custody.

15. Complete the Chain of Custody form and transport samples to the laboratory.

Quality Control and Quality Assurance

- Co-located field duplicates will be two sorbent tubes placed in the same sampling enclosure to determine precision of the measurements. One field duplicate will be collected for every 10 samples.
- One trip blank will be sent with each shipment of up to 20 samples.
- Passive sorbent tubes supplied by the analytical laboratory must follow the performance criteria and quality assurance prescribed in EPA Method TO-17 for conditioning and certification.

Attachments

- Indoor, Outdoor, and Crawlspace Air Sampling Log—Passive Sampler Method
- “Do Not Disturb” sign providing contact information.

References

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. 2015. *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.* June.

Indoor, Outdoor, Crawlspace Air Sampling Log - Passive Sampler Method

Project: ______________________________

Building: ______________________________

Field Sample ID	Location	Tube ID	Start Temperature	Start Date	Start Time	End Date	End Time	End Temperature	Temperature Logger ID (if used)

Weather Conditions

General weather conditions: ______________________________

____

Temperature Range (indoor and outdoor): ______________________________

Was there significant precipitation within 24 hours prior to (or during) the sampling event? ______________________________

Air Testing in Progress

Please Do Not Disturb

Contact for Further Information:

Name: ______________________________

Organization:______________________

Phone:______________________________

Utility Clearance for Intrusive Operations

Purpose

This Standard Operating Procedure (SOP) describes the utility mark-out and clearance process to be followed before completing any exterior or interior intrusive subsurface activities.

Equipment and Materials

The private utility locator will supply the necessary equipment and materials. Have site maps available as back up to identify proposed locations and any conflict identified during the utility locate.

Procedures and Guidelines

Before mobilizing to perform exterior intrusive work, the scope of work must be submitted to the state contact for digging safely (i.e. 8-1-1 or One-Call) so public utility lines can be marked before third-party utility locators are on site. The decision to get a public utility clearance on the exterior of building for intrusive work to be performed inside of buildings should be made on a project- and site-specific basis. Note: the public utility clearance will only be performed up to a private property boundary.

Public Utilities

The state call center for digging safely must be contacted before any exterior intrusive work. The following general information must be provided during the call:

- Your name, company, address, phone number where you can be reached, and the company doing the digging.
- The name and phone number of the site contact.
- The county and city or county and unincorporated area of the township of the excavation.
- The location of the intrusive work, which may include, but not be limited to, address, cross street, and lot numbers. At least one of the following must be provided: (1) appropriate section and quarter section grid information; (2) sufficient address or descriptive information to allow the establishment or drawing of a dig site polygon; (3) sufficient address, street, and cross-street information to allow for the determination of the appropriate section and quarter section grid(s); or (4) global positioning system (GPS) coordinates.
- The start date and time of the planned activities.
- If subcontractors are responsible for utility locates, proper documentation must be received from them before the start of intrusive activities and placed in the project folder.

The following information should be collected and documented in the project files:

1. Members Notified. The identity of public utility locators notified will be provided to the caller. A copy should be retained in the project files and kept it onsite while intrusive work is being performed.
2. Case Reference Number. An identification number associated with the call should be retained for future reference, if needed. A copy should be retained in the project files and kept it onsite while intrusive work is being performed.

The site safety coordinator should retain a copy in the project records and keep it onsite while intrusive work is being performed.

All public utilities in the area where intrusive work is to be performed should be marked out on the ground by the utility locator using the American Public Works Association (APWA) Uniform Color Code

(Attachment 1).

Utility locates are good for 21 calendar days, including the day the call was made. Extended tickets are available and will be extended, and the state One Call Center must be notified if extended tickets are needed.

Private Utility Clearance – Exterior Intrusive Work

Utilities must be cleared by a private utility locator before any exterior intrusive work as follows:

1. Identify the location(s) where intrusive work will occur during a site visit with the private utility locator. The proposed areas where intrusive work will be performed should be pre-marked before this site visit. It is important to take access issues into consideration while pre-marking.
2. Verify that the public utility clearance has been completed before beginning the private utility clearance. If it has not been cleared, the state call center for digging safely must be notified to complete the public utility clearance before the private utility clearance may be performed.
3. Oversee the following tasks performed by the private utility subcontractor:
    - 3.1. Clear a 10-foot by 10-foot area around the area where intrusive work will be performed. Additional area (if possible) to be cleared by the private utility locator is based on the work to be performed.
    - 3.2. Use surface geophysical methods (for example, direct-connect wire tracing, metal detecting, ground penetrating radar, magnetometers, air knife, Acoustic Pipe Locator, RD-7000 locator and Transmitter, Cable Avoidance Tool, and Genny), to identify underground utility lines, pipes, structures, or anomalies.
    - 3.3. Identify, mark out, and differentiate between any underground utilities (for example, electrical, water, gas, sewer, telephone, and cable lines), buried pipes, process lines, structures, and anomalies within the subsurface.
    - 3.4. The cleared area should be marked with white paint or flags, and the proposed intrusive work location should be identified with white paint or flags. Mark with color-coded spray paint and/or pin flags using the same standard color schemes as the state call center for digging safely, shown in Attachment 1 (to indicate electric, gas, water, steam, telephone, TV cable, fiber optic, sewer, and foundation), all identified underground utility lines, structures, and anomalies.
4. Record the name and telephone number of the representative conducting the utility clearances.
5. The utility clearance is applicable for a 30-day period. Any intrusive work conducted after this 30-day period requires a new utility clearance.

Private Utility Clearance – Interior Intrusive Work

Utilities must be cleared by a private utility locator before any interior intrusive work as follows:

1. Identify the location(s) where intrusive work will occur during a site visit with the private utility locator. It is important to consider access issues when the areas to be cleared are designated.
2. Oversee the following tasks performed by the private utility subcontractor:
    - 2.1. Clear a 2-foot by 2-foot area around the area where intrusive work will be performed. Additional area (if possible) to be cleared by the private utility locator is based on the work to be performed.

   2.2. Use ground-penetrating radar, electronic utility-locating equipment, and other utility locator technologies that are necessary to identify and differentiate between underground utilities, pipes, structures, or anomalies. A concrete scanner, which is a type of ground-penetrating radar designed for use on concrete slabs, should be used for utility clearance inside of a building.

   2.3. Identify, mark out, and differentiate between any underground utilities (for example, electrical, water, gas, sewer, telephone, and cable lines), buried pipes, process lines, structures, anomalies, conduit, rebar, post-tension cables, radiant floor tubing, wire mesh, and other nonconductive targets within or below the concrete slab.

   2.4. The cleared area and the proposed drilling location should be marked with chalk, crayons, or tape. If it is not possible to mark utilities, provide a figure that shows the field team exactly where the utilities are located and the extent of the area marked.

3. Record the name and telephone number of the representative conducting the utility clearances.
4. The utility clearance is applicable for a 30-day period. Intrusive work conducted after this 30-day period requires a new utility clearance.

Before and During Intrusive Work

The following should be completed before commencing intrusive work:

1. For exterior intrusive work, verify that all public utility companies have identified the presence of utilities with marking paint or have provided a response back indicating the absence of utilities in the area. To verify what the utility markings on the ground indicate, use the color code in Attachment 1 (for public utilities). If utilities have not been marked or a negative response has not been confirmed, do not perform intrusive work in that area. Contact the state call center for digging safely and alert them of the situation.
2. For exterior intrusive work being performed by a subcontractor with a drilling rig, review the utility clearance documentation with the drilling subcontractor during the tailgate meeting.
3. For exterior intrusive work, use other methods to identify utilities if there are numerous utility lines around the area and/or lines that cannot be clearly located where intrusive work is to be performed. If possible, hand-digging or hand augering will be performed down to 5 feet below ground surface (bgs). Another method would involve the use of an air knife to bore 5 feet bgs with the use of high-pressure air that would not damage any utilities encountered.
4. Intrusive work can only be performed in the cleared area. If intrusive work needs to be performed outside of the cleared area, the appropriate utility locator(s) must clear the new location. If the new area cleared involves private utilities, an addendum to the initial utility clearance signoff sheet should be provided.
5. While performing intrusive work, monitor for signs of an encounter with a utility line. These signs include encountering fill material such as gravel, sand, or other fill material; warning tape; plastic; or metal. If it is believed that a utility was struck, stop work, call the appropriate personnel, and document in the field logbook.
6. If refusal occurs while drilling and it is believed not to be related to a utility, then advancement will be tried up to two more times within the cleared area. If the same refusal is observed, then the location will be abandoned.

Quality Control and Quality Assurance

- The field notes and utility-locate drawings will be reviewed by the field quality manager at the end of each workday performed.
- Verify intrusive activities are performed prior to staking request expiration dates.

Attachments

APWA Uniform Color Code

Know the APWA Color Code

WHITE:	Proposed excavation
PINK:	Temporary survey markings
RED:	Electric power lines, cables, conduit, and lighting cables
YELLOW:	Gas, oil, steam, petroleum, or gaseous materials
ORANGE:	Communication, alarm or signal lines, cables or conduit
BLUE:	Potable water
PURPLE:	Reclaimed water, irrigation and slurry lines
GREEN:	Sewer and drain lines

Installation and Abandonment of Vapor Pins as Subslab Soil Vapor Probes

Purpose

This Standard Operating Procedure (SOP) presents general guidelines for installing and abandoning Cox Colvin & Associates, Inc. (Cox-Colvin) Vapor Pins as subslab soil vapor probes.

Equipment and Materials

Vapor pin installation materials are as follows:

- Rotary hammer drill and drill bits (1.5-inch and 5/8-inch diameter).
    - The 5/8-inch diameter drill bit should be long enough to drill through the thickness of the slab.
    - The 1.5-inch drill bit is only necessary for installation of permanent subslab soil vapor probes so they can be finished with a flush-mount cover.
    - *Optional* – Cox-Colvin countersink drill bit. Can be used in high traffic areas to facilitate a true flush-mount installation of the stainless-steel secure cover.
- *Optional* – Cox-Colvin stainless steel drilling guide (for countersink installation) or stick-up vapor pin drilling guide
- Vacuum cleaner for removing concrete dust generated while drilling through the slab (shop-vac type, with both a dust bag and high-efficiency particulate air [HEPA] filter)
- Dust collection shroud to minimize airborne dust
- *Recommended* – Field instrument such as MultiRAE photoionization detector (PID) to measure total volatile organic compounds (VOCs) and carbon monoxide in the breathing zone for health and safety monitoring.
- Extension cord with multiple outlets and in-line ground fault circuit interrupter (GFCI)
- Laster measuring tool, walking wheel, or measuring tape

Assembled Vapor Pin – the standard Vapor Pin is shown in Figure 1. Cox-Colvin also offers a Mini Vapor Pin that can be used for flush-mount installation in thin slabs, and Vapor Pins with extensions that can be used for thicker slabs.

Figure 1. Assembled Standard Vapor Pin

- Vapor Pin 3/4-inch pipe brush for cleaning debris out of the drilled hole

- Vapor Pin clear silicone sleeve (see Figure 1)
- Vapor Pin white silicone protective caps
-
- Vapor Pin installation/extraction tool
- Dead-blow hammer or rubber mallet
- Vapor Pin black plastic or stainless-steel secure cover (optional for permanent probes)
- Vapor Pin spanner screwdriver for secure cover
- *Optional* – Traffic cone (for protecting stick-up probes)

Vapor Pin abandonment materials:

- Vapor Pin installation/extraction tool
- Cement patch (low- or no-VOC), water, and mixing container
- Trowel for applying cement patch

Procedures and Guidelines

Procedures for installing Vapor Pins are as follows:

1. A private utility clearance must be performed prior to drilling through the slab, as with all intrusive site work. The private utility clearance should be performed with a concrete scanner (small, handheld ground-penetrating radar unit designed for “seeing through” concrete slabs) to identify utilities, wire mesh, and/or rebar in the slab prior to drilling. A public utility locate may also be necessary depending on the site. The public utility clearance will only be completed outside of the building and/or property. In buildings where radiant floor tubing is in the slab, infrared scanning may also be necessary.
2. Temporary stick-up subslab soil vapor probes (Figure 2) or Mini Vapor Pin (with secure cover):
   2.1. Drill a 5/8-inch diameter hole through the entire concrete slab with the rotary hammer drill while continuously vacuuming through the dust collection shroud.
   2.2. Drill approximately 3 inches down into the subslab material to create a void space that is free of obstructions that might plug the probe during sampling.

Figure 2. Temporary Stick-Up Vapor Pin

3. Permanent flush-mounted probes (Figure 3):

3.1. The slab must be at least 3.5 to 4 inches thick to install a permanent flush-mounted standard Vapor Pin. If the thickness of the slab is unknown, then the 5/8-inch diameter hole should be drilled through the entire concrete slab first determine the slab thickness. However, if the slab is known to be at least 3.5 to 4 inches thick, then the 1.5-inch diameter hole may be drilled first.

3.2. Drill a 1.5-inch-diameter hole to a depth of 1.75 inches with the rotary hammer drill while continuously vacuuming through the dust collection shroud.

3.3. If a true flush-mount installation is required, the Cox-Colvin countersink bit can be used to drill both the 1.5-inch-diameter hole as well as the 2-inch diameter 1/8-inch deep counter sink.

3.4. Drill a 5/8-inch diameter hole through the rest of the concrete slab with the rotary hammer drill while continuously vacuuming through the dust collection shroud.

3.5. Drill approximately 3 inches down into the subslab material to create a void space that is free of obstructions that might plug the probe during sampling.

Figure 3. Permanent Installation of Flush-Mount Standard Vapor Pin

4. Monitor VOC concentrations in the breathing zone and explosive concentrations at the slab when drilling through the slab.
5. Record the approximate thickness of the slab, the approximate depth drilled beneath the slab, and the observed subslab material in the field logbook.
6. Clean out the hole with the Vapor Pin pipe brush and the shop vac.
7. Install the Vapor Pin into the hole with the installation and extraction tool and dead-blow hammer or rubber mallet. During installation, the silicon sleeve will form a slight bulge between the slab and the Vapor Pin shoulder. Place the white protective cap on the Vapor Pin.
8. Permanent standard flush-mounted probes – place either the black plastic or stainless-steel secure cover over the Vapor Pin. Tighten the stainless-steel secure cover using the spanner wrench.
9. Temporary stick-up probes – place a traffic cone over the probe to protect people from tripping over it.
10. Mini Vapor Pin – remove the screw-in barb and screw on the secure cover.
11. Measure the location of the probe from two perpendicular exterior walls using the laser measuring tool, walking wheel, or measuring tape. Record the probe location in the field logbook or on a building layout figure.

12. Wait at least 2 hours after installation is complete before purging, leak testing, and collecting subslab soil vapor samples to allow the subsurface to equilibrate.

Procedures for abandoning Vapor Pins are as follows:

1. Remove the Vapor Pin using the installation/extraction tool.
2. Fill the hole with concrete patch and smooth surface with the trowel.

Quality Control and Quality Assurance

Verify the purge and leak testing passes controls before collecting the subslab soil vapor samples.

References

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. 2015. Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. June.

Cox Colvin & Associates, Inc. (Cox-Colvin). 2023. Standard Operating Procedure – Installation and Extraction of the Vapor Pin Sampling Device. August.

Cox Colvin & Associates, Inc. (Cox-Colvin). 2023. Standard Operating Procedure – Drilling Guide & Secure Cover. August.

Cox Colvin & Associates, Inc. (Cox-Colvin). 2023. Standard Operating Procedure – Installation of the Mini Vapor Pin Sampling Device. August.

STANDARD OPERATING PROCEDURE SOP-8

Subslab Soil Vapor Sampling from Vapor Pins

Purpose

This Standard Operating Procedure (SOP) presents general guidelines for collecting subslab soil vapor samples from Cox-Colvin & Associates, Inc. (Cox-Colvin) Vapor Pins. Methods for purging and leak-checking the Vapor Pins are also included in this SOP. The number, location, analytical method (including sampling container), and sampling duration of subslab soil vapor samples should be determined on a project-specific basis. A building survey is typically performed before sampling to obtain building characteristic information.

Scope

This SOP provides a general description of how to purge and leak test Vapor Pins using water and then collect subslab soil vapor samples. Some states require leak testing subslab soil vapor probes with a tracer gas such as helium (for example, California and Michigan), so additional leak testing procedures outside of the scope of this FOP may be necessary. This SOP describes sampling with evacuated canisters and additional optional sampling methods including Bottle-Vacs, Tedlar bags, and sorbent tubes.

Equipment and Materials

Purge and water dam leak-check:

- Vapor Pin spanner wrench to open the secure locking cover
- Vacuum pump with rotameter capable of a flow rate set to 200 milliliters per minute (mL/min)
- Three-way sampling manifold consisting of Swagelok gas-tight fittings, three quarter-turn Swagelok valves, and one vacuum gauge.
- Teflon tubing, 0.25-inch outer diameter
- Flexible silicon tubing (3/8-inch inner diameter to connect Teflon tubing from Vapor Pin)
- Swagelok nut and ferrule set (part #SS-400-NFSET) to connect tubing to the sampling manifold
- Gas sampling bag (such as Tedlar brand) (1-liter or 3-liter) to collect the purged soil vapor so: (1) it is not discharged into the building; (2) the approximate volume of purged soil vapor can be measured; and (3) field screening can be performed on the purged soil vapor.
- Wrenches and screwdriver, various sizes as needed for connecting fittings. A 9/16-inch wrench fits the 0.25-inch Swagelok fittings.
- Water
- Vapor Pin water dam or similar
- Volatile organic compound (VOC)-free modeling clay (like Play-Doh) to secure the water dam to the floor
- Paper towels
- Turkey baster or large plastic syringe (for removing water from the water dam)

- *Recommended* – field instrument such as a MultiRAE photoionization detector (PID) to measure total VOC and carbon monoxide concentrations in the breathing zone for health and safety monitoring. It is also optional to collect field measurements of total VOCs from the purged soil vapor so the analytical laboratory can be warned if high concentrations are expected in the samples so they can dilute the sample before analysis.
- *Optional* – LandTec GEM Landfill Gas Meter to collect field measurements from the purged soil vapor of oxygen, carbon dioxide, and methane

Subslab soil vapor sampling with evacuated canisters:

- Stainless-steel sample canister(s) certified clean and evacuated by the analytical laboratory.
- Flow controller(s) set at desired sampling rate by the analytical laboratory.
- Analog vacuum gauge dedicated to the canister (provided by the analytical laboratory) may be permanently attached to either the canister or flow controller. This vacuum gauge will be used to monitor the canister vacuum during sampling.
- *Recommended* – Digital vacuum gauge with a -30 to 0-inch mercury (Hg) range, and 0.50 inches Hg accuracy, equipped with appropriate fitting for canister setup. Digital gauges should not be shared between soil vapor samples and air samples (indoor, outdoor, or crawlspace) to prevent cross-contamination. Analog vacuum gauges may be used instead of digital ones, but they may not be as accurate.
- T-connector (provided by the analytical laboratory) for collecting simultaneous duplicate samples.
- Shipping container, suitable for protection of canister(s) during shipping. Typically, strong cardboard boxes or plastic totes are used for canister shipment. The canisters should be shipped to the analytical laboratory in the same shipping container(s) in which they were received.
- *Optional* – Laminated "Do not disturb" signs identifying the canister as an air sample and providing contact information. (These signs are for extended duration samples only because grab samples will not be left unattended.)

Alternative subslab soil vapor sampling methods:

- Bottle-Vacs:
  - Bottle-Vac(s) evacuated and provided by the analytical laboratory.
  - Flow controller(s) set at desired sampling rate by the analytical laboratory. Double-check that flow controllers intended for duplicate samples (if flow rate is different than single-bottle setup) are kept separate until needed.
  - *Recommended* – Digital vacuum gauge with a -30 to 0-inch Hg range, and 0.50-inch Hg accuracy, equipped with appropriate fitting for Bottle-Vac setup. Digital gauges should not be shared between soil vapor samples and air samples (indoor, outdoor, or crawlspace) to prevent cross-contamination. Analog vacuum gauges may be used instead of digital ones, but they may not be as accurate.
  - T-connector (provided by the analytical laboratory) for collecting simultaneous duplicate samples.
  - Shipping container, suitable for protection of canister(s) during shipping. Typically, strong cardboard boxes or plastic totes are used for Bottle-Vac shipment. The Bottle-Vacs should be shipped to the analytical laboratory in the same shipping container(s) in which they were received.

  - *Optional* – Laminated “Do not disturb” signs identifying the Bottle-Vac as an air sample and providing contact information. (These signs are for extended duration samples only because grab samples will not be left unattended.)
- Gas sampling bag (such as Tedlar brand):
  - Gas sampling bag
  - Lung box
- Sorbent Tubes:
  - Sorbent tube(s) provided by the analytical laboratory. Include one extra to use for flow calibration purposes.
  - SKC flow calibrator 5 to 500 mL/min to measure the exact flow rate while sampling

Procedures and Guidelines

This SOP describes the general guidelines for purging and water dam leak testing Vapor Pins, then collecting subslab soil vapor samples using various sample containers. Purging, leak testing, and sampling information should be recorded in the field logbook and on the attached “Subslab Soil Vapor Sampling Log” form.

System Setup:

1. Wait at least 2 hours after probe installation is complete before collecting subslab soil vapor samples to allow the subsurface to equilibrate.
2. Remove the secure cover and the white cap on the Vapor Pin.
3. Attach a new piece of flex tubing, approximately 1-inch long, to the barbed fitting at the top of the Vapor Pin. Then attach 0.25-inch Teflon tubing to the flex tubing.
4. Place the water dam over the subslab probe by threading the Teflon tubing through the hole of the water dam. Press the water dam down so it seals on the concrete slab using VOC-free modeling clay. Fill with water. The water level should be above the connection between the flex tubing and the Teflon tubing.
5. Attach the other end of the Teflon tubing to the sampling manifold using a Swagelok nut and ferrule set.
6. Attach the vacuum pump to the sampling manifold using Teflon tubing and Swagelok nut and ferrule sets.
7. System set up for canister sampling:
   7.1. Measure the initial canister vacuum with the digital vacuum gauge. The initial vacuum should be between -28 to -30 inches Hg. If it is less than -26 inches Hg do not use the canister for sampling. If it is between -28 to -26 inches Hg, only use the canister if there are no other spare canisters available. Note that altitude can affect vacuum readings and account for these differences (i.e., each additional 1,000 feet of elevation above sea level reduces the maximum vacuum measured in a canister by approximately 1-inch Hg).

   7.2. In the field log, record the canister identification (ID), flow controller ID, initial vacuum, desired flow rate, sample location information, and all other information pertinent to the sampling effort.

   7.3. If using a canister with a valve, connect the flow controller and analog vacuum gauge to the canister. When the flow controller and vacuum gauge are attached correctly, they will not move separately from the canister (they will not spin around). If the canister uses a quick-connect fitting and is not equipped with a valve, do not attached the flow controller until it is time to initiate sample collection.

7.4. Connect the canister via the flow controller to the sampling manifold.

Manifold Vacuum Leak Check:

The purpose of the manifold leak test is to make sure the connections in the sampling train are air-tight. For canister sampling, the connections on the sampling manifold through the flow controller to the valve on the canister will be leak tested (Figure 1); for duplicate samples the whole assembly with the T-connector should be vacuum leak tested. However, if the canister has a quick-connect, then the canister will not be attached during the manifold vacuum leak test (Figure 2). For alternative sampling methods, the connections on the sampling manifold will be leak tested.

1. Close the valve to the probe, open the valve to the pump. For canister sampling open the sampling valve to the canister on the manifold; the valve on the canister is closed.
2. Turn the pump on and wait for the gauge on the manifold to approximately -10 inches Hg. Close the valve to the pump and turn the pump off. The sampling train is now a closed system.
3. Wait approximately 30 seconds to ensure that the vacuum is maintained and there are no leaks (as shown by the stability of the vacuum gauge).
4. If there is a visible loss of vacuum, tighten the connections and redo the leak test until it passes.

Figure 1. Sampling Manifold Setup for Canister Sampling

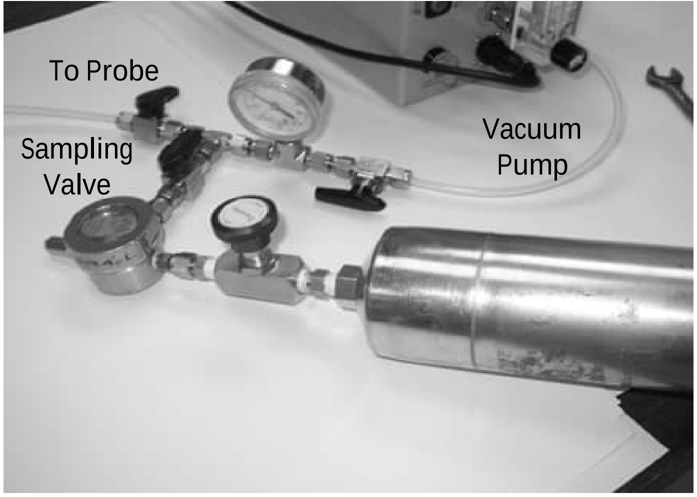


Figure 2. Sampling Manifold Setup for Canister Sampling with a Quick-Connect

Purge and Water Dam Leak-Check

8. Purging and leak testing the soil vapor probe is required before sampling every time. Purging removes ambient air from the sampling train and stagnant soil vapor around the probe.
9. Open the valves to the pump and probe and attach the Tedlar bag to the pump effluent. The sampling valve should be closed.
10. Turn the pump on with the flowrate at 200 mL/min and purge for approximately 5 minutes to fill the 1-liter Tedlar bag.
11. Monitor the purging vacuum on the sampling manifold vacuum gauge. The purging vacuum should not exceed -7 inches Hg; if it does, turn the pump off, close the valve to the pump, and wait to see if there is recovery.
    11.1. The probe may be clogged or there may be water or tight soils present beneath the slab that do not allow for soil vapor sampling.
    11.2. Try unclogging the probe with a thin metal rod or remove the probe and check for blockages.
    11.3. If purging cannot be completed without creating a vacuum exceeding -7 inches Hg, then the probe cannot be sampled.
12. Observe the water level in the water dam for indications that water is entering the subslab (drop in water level or bubbles). If there is, the Vapor Pin failed the leak check and corrective action is required. The leak test must be performed again after corrective actions are taken until the Vapor Pin passes the leak test. Note: Water level might drop slightly because of absorption into the concrete.
13. There are five corrective action options (first remove the water from the water dam with a turkey baster):
    13.1. Remove the Vapor Pin, clean out the drilled hole thoroughly, replace the silicone sleeve with a new one, and reinstall.

    13.2. Fill in visible concrete cracks inside the drilled hole with quick-setting cement and, after allowing the cement to cure, retest.
    13.3. Try fortifying the Vapor Pin seal by adding modeling clay to the base of the Vapor Pin. This temporary repair is only acceptable if grab samples will be collected; permanent repairs must be made for extended duration samples (for example, 8- or 24-hour) because the clay may dry and crack.
    13.4. Add Teflon tape to the barbed connector and the Teflon tubing, reattach the flex tubing and the Teflon tubing, make sure that all the fittings are tight and repeat the purge and leak-check procedure.
    13.5. If the previous options fail, then the Vapor Pin should be abandoned.
14. *Optional* - Field readings of total VOCs with a PID, and/or oxygen, carbon dioxide, and methane with a LandTec GEM Landfill Gas meter may be performed on the purged soil vapor. Perform readings outside of the building so that soil vapor is not released into indoor air.
15. Record the purge and leak-check information on the Subslab Soil Vapor Sampling Log.

Canister Sampling:

1. For extended duration samples (for example, 8- or 24-hour)
    1.1. Remove the sampling manifold by detaching the canister from the manifold, then detaching the probe tubing from the manifold and quickly attaching it to the canister via the flow controller.
    1.2. *Optional* – Attach the sign (identifying the canisters as an air sample, saying "Do Not Disturb" and providing contact information) to the canister.
    1.3. Make sure the canister will be secure at the sampling location; place traffic cones around the probe and canister if necessary.
2. To begin sampling, open the canister valve one full turn, or attach the canister to the flow controller via the quick-connect fitting, and record the sample start time. (For grab samples, the canister will still be attached to the sampling manifold.).
3. Monitor the canister vacuum on the analog gauge (if present) several times during the sample period, to ensure the canister is filling at the desired rate and the final canister vacuum does not fall to 0-inch Hg.
4. At the end of the sample period, close the canister valve, or detach the quick-connect fitting, and record the sample end time. Detach the canister and flow controller from the manifold or probe tubing.
5. Measure the final canister vacuum with the digital vacuum gauge. The final vacuum should be between -10 to -2 inches Hg. If it is 0-inch Hg, do not submit the sample for analysis. If it is between -2 and 0-inches Hg, re-deploy the sample if possible; if not submit it to the analytical laboratory for analysis but make sure it is received with some residual vacuum.
6. Replace the protective cap on the canister.
7. Duplicate samples should be collected simultaneously with a dedicated T-connector.
    7.1. Grab sample duplicates should be collected by attaching the T-connector to each canister and then connecting one flow controller to the top of the T-connector. (If there was a flow controller on each canister, then the sampling flow rate would be twice as fast as the other samples.) The duplicate sample will take twice as long to collect.

   7.2. Extended duration samples should be collected by attaching a flow controller to each canister and then connecting the T-connector to each flow controller. (If only one flow controller was used, then the sampling duration would be twice as long.)

Bottle-Vac Sampling:

1. Measure the initial vacuum with the digital vacuum gauge. The initial vacuum should be between -28 to -30 inches Hg. If it is less than -26 inches Hg, do not use the Bottle-Vac for sampling. If it is between -28 to -26 inches Hg, only use the Bottle-Vac if there are no other spares available. Note that altitude can affect vacuum readings and account for these differences (i.e., each additional 1,000 feet of elevation above sea level reduces the maximum vacuum measured in a canister by approximately 1-inch Hg to -29 inches Hg, etc.). In the field log, record the Bottle-Vac ID, flow controller ID, initial vacuum, desired flow rate, sample location information, and all other information pertinent to the sampling effort.
2. For extended duration samples (for example, 8- or 24-hour)
   2.1. Remove the sampling manifold and attach the probe tubing to the flow controller.
   2.2. *Optional* – Attach the sign (identifying the canisters as an air sample, saying “Do Not Disturb” and providing contact information) to the canister.
   2.3. Make sure the canister will be secure at the sampling location; place traffic cones around the probe and canister if necessary.
3. For grab samples – Attach the flow controller to the sampling valve on the sampling manifold.
4. To begin sampling, attach the Bottle-Vac to the to the flow controller via the quick-connect and record the sample start time.
5. At the end of the sample period, detach the Bottle-Vac from the flow controller and record the sample end time. Detach the flow controller from the probe tubing or sampling manifold.
6. Measure the final Bottle-Vac vacuum with the digital vacuum gauge. The final vacuum should be between -10 to -2 inches Hg. If it is 0-inch Hg, do not submit the sample for analysis. If it is between -2 and 0-inch Hg, redeploy the sample if possible; if not submit it to the analytical laboratory for analysis but make sure it is received with some residual vacuum.
7. Duplicate samples should be collected simultaneously with a dedicated T-connector as described in the Canister Sampling section.

Tedlar Bag Sampling:

1. Detach the vacuum pump from the sampling manifold and attach it to the lung box, then attach the probe tubing via the sampling manifold to the lung box influent.
2. Place a Tedlar bag in the lung box using dedicated Teflon and flexible silicon tubing, open the Tedlar bag, and close the lid to the lung box.
3. To begin sampling, turn the pump on and record the sample start time.
4. Turn the pump off when the Tedlar bag is full and record the sample end time. The Tedlar bag should only be filled approximately 50 to 75 percent if it will be shipped via plane.
5. Close the Tedlar bag’s valve and remove the bag from the lung box.
6. Detach the probe tubing and vacuum pump from the lung box.

Sorbent Tube Sampling:

1. Disconnect the pump tubing from the manifold.

2. Attach a spare sorbent tube provided by the analytical laboratory to the vacuum pump tubing using a 1/4-inch Swagelok union or flex tubing. Do not use a tube that is intended for sampling. Be sure to attach the sorbent tube so that the flow direction is correct.
3. Attach the SKC flow calibrator to the vacuum pump exhaust.
4. Turn on the vacuum pump and adjust the flow to achieve the desired flow rate of 200 mL/min using the flow calibrator.
5. Remove the spare sorbent tube from the pump tubing.
6. Remove the end caps from the sorbent tube to be used for sampling and attach it to the vacuum pump tubing using a 1/4-inch Swagelok union or flex tubing. Be sure to attach the sorbent tube so that the flow direction is correct. Record the sample tube ID on the field form.
7. Attach the other end of the sorbent tube to the sample manifold where the pump tubing used to be attached using either Swagelok fittings or flex tubing.
8. Make sure both the probe valve and the vacuum pump valve are open and the sampling valve is closed.
9. Start the pump and record the start time. Using flow calibrator, record initial flow rate.
10. If the flow rate starts to drop, it may indicate that the sorbent tube is becoming plugged with water. Stop the vacuum pump and record the end time.
11. After the required amount of time, record the final flow rate from the flow calibrator. Turn off the pump and remove the sorbent tube. Record the end time.
12. Replace the end caps on the sorbent tube. Replace the sorbent tube into the container it was received in.

After Sample Collection is Completed:

1. Disassemble the sampling system and replace the white silicone cap on the Vapor Pin.
2. For permanent probes – replace the black plastic or stainless-steel secure cover and make sure it is securely in place. For temporary probes – replace the safety cone or abandon the probe.
3. Fill out all appropriate documentation (chain-of-custody and sample tags) and return samples and equipment to the laboratory in the same shipping container in which they were received. Do not place sticky labels or tape on surface of the canister.
4. Canisters, Bottle-Vacs, and Tedlar bags should not be cooled during shipment. DO NOT put ice in the shipping container. Sorbent tubes may require ice for shipping.

Quality Control and Quality Assurance

- Verify no less than 2 hours between probe installation and collecting subslab soil vapor samples.
- Canisters supplied by the analytical laboratory must follow the performance criteria and quality assurance prescribed in U.S. Environmental Protection Agency (EPA) Method TO-14/15 for canister cleaning, certification of cleanliness, and leak checking.
- Flow controllers supplied by the analytical laboratory must follow the performance criteria and quality assurance prescribed in EPA Method TO-14/15 for flow controller cleaning and adjustment.
- Field duplicates and trip blanks (sorbent tube methods only) may be required.

Attachments

- Subslab Soil Vapor Sampling Log
- “Do Not Disturb” sign providing contact information.

References

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. 2015. *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. June.

Cox-Colvin & Associates, Inc. (Cox-Colvin). 2023. *Standard Operating Procedure – Leak Testing the Vapor Pin Sampling Device Via Water Dam*. August.

Subslab Soil Vapor Sampling Log

Jacobs

Project:

Sampler:

Sample Location Information

Property ID/Address:

Condition of slab in the surrounding area:

Location ID:

Sample ID:

Sample Location Description (Room Name/Number and surrounding, identifying features):

Subslab Soil Vapor Probe Leak Checking and Sampling Log

Manifold Leak Check

	Pass	*Fail*
Manifold leak check (procedure: ensure manifold holds pressure at -10 "Hg for 30 seconds). If using a pelican-case pump, open the lid during leak check to ensure all interior pieces are in-tact.		

Describe corrective measures taken to pass the manifold leak test:

Subslab Soil Vapor Probe Water Dam Leak Check and Purge Results

Purge rate (mL/Min):

Start Time:

Purge Vacuum ("Hg):

End Time:

	Pass	*Fail*
Probe Leak Check Result*:		

*The subslab soil vapor probe passes the water dam leak check if there are no bubbles observed and the water level does not draw down during purge. Do NOT collect a subslab soil vapor sample if the leak check fails.

Field Analysis (required readings are determined on a project-specific basis. Fill in all that are necessary):

MiniRAE or MultiRAE Photoionization Detector

Total VOCs (ppm):

O_2 (%):

H_2S (ppm):

LEL (%):

CO (ppm):

LandTec GEM Landfill Gas Meter

O2 (%):

CO2 (%):

CH4 (%):

Sampling Information

Evacuated Canister or Bottle-Vac

Container Size (L):

Initial Pressure (" Hg):

Container ID:

Start Date and Time:

Flow Controller ID:

End Date and Time:

Sampling Rate (mL/min, hours):

Final Pressure (" Hg):

Sampling Vacuum ("Hg):

Tedlar Bag

Tedlar Bag size (L):

Start Date and Time:

Sampling Rate (mL/min):

End Date and Time:

Sorbent Tube

Sorbent Tube type and size:

Start Date and Time:

Sorbent Tube ID:

End Date and Time:

Initial Flow Rate (mL/min):

Final Flow Rate (mL/min

Calculated Sampling Volume:

Weather Conditions and Additional Notes

Weather Conditions During Sampling:

Additional Notes:

Air Testing in Progress

Please Do Not Disturb

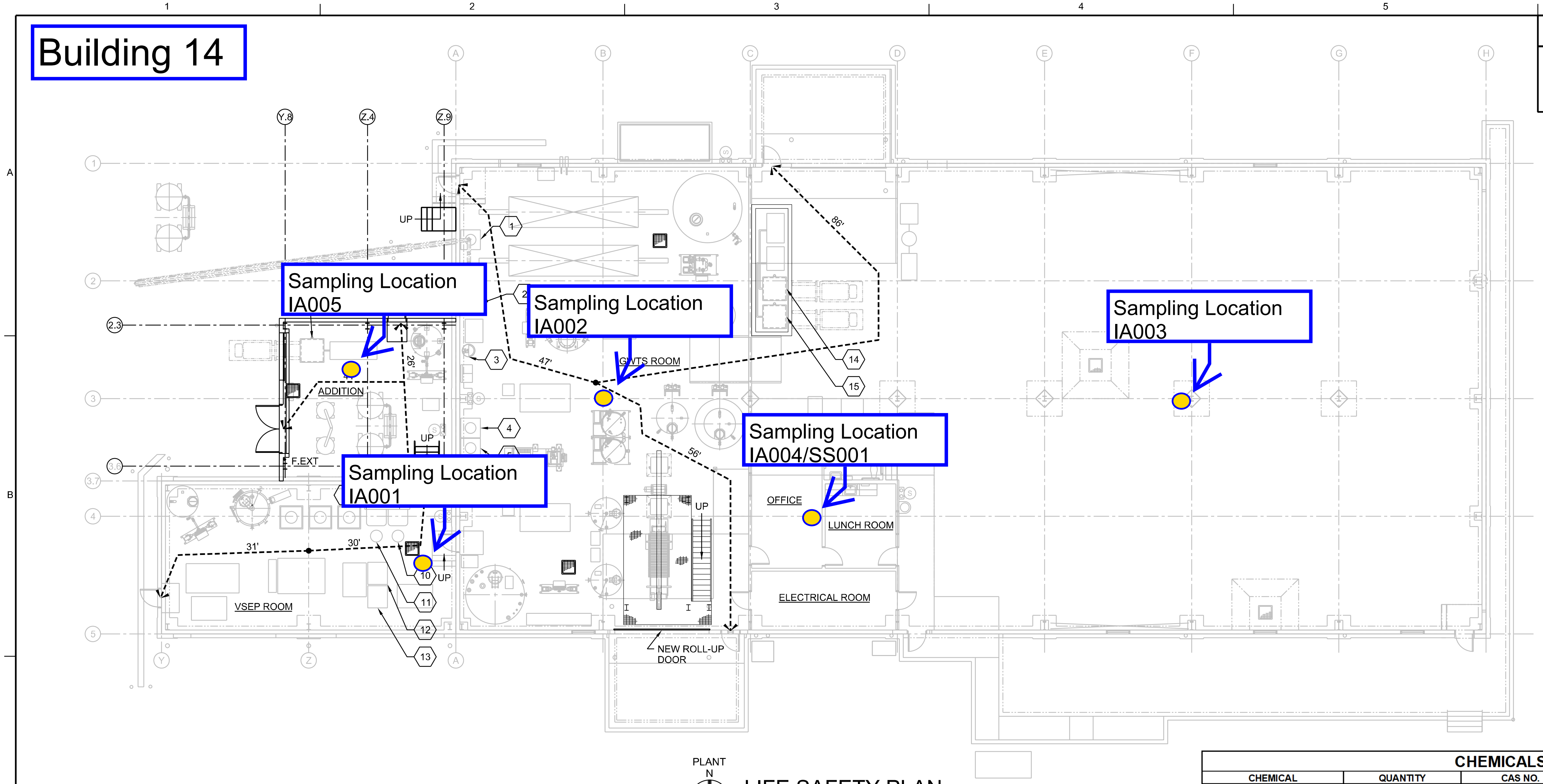
Contact for Further Information:

Name: ______________________________

Organization:______________________

Phone:_____________________________

Appendix E
Default Sampling Location Figures for Buildings Undergoing Vapor Intrusion Investigation



GENERAL SHEET NOTE

1. FOR THE FINAL DETAILS, SEE THE TYCO TREATMENT BUILDING FOR CONSTRUCTION DESIGN DRAWINGS BY AMERICAN BUILDINGS (SEALED 7/27/2022).

PLANT N

LIFE SAFETY PLAN

3/32"=1'-0"

SHEET KEYNOTES

1. BIOCIDE DRUM AND FEED PUMPS 1 & 2
2. SODIUM BISULFITE DRUM AND FEED PUMPS 1 & 2
3. EXISTING SCALE INHIBITOR TANK
4. MAGNESIUM CHLORIDE TOTE AND FEED PUMPS 1 & 2
5. CITRIC ACID DRUM AND TRANSFER PUMP
6. SODIUM HYDROXIDE DRUM AND TRANSFER PUMP
7. SULFURIC ACID IBC TOTE
8. T-505 264 GALLON TOTE NLR 505
9. T-404 264 GALLON TOTE NLR 404
10. T-759
11. T-560 NLR 560
12. T-404 264 GALLON TOTE NLR 404
13. T-505 264 GALLON TOTE NLR 505
14. SODIUM HYPOCHLORITE IBC TOTE
15. SODIUM HYDROXIDE IBC TOTE

BUILDING CODE DATA:

WATER TREATMENT BUILDING

BUILDING CODE:	WISCONSIN COMMERCIAL BUILDING CODE	TRAVEL DISTANCE ALLOWED (MAX.):	B: 300 FEET, H-3: 150 FEET, H-4: 175 FEET
OCCUPANCY GROUP:	H-3/H-4, OFFICE AREA: B	COMMON PATH OF EGRESS (MAX):	B: 75 FEET, H-3: 25 FEET
TYPE OF CONSTRUCTION:	IIB, NONRATED, NONCOMBUSABLE	FIRE RESISTANCE RATING FOR BUILDING ELEMENTS:	
MAXIMUM STORIES ALLOWED:	2 STORIES	STRUCTURAL FRAME:	0 HOURS
ACTUAL NUMBER OF STORIES:	ONE STORY	BEARING WALLS:	0 HOURS
MAXIMUM HEIGHT ALLOWED:	55 FEET	NONBEARING WALLS, INTERIOR:	0 HOURS
ACTUAL HEIGHT:	22 FEET	FLOOR CONSTRUCTION:	0 HOURS
MAXIMUM AREA ALLOWED PER FLOOR:	24,500 SQ FT	ROOF CONSTRUCTION:	0 HOURS
EXISTING BUILDING AREA: NEW ADDITION AREA: ACTUAL TOTAL AREA:	14,920 SQ FT 769 SQ FT 15,689 SQ FT	EXTERIOR WALL FIRE-RESISTANCE BASED ON DISTANCE AT A POINT BETWEEN EACH BUILDING:	H-3/H-4: 1 HOUR <30'
CALCULATED NUMBER OF OCCUPANTS:	52 OCCUPANTS	OCCUPANCY SEPARATION / FIRE RATING:	1 HOUR BETWEEN H-3/H-4 AND B 2 HOUR ELECTRICAL ROOM TO AVOID SPRINKLING
ACTUAL NUMBER OF OCCUPANTS:	2 OCCUPANTS	FIRE SUPPRESSION SYSTEM:	FULLY SPRINKLED AND FIRE EXTINGUISHERS AT EXITS

CHEMICALS

CHEMICAL	QUANTITY	CAS NO.	CLASSIFICATION	OCCUPANCY
ANTISCALANT: AWC A-119 OR CHEMTREAT RL-9909	5 GAL CARBOYS OR 55 GAL DRUM 30 GAL TOTE	PROPRIETARY BLEND 37971−36−1 (5-10%) 22042−96−2 (5-10%) 26099−09−2 (3-7%)	CORROSIVE	H-4
2-2-DIBROMO-3-NITRILOPROPIONAMIDE (DBNPA) ANTIMICROBIAL N-20 (17-23% SOLUTION)	4 x 55 GAL DRUMS TOTAL = 220 GALLONS	10222-01-2	CORROSIVE	H-4
CITRIC ACID (50% SOLID)	55 GAL DRUMS	77-92-9	NON-HAZARDOUS IRRITANT	
KAOLIN CLAY (100%)	1 GAL OR LESS	1332-58-7	NON-HAZARDOUS	
MAGNESIUM CHLORIDE (30% SOLUTION)	55 GAL DRUMS OR TOTES	7786-30-3	NON-HAZARDOUS	
NLR 404 CITRIC ACID (25-50% SOLUTION)	4 x 55 GAL DRUMS TOTAL = 220 GALLONS	77-92-9	NON-HAZARDOUS IRRITANT	
NLR 505 BASE (5-27% SOLUTION) OR CHEMTREAT RL1700	55 GAL DRUMS	7758-29-4 (2-12%) 64-02-8 (2-12%) 25155-30-0 (2.5%) 64-02-8 (10-<20%) 77-92-9 (1-<3%) 1310-73-2 (1-<3%) 5064-31-3 (<1%)	CORROSIVE	H-4
NLR 550 SODIUM CARBONATE PERHYDROXIDE	4 x 55 GAL DRUMS TOTAL = 220 GALLONS	15630-89-4 (85%) 497-19-8 (13%) 1344-09-8 (1.5%)	CLASS 2 OXYDIZER	H-3
NLR 759 PHOSPHONIC ACID (25% SOLUTION)	4 x 55 GAL DRUMS TOTAL = 220 GALLONS	2809 -21-4	NON-HAZARDOUS IRRITANT	
SODIUM BISULFITE (38% SOLUTION)	4 x 55 GAL DRUMS TOTAL = 220 GALLONS	7631-90-5	TOXIC	H-4
SODIUM CHLORIDE	1 GAL OR LESS	7647-14-5	NON-HAZARDOUS	
SODIUM PERCARBONATE (100%)	1 GAL OR LESS	15630-89-4	CLASS 2 OXYDIZER, TOXIC	H-3/H-4
SODIUM HYDROXIDE (50% SOLUTION)	TOTES AND 55 GAL DRUMS	1310-73-2	CORROSIVE	H-4
SODIUM HYPOCHLORITE (12% SOLUTION)	320 GAL TOTES	7681-52-9	CORROSIVE	H-4
SULFURIC ACID (93% SOLUTION)	2 x 263 GAL TOTE TOTAL = 526 GALLONS	7664-93-9	CLASS 2 WATER REACTIVE, CORROSIVE	H-3/H-4
LIME	50 LB BAGS	1305-62-0	CORROSIVE	H-4

RECORD DRAWINGS

Revisions Drawn By DL MICHALEK Date JULY 2024

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

DSGN	DR	CHK	APVD
R. SIEBERS	D. MICHALEK	V. MILEWSKI	W. ANDRAE

TYCO FIRE PRODUCTS LP
MODIFIED GROUND WATER
TREATMENT SYSTEM DESIGN
MARINETTE, WISCONSIN

Jacobs

ARCHITECTURAL

TREATMENT BUILDING
LIFE SAFETY PLAN AND
CODE DATA

3/32"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	FEBRUARY 2022
PROJ	D3526500
DWG	A-001
SHEET	14 OF 98

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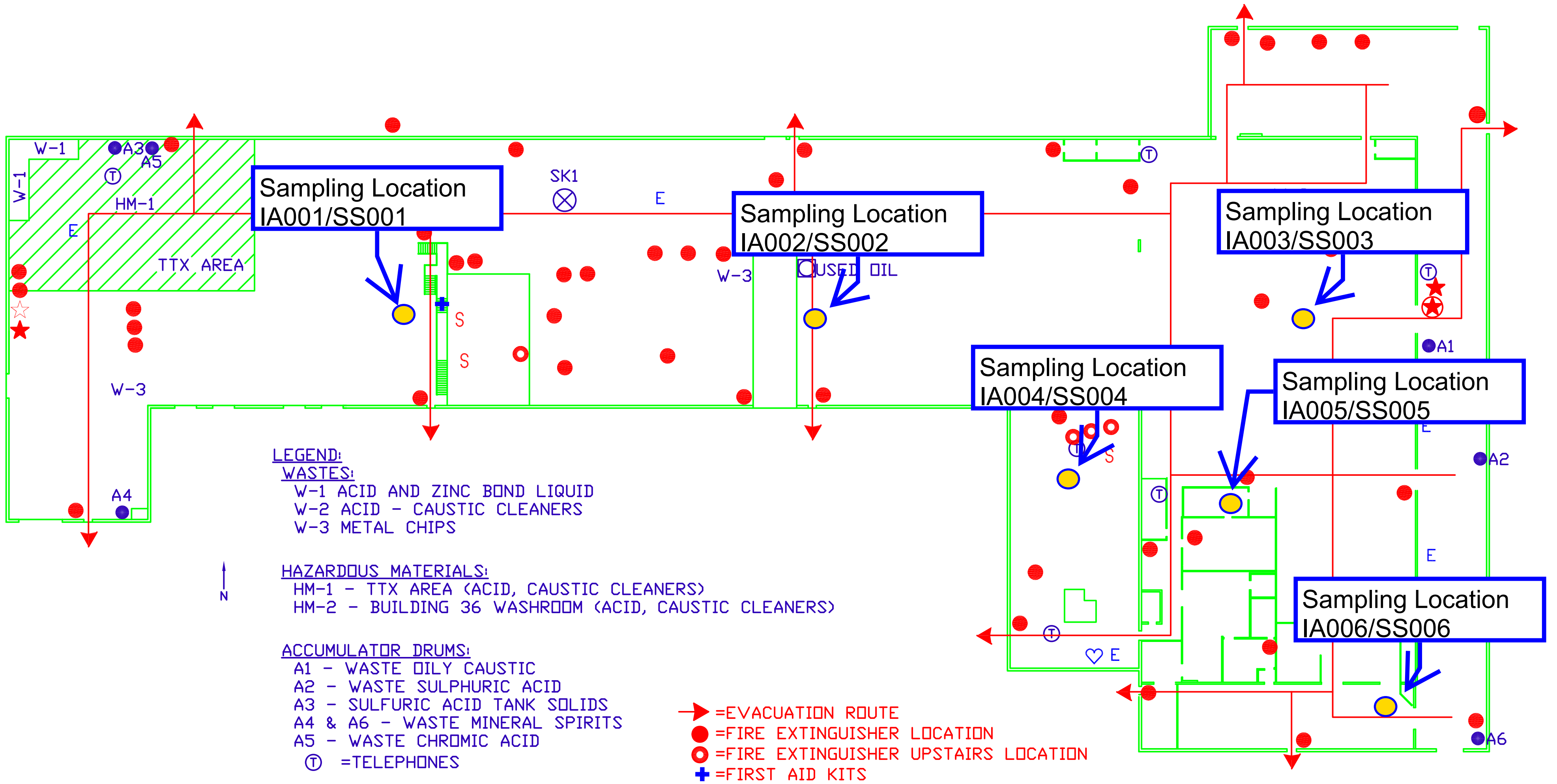
Building 36



LEGEND:

WASTES:
- W-1 ACID AND ZINC BOND LIQUID
- W-2 ACID - CAUSTIC CLEANERS
- W-3 METAL CHIPS

HAZARDOUS MATERIALS:
- HM-1 - TTX AREA (ACID, CAUSTIC CLEANERS)
- HM-2 - BUILDING 36 WASHROOM (ACID, CAUSTIC CLEANERS)

ACCUMULATOR DRUMS:
- A1 - WASTE OILY CAUSTIC
- A2 - WASTE SULPHURIC ACID
- A3 - SULFURIC ACID TANK SOLIDS
- A4 & A6 - WASTE MINERAL SPIRITS
- A5 - WASTE CHROMIC ACID
- Ⓣ =TELEPHONES

SPILL KITS:
- SK1 - HAZMAT SPILL KIT

→ =EVACUATION ROUTE
● =FIRE EXTINGUISHER LOCATION
○ =FIRE EXTINGUISHER UPSTAIRS LOCATION
✚ =FIRST AID KITS
♡ =AED
E =EYEWASH/SHOWER
S =SHELTER AREA
☆=SPILL-XS
★=SPILL-XA
✪=SPILL-XC

X SOUTHEAST
PARKING LOT

DO NOT SCALE PRINT
LINEAR DIMENSIONS IN INCHES, WHEN TOLERANCES ARE NOT GIVEN, THEY ARE:
2 PLACE +/- 0.5 0.02
3 PLACE +/- 0.13 0.005
ANGLES +/- 1/2
MATERIAL
N/A

THIRD ANGLE PROJECTION
SHEET 1 OF 1
A.Q.L. Defect Classification
Ⓒ Critical Ⓜ Major

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Scale N/A

CAD DRAWING EXISTS
Used On | Dwg. | Req'd

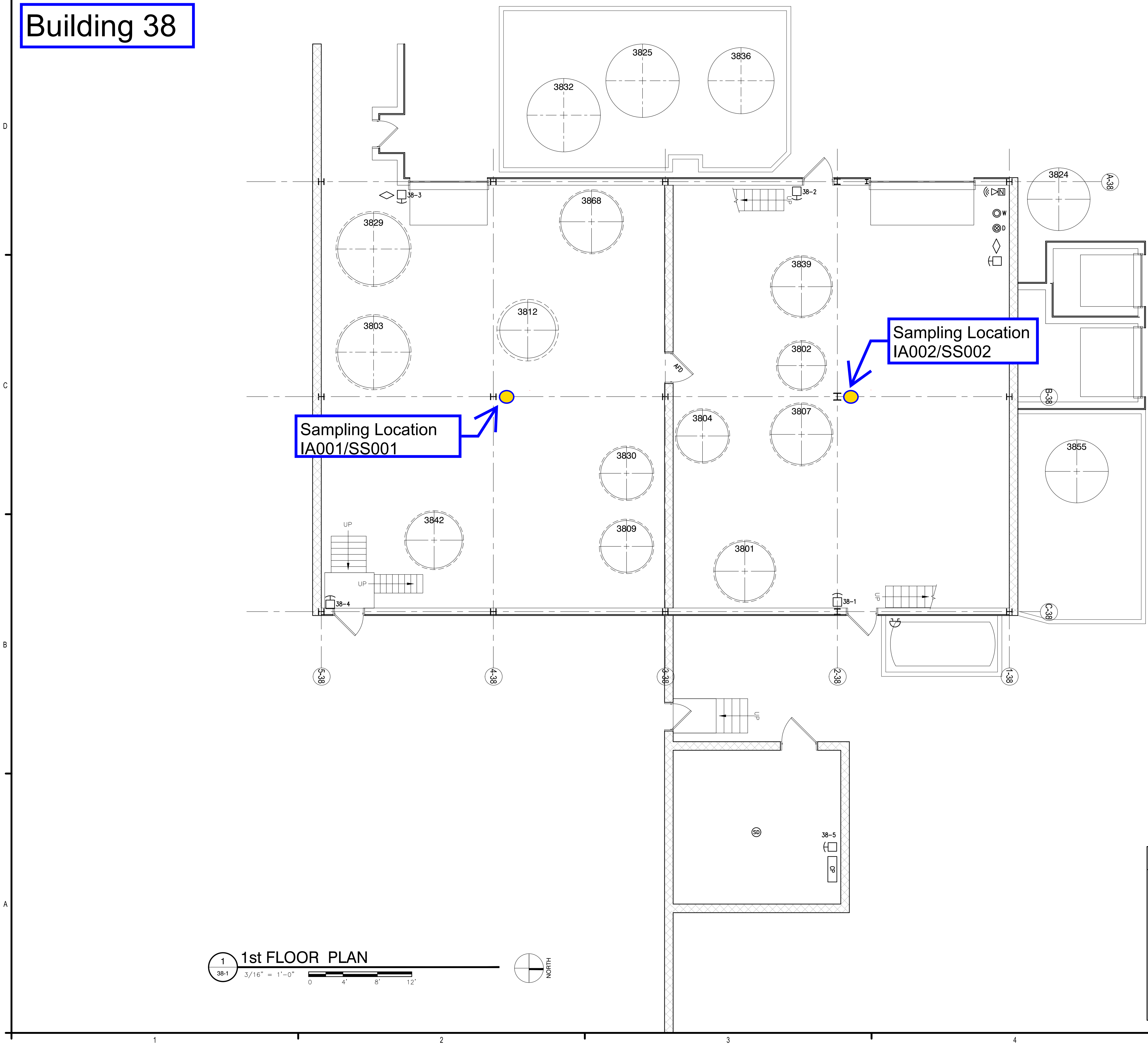
ANSUL. ANSUL FIRE PROTECTION
MARINETTE, WI 54143-2542

Date 5/7/09
Drawn By J.S.K.
Checked By J.S.K.
Approved By
Location

Description
BUILDING 36
LAYOUT

Drawing Number Bldg. 36
Rev.

Building 38



Sampling Location
IA001/SS001

Sampling Location
IA002/SS002

1 / 38-1 1st FLOOR PLAN
3/16" = 1'-0"
0 4' 8' 12'

SYMBOLS AND ABBREVIATIONS

PULL STATION:	⊏□	CP = CONTROL PANEL LNA = LOW NITROGEN ALARM P = PUMP JP = JOCKEY PUMP
MANUAL DELUGE VALVE:	◇	
WET STAND PIPE:	◎W	
DELUGE STAND PIPE:	⊗D	
SMOKE ALARM:	SD	
UNIMODE BELL:		
SELECTONE HORN:	▷□	
CONTROL PANEL:	CP	
PUMP:		
LOW NITROGEN ALARM:	▷N	

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BUILDING SURVEY
CHEM DESIGN PRODUCTS INC.
2 STANTON STREET
MARINETTE, WI 54143

DATE: #### #### #### #### #### #### #### #### #### #### ####
ISSUED FOR: #### #### #### #### #### #### #### #### #### #### ####

BUILDING SURVEY
CHEM DESIGN PRODUCTS, INC.
PROJECT NO: C112-01534
DESIGNED BY:
DRAWN BY: BJK
CHECKED:
APPROVED:

1st Floor Plan
Building 38

38-1

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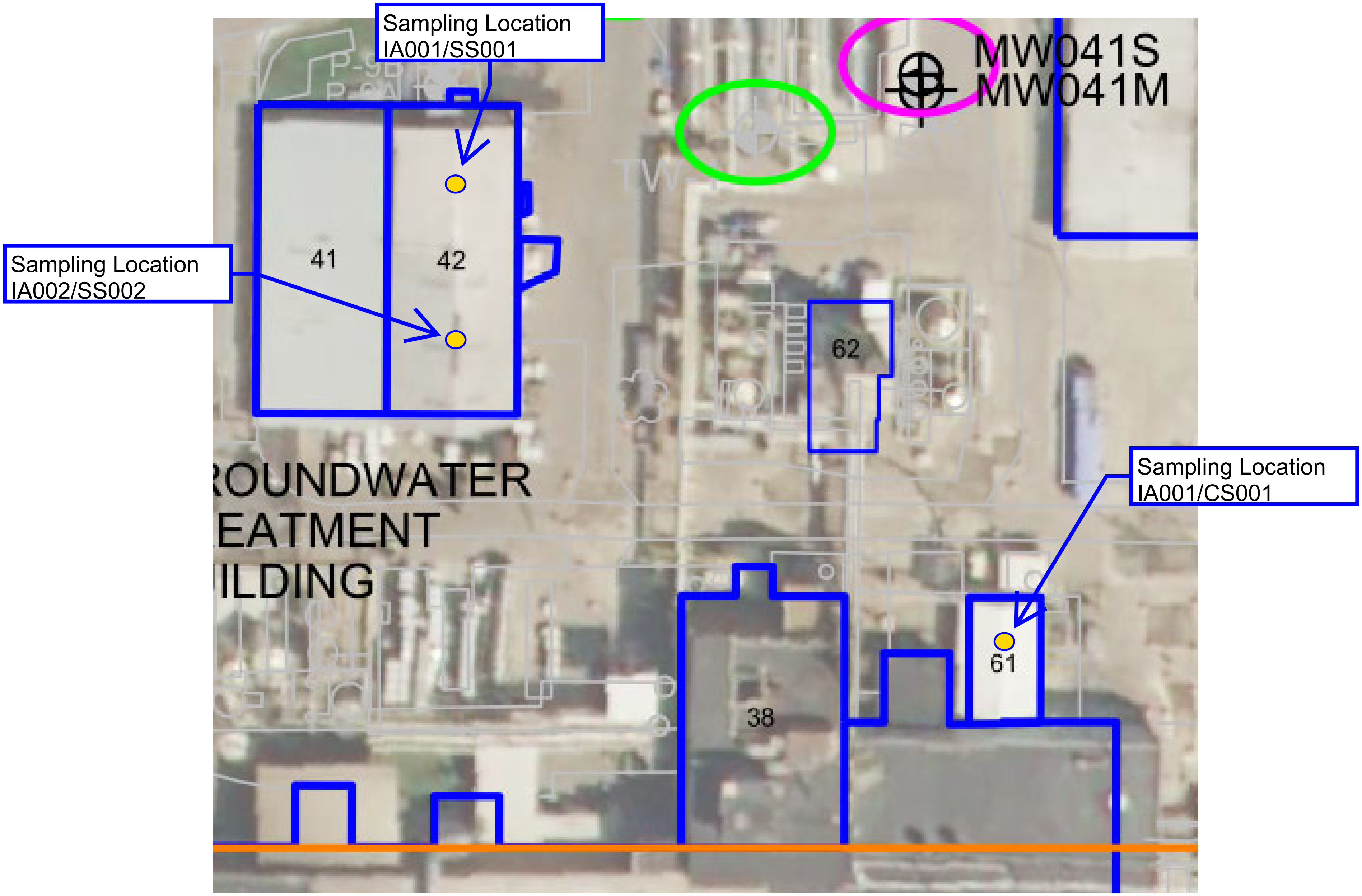
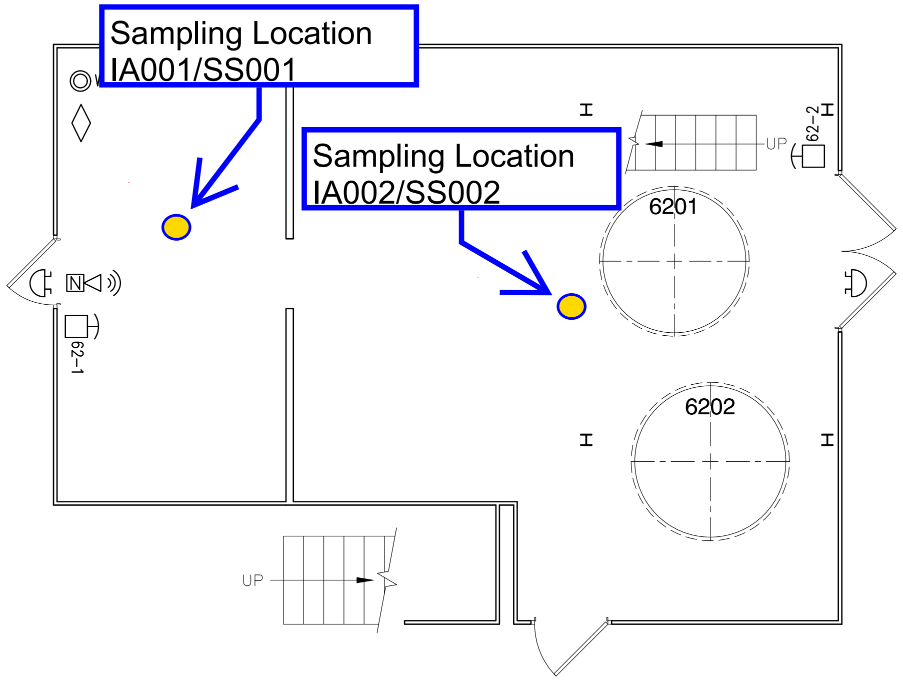
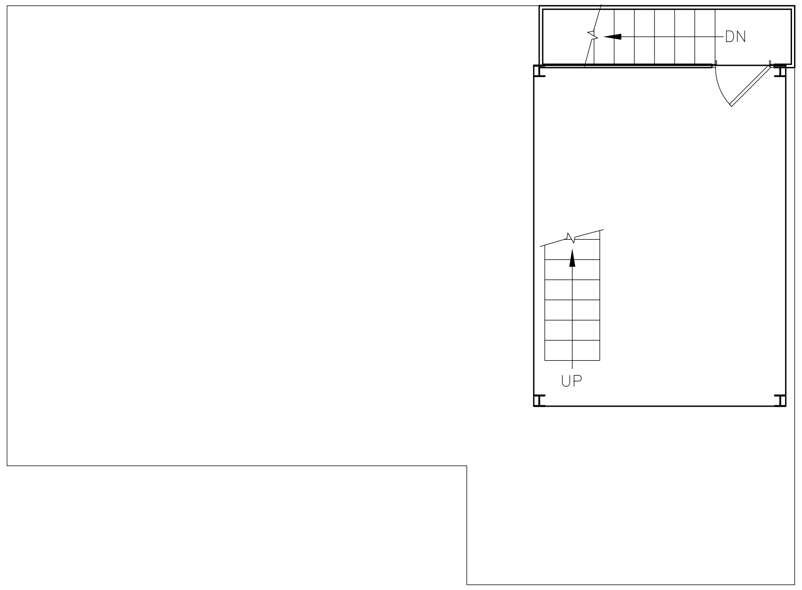
Buildings 42 and 61



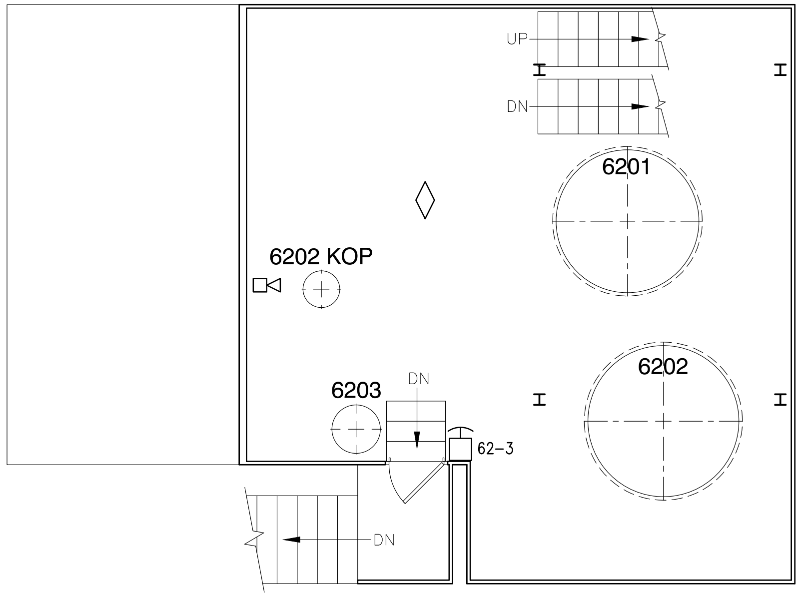
Building 62



1 / 62 1st FLOOR PLAN
1/4" = 1'-0"
0 2' 4' 8'
NORTH



3 / 62 3rd FLOOR PLAN
1/4" = 1'-0"
0 2' 4' 8'
NORTH



2 / 62 2nd FLOOR PLAN
1/4" = 1'-0"
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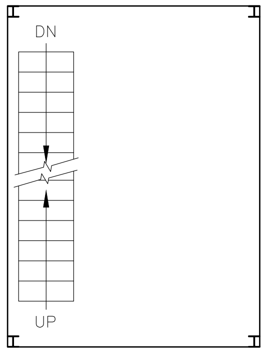
NORTH



4 / 62 4th FLOOR PLAN
1/4" = 1'-0"
0 2' 4' 8'
NORTH

SYMBOLS AND ABBREVIATIONS

PULL STATION:	⊏□
MANUAL DELUGE VALVE:	◇
WET STAND PIPE:	◎W
DELUGE STAND PIPE:	⊗D
SMOKE ALARM:	(SD)
UNIMODE BELL:	◡
SELECTONE HORN:	▷□
CONTROL PANEL:	CP
PUMP:	◔
LOW NITROGEN ALARM:	((▷N

CP = CONTROL PANEL
LNA = LOW NITROGEN ALARM
P = PUMP
JP = JOCKEY PUMP

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CHEM DESIGN PRODUCTS INC.
2 STANTON STREET
MARINETTE, WI 54143

DATE: #### #### #### #### #### #### #### #### ####
ISSUED FOR: #### #### #### #### #### #### #### #### ####

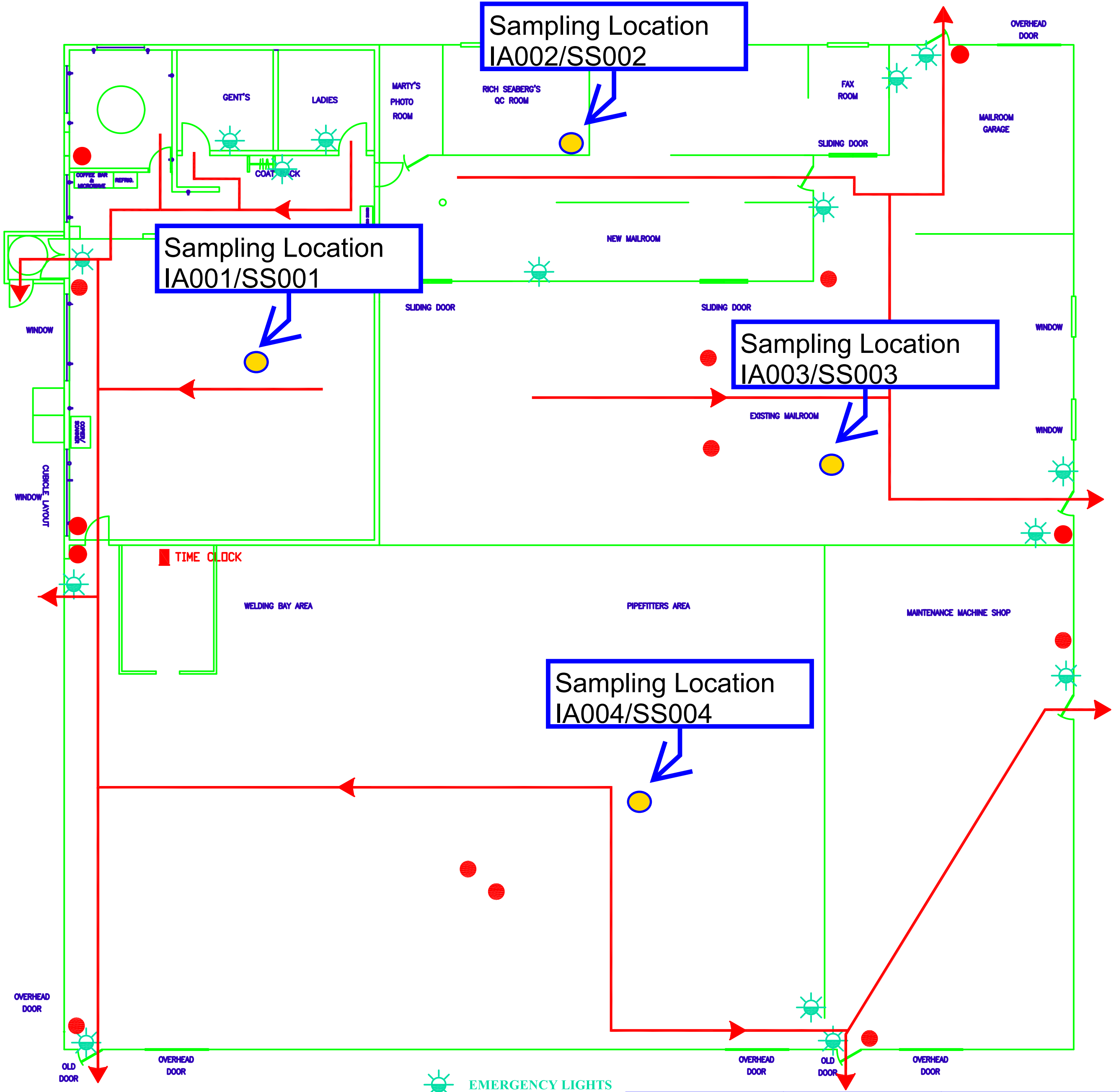
BUILDING SURVEY
CHEM DESIGN PRODUCTS, INC.
PROJECT NO: C112-01534
DESIGNED BY: BJK
DRAWN BY:
CHECKED:
APPROVED:

BUILDING 62

62

Building 71

△		DATE	BY	APP'D BY	RELEASE NO.
4					



N

→ =EVACUATION ROUTE

● =FIRE EXTINGUISHER LOCATION

DO NOT SCALE PRINT

LINEAR DIMENSIONS IN INCHES, WHEN TOLERANCES ARE NOT GIVEN, THEY ARE:

2 PLACE	+/-	0.5	0.02
3 PLACE	+/-	0.13	0.005

ANGLES +/- 1/2

UPDATED 7/22 PER D.L.

MATERIAL
NOTED

THIRD ANGLE PROJECTION

SHEET 1 OF 1

A.Q.L. Defect Classification
Ⓒ Critical Ⓜ Major

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Scale
NOTED

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ANSUL FIRE PROTECTION
MARINETTE, WI 54143-2542

Date
7/21/04

Drawn By
J.S.K.

Checked By
J.S.K.

Approved By

Location

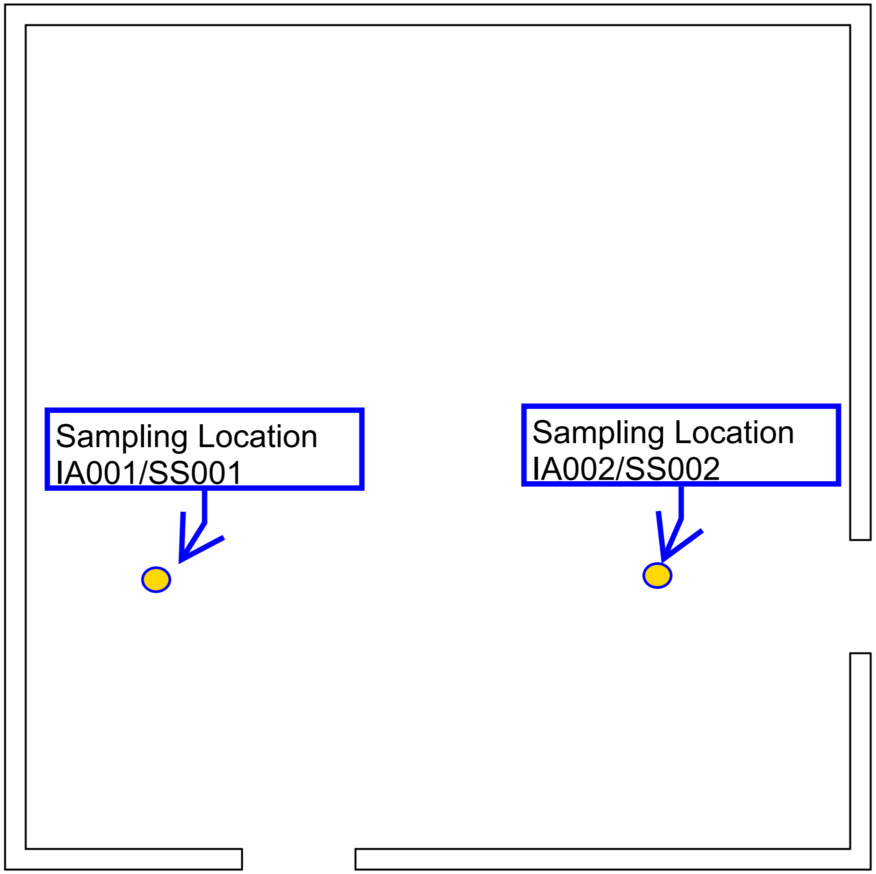
Description
BUILDING 71
MAILROOM, MAINTENANCE &
ENVIRONMENTAL DEPARTMENT

Drawing Number
BLDG. 71

Rev.

Building 86

		DATE	BY	APP'D BY	RELEASE NO.
3					
4					



→ =EVACUATION ROUTE

● =FIRE EXTINGUISHER LOCATION

DO NOT SCALE PRINT

LINEAR DIMENSIONS IN INCHES, WHEN TOLERANCES ARE NOT GIVEN, THEY ARE:

2 PLACE	+/−	0.5	0.02
3 PLACE	+/−	0.13	0.005

ANGLES +/− 1/2

THIRD ANGLE PROJECTION

SHEET 1 OF 1

MATERIAL
N/A

A.Q.L. Defect Classification
Ⓒ Critical Ⓜ Major

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Scale
N/A

CAD DRAWING EXISTS

Used On	Dwg.	Req'd

ANSUL®
ANSUL FIRE PROTECTION
MARINETTE, WI 54143−2542

Date
3/25/09

Drawn By
J.S.K.

Checked By
J.S.K.

Approved By

Description
BUILDING 86
LAYOUT

Location

Drawing Number
BLDG. 86

Rev.

Memorandum

Response to Vapor Intrusion Work Plan HAPSITE Comments

Date:	January 30, 2025
Project name:	Tyco Fire Products LP, One Stanton Street, Marinette, Wisconsin
Project no:	D3924000
Attention:	Andrew Kleinberg
Company:	U.S. Environmental Protection Agency
Prepared by:	Jacobs
Document no:	D3924000.325
Copies to:	Sarah Krueger, WDNR Angela Carey, WDNR Ryan Suennen, Tyco Fire Products Denice Nelson, Johnson Controls Heather Ziegelbauer, Jacobs

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Suite 201
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On behalf of Tyco Fire Products LP (Tyco), Jacobs Engineering Group Inc. (Jacobs) submitted a memorandum entitled *Response to Comments on Vapor Intrusion Work Plan Review With Comments* dated September 4, 2024 (Jacobs 2024). On December 4, 2024, the U.S. Environmental Protection Agency (EPA) and Wisconsin Department of Natural Resources (WDNR) (collectively referred to as the Agencies) provided comments in a letter entitled *Review - Vapor Intrusion Workplan Response to Comment.*

The Agencies provided three comments in the December 4, 2024 letter. This memorandum responds to comment #3 regarding the proposed HAPSITE gas chromatography/mass spectrometry (GC/MS) screening device. The Agencies' Comment #1 has been addressed as part of the revised vapor intrusion (VI) work plan (Revised VI Work Plan; Jacobs 2025), and Comment #2 will be addressed with a separate quality assurance project plan submittal.

Agencies Comments 3.a.i and 3.a.ii.:

3. *EPA and WDNR Requests the following information to be included in the revised work plan as it relates to the use the HAPSITE screening device:*
    a. *Document device methodology summary:*
        i. *Provide device product specifications and manufacturer's Standard Operating Procedures*
            1. *What are the principle uses and limitations (for example; expected precision, concentration working range, impact from non-target compounds, other interferences).*
        ii. *Document Quality Assurance and Quality Controls and provide a description of the procedures and frequency used to check the accuracy of the sampling and analysis, including calibration, field blanks, or duplicates. Provide a description of how calibration sample results are used to correct for instrument drift or determine the need for recalibration, and method used for standard preparation.*

1. *Provide calibration requirements and procedures per the manufacture's specifications.*

Tyco Response to 3.a.i. and 3.a.ii.:

The operating manual is included as Attachment 1, and provides the HAPSITE specifications. The manufacturer does not have calibration specifications that are pertinent to how the HAPSITE GC/MS screening device will be used as part of the VI investigation; however, a Jacobs standard operating procedure (SOP) that will be used for the VI investigation is included in SOP-2 (Analytical Method for the Determination of Volatile Organics in Soil Vapor or Air Using the HAPSITE Field GC/MS). SOP-2 details the quality control and analytical procedures. SOP-2 is included in Appendix D of the Revised VI Work Plan and is also included as Attachment 2 to this memorandum.

Agencies Comment 3.a.iii.:

3.a.iii. Document Reporting limits and what method detection limits and reporting (quantitation) limits are being achieved for each COC for the project. If concentrations of results are being used to make risk decisions as opposed to screening to determine if the COC is present or for locating preferential pathways, reporting limits should be below the VAL for samples collected in indoor air, sumps, interior plumbing conduits, or crawl spaces, below the VRSL for sub-slab or soil gas samples, and below the SSGSL for samples from sanitary sewer main pipes or manholes, for the type of building being assessed and take into account sampling precision.

Tyco Response to 3.a.iii.:

The HAPSITE procedures generally follow EPA Standard Method TO-15 for analysis of volatile organic compounds (VOCs) in air via GC/MS. However, a method detection limit study will not be conducted, because one would have to be performed for each instrument at each site location, which would be an impractical, time-consuming process. Instead, the lowest point of the calibration curve will be reported (HAPSITE reporting limit). The lowest point of the calibration curve is at least one order of magnitude lower than the WDNR air vapor action levels for the HAPSITE VOCs. Table 4-1 (Vapor Intrusion VOC HAPSITE Analyte List) in the Revised VI Work Plan presents the VOCs of interest along with the sanitary sewer gas screening levels (SSGSLs) and the corresponding HAPSITE reporting limits, which are well below 10 percent of the SSGSLs. Table 4-1 is also included as Attachment 3 to this memorandum, and a similar table was provided in Attachment 4 of the September 4, 2024 memorandum (Jacobs 2024).

As indicated in the Revised VI Work Plan, the initial real-time HAPSITE assessment will be used to (1) conduct initial sampling of indoor air in buildings and (2) assess the potential for VI through the sanitary sewers and other identified utility conduits. The HAPSITE data will not be used to make human health risk calculations or risk-management decisions. The data will be used as a line of evidence to help refine locations for conventional sampling (that is, canister or passive sampling for laboratory analysis). For HAPSITE-measured concentrations of less than 10 percent of the SSGSLs in a sanitary sewer main (or other identified exterior utility conduits), Tyco is proposing that the HAPSITE data be considered sufficient to conclude that no further sampling in the corresponding sewer main or utility is needed, consistent with the chart presented in WDNR guidance (WDNR 2021, Figure 5).[1]

Agencies Comment 3.a.iv.:

3.a.iv: Document carryover and what measures are taken to prevent analysis of high concentration samples affecting concentrations of subsequent sample.

Tyco Response to 3.a.iv.:

Procedures for addressing carryover are discussed in SOP-2 (Attachment 2).

Agencies Comment 3.b.:

3.b.: Provide a description of how the sample analyzed is collected and delivered to the device.

Tyco Response to 3.b.:

Sample introduction and analysis is discussed in SOP-2 (Attachment 2).

Agencies Comment 3.c.:

3.c.: Provide examples of successful use of the device in situations like those in the setting being evaluated. These build confidence in the use for the current investigation.

Tyco Response to 3.c.:

Three publicly available examples of similar projects are:

- Naval Base San Diego Site, California—Refer to Appendix E (CH2M 2022) of Attachment 1 (CH2M 2021) at PDF pages 367 to 452 of the following document: *Action Memorandum Non-Time-Critical Removal Action, Installation Restoration Program Site 22, Building 3280 Wing A, Naval Base San Diego, San Diego, California* (CH2M 2023).
- Former Bull HN Information Systems Site, Brighton, Massachusetts—Refer to PDF pages 9 and 383 to 392 of the following document: *Post–Temporary Solution Status and Remedial Monitoring Reports October 2014 through March 2015, Former Bull HN Information Systems Inc. Facility, RTN 3-00158* (CH2M 2015a).
- Allegany Ballistics Laboratory Rocket Center, West Virginia—Refer to the following document (note that the final investigation report for this work is not yet publicly available): *Uniform Federal Policy Sampling and Analysis Plan: Vapor Intrusion Investigation for Sites 10 and 12, Allegany Ballistics Laboratory Rocket Center, West Virginia* (CH2M 2015b).

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[1] This approach will be used for samples collected outside a building (for example, a sewer main or other exterior utility maintenance hole) because the use of SSGSLs is not appropriate for screening indoor plumbing or unsealed sumps (WDNR 2021).

Agencies Comment 3.d.:

3.d.: Document personnel qualifications and document whether sampling technicians meet the minimum qualifications and training for operating the device as recommended by the manufacturer.

Tyco Response to 3.d.:

Ben Thompson (a Jacobs chemist and VI field sampling subject-matter expert) has been involved with the Revised VI Work Plan preparation and will provide support throughout the investigation, including remote oversight of the fieldwork and data quality. Mr. Thompson will also provide the Jacobs internal HAPSITE training for field staff and will determine when a field staff member has the appropriate skills and experience to perform the analytical fieldwork. He will work with the team on a daily basis to make sure that the field procedures are followed, and quality control elements and overall data quality are acceptable. Mr. Thompson has over 30 years of environmental analytical experience and over 14 years of experience with the HAPSITE GC/MS screening device. His HAPSITE operator training certificate is included as Attachment 4.

Agencies Comment 3.e.:

3.e.: Provide any additional and relevant information that is specific to the device being used.

Tyco Response to 3.e.:

Please let us know if you need additional information beyond that provided in the Revised VI Work Plan, SOP-2, or this memorandum.

Agencies Comment 3.f.:

3.f.: For future data reporting ensure data is presented in tabular format and in a manner which quickly communicates results and exposures.

Tyco Response to 3.f.:

Jacobs has developed an ArcGIS tool that imports data from the HAPSITE GC/MS screening device and combines it with information gathered on electronic forms in the field. Once these data are in the database, it can generate table and figure outputs, as desired.

References

CH2M HILL, Inc. (CH2M). 2015a. *Post–Temporary Solution Status and Remedial Monitoring Reports October 2014 through March 2015, Former Bull HN Information Systems Inc. Facility, RTN 3-00158*. July 1. https://fileservice.eea.comacloud.net/V1.4.0/FileService.Api/file/bdbcbaaj.

CH2M HILL, Inc. (CH2M). 2015b. *Uniform Federal Policy Sampling and Analysis Plan: Vapor Intrusion Investigation for Sites 10 and 12, Allegany Ballistics Laboratory Rocket Center, West Virginia*. December. https://administrative-records.navfac.navy.mil/Public_Documents/MID_ATLANTIC/ROCKET_CENTER_NIROP/N91571_003019.pdf.

CH2M HILL, Inc. (CH2M). 2021. *Memorandum: Phase 2 and Phase 3 Vapor Intrusion Investigation Results, Installation Restoration Program Site 22, Building 3280, Naval Base San Diego, San Diego, California*. DCN: CH2M-9000-FZ02-0070. June.

CH2M HILL, Inc. (CH2M). 2022. *Engineering Evaluation and Cost Analysis for Installation Restoration Program Site 22 (Building 3280), Naval Base San Diego, San Diego, California*. DCN: CH2M-4015-5008-0001. July.

CH2M HILL, Inc. (CH2M). 2023. *Action Memorandum Non-Time-Critical Removal Action, Installation Restoration Program Site 22, Building 3280 Wing A, Naval Base San Diego, San Diego, California*. DCN: CH2M-4015-5008-0005. Final. April. https://administrative-records.navfac.navy.mil/Public_Documents/SOUTHWEST/NAVAL_BASE_SAN_DIEGO/N00245_001890.PDF.

Jacobs. 2024. *Memorandum: Response to Comments on Vapor Intrusion Work Plan Review With Comments*. September 4.

Jacobs. 2025. *Vapor Intrusion Assessment and Work Plan, Revision 2*. January 30.

U.S. Environmental Protection Agency (EPA). 2024. *Review - Vapor Intrusion Workplan Response to Comments*. December 4.

Wisconsin Department of Natural Resources (WDNR). 2021. *Guidance for Documenting the Investigation of Human-made Preferential Pathways Including Utility Corridors*. Publication RR-649. June. https://widnr.widen.net/s/kxtjjk5hbg.

Attachment 1

HAPSITE Smart Plus Chemical Identification System Operating Manual

HAPSITE Smart Plus Chemical Identification System Operating Manual is provided as a separate electronic PDF file. The operating manual is also available at the following link for download:

https://www.inficon.com/media/4264/download/074-472-P1C-HAPSITE-Smart-Plus-OM.pdf?v=1&language=en

Attachment 2

HAPSITE Field Gas Chromatograph/ Mass Spectrometer Standard Operating Procedure

Analytical Method for the Determination of Volatile Organics in Soil Vapor or Air Using the HAPSITE Field GC/MS

Purpose

This standard operating procedure (SOP) presents general guidelines for using a HAPSITE gas chromatograph (GC)/mass spectrometer (MS) to analyze soil vapor or air samples in the field using U.S. Environmental Protection Agency (EPA) Method TO-15 as guidance.

Scope

This SOP provides a general description of how to analyze soil vapor or air samples in the field with a HAPSITE GC/MS. This SOP is intended to be used by GC/MS chemists with proper training and experience. These procedures are based upon EPA Method TO-15, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, *Second Edition* (1999), and the HAPSITE user manual. This method is applicable to specific volatile organic compounds (VOCs) in soil vapor or air. Table 1 presents a list of VOCs with reporting limits (RLs) that can be analyzed with this procedure.

Equipment and Materials

HAPSITE GC/MS sampling materials:

- Inficon HAPSITE Smart, Smart Plus, or ER GC/MS
- GC Column – VOC (Standard)
- Gas sampling bags (such as Tedlar brand) in varying sizes as needed (including canister-to-bag adapter for calibration standards).
- Gastite syringes in various sizes from 25 microliters (µl) to 100 milliliters (mL) with Teflon plunger and rounded needle tip.
- Portable Windows-based laptop computer, equipped with HAPSITE Smart IQ software for acquisition, integration, quantitation, and storage of mass spectral data (including communication cable between HAPSITE and laptop and a transfer method for retrieving data from the vendor-supplied laptop). The HAPSITE can operate without connection to a computer, but a computer is necessary for higher-quality data reprocessing.
- Power source – either line power or an automobile power inverter. The HAPSITE has an onboard battery, but it needs to be re-charged periodically.
- Internal/Surrogate/Tuning Standard mix, provided with the HAPSITE in a disposable gas cylinder.
- Nitrogen Carrier Gas, provided with the HAPSITE in a disposable gas cylinder.
- Two-stage regulator for nitrogen cylinder (optional). CGA 580 fitting.
- Calibration standards – 6 liter (L) evacuated canisters prefilled with 5 parts per billion by volume (ppbV) and 0.5 ppbV of mixed gas standard for calibrating the HAPSITE and verifying calibration daily.

- Method blank standard – 6 L evacuated canister prefilled with high-purity nitrogen, to verify the HAPSITE is free of contamination daily.

Procedures and Guidelines

This SOP describes the general procedures and guidelines for using a HAPSITE GC/MS, to analyze soil vapor or air samples in the field.

Overview of the Analytical Process

- Soil vapor and air samples are collected through the sampling probe at ambient pressure.
- The HAPSITE can be operated in two different modes. Analytical mode for quantitative (quant) and qualitative results, or survey (sniff) mode for qualitative screening.
- Quant mode: Samples are introduced into the GC/MS system by way of a sample probe and concentrator. The concentrator traps the sample onto an adsorbent trap, which allows atmospheric gases to pass through (such as, carbon dioxide, oxygen, and nitrogen [N_2]). The trap is then heated, and the analytes are transferred to the GC column, then to the MS detector.
- Survey mode: Samples are introduced through the sample probe directly into the MS detector.
- Data are collected and stored into the HAPSITE system memory. The data can then be used by an external computer for calibration, data processing, reporting of samples, and data archiving.
- SIM and SCAN: The MS system can operate in SCAN or SIM mode, depending on analytical or specific project requirements. SCAN mode is used for more conventional TO-15 analysis or if tentatively identified compounds (TIC) are required. In this mode, the MS scans a range of ions (typically 35 to 250 atomic mass units). This range contains all ions necessary to identify and quantitate all compounds in the TO-15 list. If lower detection levels are required, SIM mode may be used. In SIM mode, the analyzer only looks at ions specific to the target compounds. Up to three ions are used per compound, 1 for quantitation and 1 or 2 for qualification. This increases the dwell time that the analyzer spends scanning for each specified ion, which increases sensitivity at the cost of selectivity. Because of this, it is not possible to produce TIC reports in SIM mode.
- After samples are analyzed, processed, and meet all acceptance criteria herein, a client report is generated and typically reviewed by a peer.

Target Analytes, Reporting Limits, and Detection Limits

Standard target analytes and RLs for the base analyte list for analysis in SIM mode are listed in Table 1. To keep the analysis time as short as possible, the analyte list should be kept to the minimum number of compounds of interest. To produce the analyte list and RLs in Table 1, it takes approximately 10 to 15 minutes from injection to injection (including sampling time, analytical run time, and post-run instrument cool down).

The RLs shall be at or above the lowest calibrated point on the initial calibration curve. RLs may increase or decrease based on the amount of time the sample is loaded onto the concentrator. Typical achievable limits for a 1-minute fill time are listed in Table 1 for SIM mode.

Table 1: Method Analytes (1-minute fill time)

Standard Analytes	Reporting limit µg/m3
1,2-DCE (cis)	2.0
1,2-DCE (trans)	2.0

Table 1: Method Analytes (1-minute fill time)	
PCE	3.5
TCE	2.8
Vinyl Chloride	1.3

*All RLs are subject to change on a client specified basis as requested by that client. Analytes listed here are referenced as the most common select list of VOCs to maintain during a HAPSITE investigation. Please check with your project-specific VI SME for the appropriate screening list.

Interferences

Contamination may occur in the sampling system if it is not properly cleaned before use. Therefore, the probe should be heated and an ambient system flush performed at the start of each day, and between samples with elevated (greater than double the highest point on the calibration curve) concentrations of VOCs.

Contamination may occur from impurities in the carrier gases and from background sources. These sources of contamination are monitored through analysis of method blanks.

Cross-contamination can occur whenever samples containing high VOC concentrations are analyzed. Therefore, whenever an unusually concentrated sample is encountered (greater than double the highest point on the calibration curve), the analyst uses professional judgment when reviewing the samples to determine whether reanalysis is necessary.

Sample Collection, Storage, Holding Times, and Preservation

Samples are collected in gas sampling bags. Analysis of gas sampling bags should be performed immediately after sample collection. Samples should be field screened with a photoionization detector before analysis to obtain an approximate dilution factor.

Standards, Gases, and Reagents

All standards are logged into the chemical inventory database upon receipt. Any standard that is prepared in the laboratory will be verified against current standards before use.

- Calibration standard—Purchase a premade standard or have a vendor prepare a calibration standard in a 6-L Summa canister. Actual concentration and composition varies by project, but typically 5 ppbV and 0.5 ppbV are good targets.
    - Stock standards—Standards are purchased as custom made mixtures in gas cylinders. Cylinders purchased from vendors are traceable to a National Institute of Standards and Technology. 62-component mixture from Scott Gases (catalog number 41973-U). Stock standard is 1,000 ppbV.
    - Primary Field Standard (5 ppbV)—Dilute the 1,000-ppbV primary standard(s) 1:200. Evacuate a clean 6-L canister. Add 50 µl of DI water. Add 90 mL of 1,000-ppbV standard. Fill canister to final pressure of 2,280 torr using Ultra High Purity (UHP) N_2. This provides 12 L of usable 5-ppbV standard (16 L total).
    - Primary Field Standard (0.5 ppbV)—Dilute the 1,000-ppbV primary standard(s) 1:2000. Evacuate a clean 6-L canister. Add 50 µl of DI water. Add 9 mL of 1,000-ppbV standard. Fill canister to final pressure of 2,280 torr using UHP N_2. This provides 12 L of usable 0.5-ppbV standard (16 L total).
    - Daily Field Calibration standards—Primary Field Daily Calibration Standard—Fill a 1-L gas sampling bag with 5-ppbV primary field standard.

- Internal/Surrogate/Tuning standard—The internal/surrogate/tuning standard mix is provided with the HAPSITE in a disposable gas cylinder. Each cylinder is prepared with bromopentafluorobenzene (BPFB) and 1,3,5-tris (trifluoromethyl) benzene (TRIS) at approximately 5 ppbV, with nitrogen as the balance gas.
- Nitrogen Carrier Gas—UHP 99.999 percent or better. Either in disposable Inficon canisters or commercially provided cylinder (if HAPSITE will be used in a fixed location and large quantities are required).

Analytical Procedure

- Startup when the HAPSITE is received:
  - Unpack the HAPSITE. It is usually shipped with the power off and the MS pumped down. Be sure that it has a significant amount of time (at least an hour or overnight if possible) to warm up and equilibrate before use.
  - Insert the carrier gas (or attach external supply) and internal standard gas cylinders. Visually verify that the sample trap has not broken during shipment.
  - Plug the HAPSITE into an external power source.
  - Attach the computer (turn on and start software). Then push the power button on the HAPSITE. The HAPSITE will go through a warm up routine, then a tune. When prompted for a trap clean out, press 'yes' on the HAPSITE screen.
  - Load the desired method on the HAPSITE screen and then denote this method as the default method. This is important because otherwise it will default to a different method at the end of each run and change zone temperature settings. Note: All files (method, tune, data) reside on the HAPSITE, not the laptop computer.
- Create a new subdirectory each day. This can be done in the method editor (Data page).
  - Startup from extended standby:
    - Press power button
    - Insert internal standard and carrier gas.
    - Wait for instrument to warm up and run tune.
  - Analytical standards and/or diluted samples in gas sampling bags are attached to the sample probe manifold with a compression fitting. Ambient air samples are simply drawn directly into the probe. Pressurized or evacuated sample or standard sources cannot be used as they will significantly change instrument response.
- Quantitation Mode
  - Using the method editor on the PC, verify that the desired sample time is set correctly in the method to be used for analysis. Typically, this will be 1 minute, but may differ depending on project requirements or dilutions. Save the method.
  - Load the appropriate quantitation method onto the HAPSITE. This can either be done from the touch screen or the PC. Be sure that the method is appropriate for the target compounds. If necessary, sensitivity can be increased by using SIM to target the most important ions of interest.
  - Run the quality control (QC) (either an initial calibration [ICAL] or calibration verification [CV] and blank). Attach a gas sampling bag containing the standard or UHP blank gas to the sample

probe. Open the bag and press run on the HAPSITE. Once QC has passed criteria, then sample analysis can begin.

  - Attach a gas sampling bag containing the sample to the sample probe and press the run button on the HAPSITE. Once the desired sample time has been completed, the gas sampling bag can be removed.
  - Once the analysis is complete, allow the GC oven to cool, then inject the next sample.
  - All the sample and QC information for an analytical run, such as laboratory and client sample identifications (IDs), injection volumes, standard IDs, and run methods, are added to the field log.
- Sample Dilution
  - Any sample that has target analytes over the calibrated range of the instrument should be diluted if possible. The subsequent dilution should be run such that the final value of the maximum concentration analyte recovers within the calibrated range on the instrument (before dilution factors are applied).
  - Required dilutions for HAPSITE analysis can be achieved in two different ways:
    - Concentrator fill time: Inject a smaller sample volume. Record all dilutions in the field form. For example, normalized to a 1 minute fill time (100 mL), a dilution of 5 times can be performed by only sampling for 0.2 minute (20 mL). Using the method editor on the PC, set the desired sample time in the method to be used for analysis. Save the method. Then load the appropriate quantitation method onto the HAPSITE. This can either be done from the touch screen or the PC
    - Gas sampling bag dilution: Take a sample with a syringe and inject it into a gas sampling bag with a known volume of clean air. Attach the bag to the instrument sampling port and withdraw an aliquot. The aliquot can be less than the normalized value (as in the section before). Both the gas sampling bag dilution factor and concentrator fill injection factors are applied to the final instrument result.
- At the end of the day, put the HAPSITE into external standby and remove carrier gas and internal standard (ISTD) if the instrument is going to be used again next day. Otherwise, the HAPSITE can be powered off.

Quality Control and Quality Assurance

All RLs, QC frequency, and QC acceptance criteria are subject to change on a project specific basis.

- The instrument is tuned using BPFB and TRIS. This is performed before analysis each day. The HAPSITE software runs a tuning program set to optimize its instrument parameters for analysis. This program optimizes sensitivity and enables library matching of the spectra.
  - There are short- and long-tune algorithms. Typically, the short tune is performed. A long tune is performed only after major instrument maintenance.
  - After running a successful tune (tune passes internal instrument criteria), it is saved to the default tune file.
  - The HAPSITE is not designed to pass the TO-15 bromofluorobenzene (BFB) tune criteria to operate at its highest potential. Therefore, BFB tune criteria are not relevant for this SOP.
- Initial Calibration—An initial calibration curve is required to demonstrate adequate instrument performance for sensitivity, linearity, resolution, and absence of active sites.

- A valid initial calibration curve must be established before samples can be analyzed. The GC/MS is calibrated following the outline herein. Variations from this standard calibration scheme are sometimes necessary because of project RL requirements.
- As the RL is driven by the lowest calibration point, any lowering of the RL will require either (A) calibrating to a lower level or (B) injection of more sample volume.
- Calibration schemes.
- The following calibration schemes have been successfully used, the actual scheme used should be tailored to the instrument and project requirements. It is based on a 1-minute sampling period (1 minutes at 100 mL/min = 100 mL)

  Cal Levels (1-minute sampling time normalization)

Table 2. Calibration Levels

Cal level	Std Concentration, ppbV	Sampling time, min.	Concentration, ppbV
Level 1	0.5	0.2	0.1
Level 2	0.5	1.0	0.5
Level 3	0.5	2.0	1.0
Level 4	5.0	1.0	5.0
Level 5	5.0	5.0	25.0

- The curve can be shifted to be more or less sensitive by increasing or decreasing the sampling time. Longer sampling time increases sensitivity, and vice versa.
- For the initial calibration, a response factor and a percent relative standard deviation (%RSD) are calculated for each analyte.
- After a new calibration is performed, the method needs to be saved with the correct filename. The method name should be the date followed by an identifier. For example, an ICAL performed on October 29, 2014, for client X shall be named 102914X.
- There must be at least three points to have a valid calibration curve. The lowest point will be below the quantitation limit required in the Quality Assurance Project Plan.
- The %RSD for all compounds must be less than 30 percent.
- If the %RSD greater than 30 percent, then a linear curve fit may be used if the curve fit greater than 0.995.
  - If the requirements are not met, then a new initial calibration must be performed. If this does not result in an acceptable initial calibration, then system maintenance may be necessary.
  - Calibrations are valid for 1 year (or until the end of the project, whichever occurs first) if QC continues to meet acceptance criteria.
  - In the following instances, a new calibration shall be required:

    Major instrument maintenance such as cleaning the MS.

    Repeated failure (more than 3 attempts) to pass continued calibration criteria.

- Method Blanks—Method blanks are required at a rate of one per day. Method blanks are analyzed to monitor possible instrument contamination. Laboratory method blanks are prepared with UHP nitrogen in a gas sampling bag every day samples are to be analyzed. The method blank is carried through the same analytical procedure as a field sample.

  - Method blanks are analyzed by injecting the full normalized volume of nitrogen (varies by system) into the HAPSITE and following procedures outlined in Section 9.
  - The blank must not contain any target analyte at a concentration greater than the RL and must not contain additional compounds with elution characteristics or mass spectral features that would interfere with identification and measurement of a method analyte. If target analytes are found in the method blank above the RL, the source of the contamination must be considered. Usually, rerunning the blank will resolve most problems (especially if the sample run prior to the blank was high in target analyte concentration). If blank contamination is still present, the analyst must perform system maintenance. Some common problems that cause a blank to show contamination are:
    - Cold spots—check heated zones for failure
    - Contaminated sample probe—flush the probe
    - Dirty gas sampling bag—flush and refill the bag or use new bag

- Continuing Calibration Verifications—a primary source standard analyzed at the beginning of an analytical batch to ensure that the instrument continues to meet the instrument sensitivity and linearity requirements originally established by the initial calibration.
  - The opening CV for each compound of interest shall be verified prior to sample analysis using the same introduction technique and conditions as used for samples. This is accomplished by analyzing one of the calibration standards used for initial calibration.
  - Concentrations for CV must be at or below the midpoint of the instrument calibration curve.
  - No closing calibration check is required for TO-15 analysis. However, a closing calibration check will be analyzed to increase confidence in data quality.
  - The percent difference (%D) for each compound may not exceed 30 percent.
  - Failure to pass continuing calibration criteria requires corrective action are performed. Repeated failure (more than 3 consecutive attempts) to pass response factor criteria requires the performance of a new initial calibration.

Attachments

- HAPSITE Log Sheet – Quant Mode
- HAPSITE Log Sheet – Sniff Mode

References

U.S. Environmental Protection Agency (EPA). 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*. January.

Infilcon. 2017. Operating Manual: HAPSITE ER Chemical Identification System. IPN 074-471-P1D.

Infilcon. 2008. Operating Manual: HAPSITE Smart Plus Chemical Identification System. IPN 074-472-P1D. November.

Hapsite Log Sheet
Quant Mode

Site ____________________

Date ____________________

Operator ____________________

SubDirectory ____________________

Location	Time	File ID	Fill Time	DF	Notes

Comments: ____

Hapsite Log Sheet
Sniff Mode

Site ____________________

Date ____________________

Operator ____________________

General Location ____________________

SubDirectory ____________________

File ID ____________________

Start time ____________________

Location	Time	Notes

Comments: ____

Attachment 3

Vapor Intrusion VOC HAPSITE Analyte List

Table 4-1. Vapor Intrusion VOC HAPSITE Analyte List

Tyco Fire Products LP, Marinette, Wisconsin

Volatile Organic Compounds	Indoor Air VAL* (µg/m^3)	Sewer Gas Screening Level (µg/m^3)	10% of Sanitary Sewer Gas Screening Level (µg/m^3)	HAPSITE Reporting Limit (µg/m^3)	Does the analyte's maximum concentration in shallow GW exceed its GW VRSLs?	Is the analyte actively used at the facility by ChemDesign?	Is the analyte a breakdown compound of TCE?	Retain as HAPSITE analyte?**
Petroleum VOCs in Groundwater								
Benzene	15.7	524	52.4	0.16	No	No	No	No
Ethylbenzene	49.1	1,640	164	0.22	Yes	No	No	Yes
Naphthalene	3.61	120	12	0.53	No	No	No	No
Toluene	21,900	730,000	73,000	0.19	No	Yes	No	Yes
Xylenes (o-xylene and m- & p-xylene)	438	14,600	1,460	0.44	Yes	Yes	No	Yes
Chlorinated VOCs in Groundwater								
Chlorobenzene	219	7,300	730	0.23	No	Yes	No	Yes
Chloromethane	394	13,100	1,310	May not be detectable	No	No	No	No
1,2-Dichlorobenzene	876	29,200	2,920	0.31	No	No	No	No
1,4-Dichlorobenzene	11.1	372	37.2	0.31	No	No	No	No
1,2-Dichloroethane	4.72	157	15.7	0.21	No	No	No	No
cis-1,2-Dichloroethene	175	5,840	584	0.20	No	No	Yes	Yes
Methylene Chloride	2,630	87,600	8,760	0.18	No	Yes	No	Yes
Trichloroethene (TCE)	8.76	292	29.2	0.27	Yes	No	No	Yes
Vinyl chloride	27.9	929	92.9	0.26	No	No	Yes	Yes

Notes:

🟧	Constituents possibly attributable to ChemDesign spills based on TRC Environmental Corporation 2012 and 2014 letter reports and review of ChemDesign spills noted in the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) on the Web
▨	Not proposed for HAPSITE

VAL = vapor action level
VOC = volatile organic compound
VRSLs = vapor risk screening levels
GW = groundwater
µg/m^3 = microgram(s) per cubic meter
VAL Source
https://widnr.widen.net/s/fvhcjvxrfs
Sewer gas screening level based on the indoor air VAL and an attenuation factor of 0.03
* For reference, the site is an active manufacturing site; for chemicals that remain actively used, indoor air samples will also be compared to applicable OSHA standards per WDNR RR-800 2018 VI guidance Section 6.1
** Analytes in the HAPSITE list include the following: (1) analytes for which groundwater concentrations exceed GW VRSLs, (2) analytes that are chemical currently used at the facility, or (3) analytes that are a breakdown of TCE

Attachment 4
HAPSITE Advanced Operator Training Certificate of Completion

KD ANALYTICAL

KD ANALYTICAL

Certificate of Completion

THIS ACKNOWLEDGES THAT

Ben Thompson

HAS SUCCESSFULLY COMPLETED
HAPSITE ADVANCED OPERATOR TRAINING

CH2M Hill

DAN SCHENK , TRAINER

MARCH, 15, 2011