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Conceptual Performance-Based Vapor Intrusion Mitigation System Remedial Design
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

WA No. 257-RDRD-B5VX/Contract No. EP-S5-06-01

Prepared for

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ch2m

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*Features from this item were partially redacted in the public version of the RI report to protect personally identifiable information or for public safety reasons.

**This item was redacted in its entirety from the public version of the RI report to protect personally identifiable information.

Acronyms and Abbreviations

ARARs	Applicable or Relevant and Appropriate Requirements
CH2M	CH2M HILL, Inc.
CPBRD	Conceptual Performance-Based Remedial Design
CVOC	chlorinated volatile organic compound
DNAPL	dense nonaqueous phase liquid
EPA	U.S. Environmental Protection Agency
IDEM	Indiana Department of Environmental Management
NAPL	nonaqueous phase liquid
NPL	National Priorities List
PCE	tetrachloroethene
PVC	polyvinyl chloride
RA	remedial action
RI	remedial investigation
ROD	Record of Decision
site	Keystone Corridor Groundwater Contamination Site
TCE	trichloroethene
VIMS	vapor intrusion mitigation system

SECTION 1

Introduction

This Conceptual Performance-Based Remedial Design (CPBRD) document includes the conceptual performance-based design of Vapor Intrusion Mitigation Systems (VIMS) for preemptive mitigation of 8 commercial structures, including 18 commercial addresses, located at the Keystone Corridor Groundwater Contamination Site (site). The site CPBRD is being completed by CH2M HILL, Inc. (CH2M) on behalf of the U.S. Environmental Protection Agency (EPA) Region 5. The CPBRD was prepared to partially meet the requirements of the Record of Decision (ROD), which was issued by EPA in September 2018. In the ROD, EPA identified the installation of VIMS as a preemptive mitigation measure for indoor air vapor intrusion of chlorinated volatile organic compounds (CVOCs).

SECTION 2

Site Description

The Keystone Corridor Groundwater Contamination Site is located in Indianapolis, Marion County, Indiana. The site consists of a contaminated groundwater plume underlying both occupied and vacant industrial, commercial, and residential properties. As presently defined, the center of the site is designated as the intersection of Keystone Avenue and East Fall Creek Parkway North Drive (Figure 1). The approximate site boundaries are 45th Street to the north, Eastern Avenue to the east, 38th Street to the south, and Norwaldo Avenue to the west. The municipal water supply Fall Creek Station Well Field, as well as multiple, independent potential sources of groundwater contamination, some of which are commingled, are located within the site. Figures 1 and 2 show the site location. Figure 3 shows the conceptual site model.

2.1 History of Investigations and Response Actions

The Indiana Department of Environmental Management (IDEM) began addressing soil and groundwater contamination along Keystone Avenue in 1989 when elevated levels of volatile organic compounds were detected in two soil borings collected near an underground storage tank on the former Tuchman Cleaners property, located at 4401 North Keystone Avenue. The Tuchman Cleaners facility operated from 1952 through 2008 and used tetrachloroethene (PCE), generated PCE waste, and had several PCE releases on the property. Due to elevated levels of contaminants found on the property, a contractor for the former property owner installed a soil vapor extraction system and groundwater pump and treat system in 1990, followed by a nonaqueous phase liquid (NAPL) recovery system in 2003 to remove PCE that had accumulated beneath the property.

Additional investigations north of Fall Creek were subsequently completed at the adjacent Vantage Point Cleaners property located at 4405 Allisonville Road, the Purtee Plating facility located at 2306 East 44th Street, and the Thomas Catering property located at 4440 North Keystone Road.

In early July 2008, National Drycleaners, Inc., the parent company of Tuchman and Tuchman Cleaners, Inc., declared Chapter 11 Bankruptcy. As of that date, all remedial efforts at the Tuchman Cleaners property ceased.

In October 2009, IDEM performed a site investigation for the Keystone Corridor Site, during which elevated levels of PCE were detected in groundwater and soil samples. In November 2011, IDEM conducted an expanded site inspection across the Keystone Corridor Site. Elevated levels of PCE and trichloroethene (TCE) were detected in soil and groundwater samples. In addition, vinyl chloride was detected in one municipal drinking water well at the Fall Creek Station, which eventually resulted in that well being taken out of service.

As a result of the above investigations, the IDEM state cleanup program held numerous discussions with potentially responsible parties north of Fall Creek, including Tuchman Cleaners, Vantage Point Cleaners, Thomas Caterers, and Purtee Plating, regarding soil and groundwater contaminated with PCE and TCE. After the Tuchman Cleaners’ parent company declared bankruptcy and the Fall Creek municipal drinking water well was found to be impacted, IDEM requested EPA's assistance with a removal action at Tuchman Cleaners.

From September 2012 to December 2014, EPA conducted a time-critical removal action at the former Tuchman Cleaners property. EPA excavated more than 2,550 tons of contaminated soil and two underground storage tanks from the property. Due to the historical presence of NAPL, the recovery of which was discontinued in July 2008, EPA also sampled soil vapor in the residential neighborhood to the east and conducted testing at more than 40 residential properties to determine if vapor intrusion was occurring. As a result, during the removal action, EPA installed active VIMS at 22 residential properties where vapor intrusion was found to be occurring. EPA also recognized that chlorinated volatile organic compounds would continue to threaten the Fall Creek Station Municipal Well Field and that a long-term response action was needed.

In December 2013, EPA added the site to the National Priorities List (NPL). Listing on the NPL allows federal Superfund funding for investigation and remedial action (RA) cleanup work.

In June and July 2014, EPA enforcement personnel evaluated approximately 40 known users or handlers of chlorinated solvents located within the Fall Creek Station's wellhead protection area based on a modeled 1-year time-of-travel in groundwater. Seven potential source properties were initially identified, and EPA obtained access to sample six of them: the former Vantage Cleaners, the former Tuchman Cleaners, Thomas Catering, and Purtee Plating all north of Fall Creek; and Lumberman's Wholesalers and S&K Laundry south of Fall Creek. The remedial investigation (RI)/feasibility study work began in fall 2015 and was completed in 2019. This CPBRD addresses locations where pre-emptive mitigation was identified for the vapor intrusion pathway (i.e., north of Fall Creek).

2.2 Vapor Intrusion Investigation During the RI

From December 2015 to March 2017, EPA collected groundwater, soil vapor, subslab soil vapor, crawl space, and indoor air samples to characterize site conditions and determine the nature and extent of contamination. The RI report included analytical results and associated multiple lines of evidence, which demonstrated that several properties likely had a completed vapor intrusion pathway or the potential for a future completed vapor intrusion pathway due to impacts from PCE and TCE in groundwater (Figures 4 and 5).

Based on multiple lines of evidence, the RI concludes that there is a potential for vapor intrusion of site-related chemicals of concern from contaminated groundwater to indoor air to occur at the site at concentrations that represent a potential threat to human health. A potential vapor intrusion area of concern was identified (Figures 6 and 7) based on a conservative estimate using soil vapor sample results in excess of the residential soil vapor intrusion screening level.

Based on the results of the RI, three residences (RP-039, RP-047, and RP-49) were found to have both a complete vapor intrusion pathway and site-related contamination in indoor air at concentrations exceeding removal management level. EPA decided that an immediate response action was warranted, and those three properties have been addressed by an EPA time-critical removal action. Additionally, eight industrial/commercial multi-unit buildings were found to have site-related contamination in indoor air and/or subslab samples at concentrations exceeding both vapor intrusion screening levels and removal management levels. These buildings were identified for pre-emptive mitigation as described in this CPBRD.

To preemptively mitigate for those eight industrial/commercial multi-unit buildings, EPA implemented an interim remedy. The interim remedy includes the additional sampling, testing, design, and installation of VIMS. The final ROD for the interim remedy was issued in September 2018.

2.3 Conceptual Site Model

Contamination at the site is in the alluvium of the Fall Creek Valley that is characterized by predominantly three hydrostratigraphic units that include a shallow outwash interval (predominantly sand and gravel), an intermediate interval composed primarily of silt or clay and silt, and a deeper outwash interval (also primarily sand and gravel). These units are present above limestone bedrock that was not investigated as part of the RI, although the alluvium is hydraulically connected to the bedrock aquifer. Additionally, while groundwater grab samples were collected in the deeper interval, which found few impacts above screening levels, there are few groundwater monitoring wells in the deep interval, which limited a study of the interaction between the deep interval and bedrock at this time.

Contamination is present north and south of Fall Creek, which appears to act as a hydraulic barrier to groundwater flow in the shallow interval. The majority of contaminant mass (sum of all CVOCs detected in groundwater) is present in the area north of Fall Creek.

Impacts are primarily noted in the shallow interval outwash and as soil vapor located primarily above the shallow groundwater plumes extending several hundred feet up- and downgradient of the plumes. Impacts occurred due to releases of dense nonaqueous phase liquid (DNAPL) chlorinated solvents that migrated vertically to groundwater then primarily laterally within the shallow interval. Downward vertical migration into the intermediate and deep intervals is generally impeded by the low permeability of the intermediate silt or silt/clay interval and an upward vertical gradient noted between the intermediate and shallow interval. Portions of the intermediate interval were observed locally to be unsaturated, further indicating discontinuous limitations to vertical transport. However, concentrations of PCE and identified DNAPL screened in an outwash lens present in the intermediate clay beneath Tuchman, indicate that DNAPL may still be present and impacting groundwater in the intermediate and deep intervals primarily beneath and immediately downgradient of this property. While removal efforts were conducted on the Tuchman property prior to the RI, residual source material still appears to be present. In addition, concentrations of PCE in vadose zone soil were detected at each of the six sampled potential source properties above soil screening levels protective of groundwater.

The presence of TCE indicates that there is some transformation of PCE occurring. However, further transformation of parent compounds to cis-1,2-dichloroethene and vinyl chloride is limited, and natural attenuation data do not present evidence that reductive dechlorination processes are significant.
The presence of cis-1,2-dichloroethene and vinyl chloride in three of the municipal bedrock wells indicates that conditions in the bedrock aquifer, or upgradient of the bedrock aquifer in the deep interval, support degradation.

Due to the volatility of the CVOCs, migration and subsequent intrusion of vapors into buildings, vapor intrusion has been identified as a primary exposure pathway for human health concerns. During the RI, VIMS were still operating on the western end of the groundwater and vapor plumes.

SECTION 3

Description of Selected Remedy

The Operable Unit 3 ROD, which facilitates an interim remedy for the vapor intrusion pathway, specifies pre-emptive mitigation via installation of VIMS at 8 commercial buildings, including 18 commercial addresses, where there is a potential for a complete vapor intrusion pathway based on concentrations of PCE and/or TCE detected in the subslab and indoor air. The VIMS will be functionally similar to radon mitigation systems. The VIMS are expected to create a negative differential pressure of 0.020 inch of water column between the subslab and indoor air consistently beneath the base of the building envelope to prevent contaminated soil vapors from entering indoor air and will remove the vapors before they can enter the occupied space. The following buildings are proposed VIMS locations:

1. [redacted] (CP-002) Floorplan and VIMS Layout
2. CP-013 Floorplans and VIMS Layouts
   - [redacted] (CP-13-01) Floorplan (no VIMS)
   - (CP-13-02) Floorplan and VIMS Layout
   - (CP-13-03) Floorplan and VIMS Layout
3. CP-016 Floorplans and VIMS Layouts
   - [redacted] (CP-16-01) Floorplan (no VIMS)
   - (CP-16-02) Floorplan and VIMS Layout
   - (CP-16-03) Floorplan and VIMS Layout
   - (CP-16-04) Floorplan and VIMS Layout
   - (CP-16-05) Floorplan and VIMS Layout
   - (CP-16-06) Floorplan and VIMS Layout
4. CP-017 Floorplans and VIMS Layouts
   - [redacted] (CP-17-01) Floorplan and VIMS Layout
   - (CP-17-02) Floorplan and VIMS Layout
   - (CP-17-03) Floorplan and VIMS Layout
5. [redacted] (CP-018) Floorplan and VIMS Layout
6. CP-023 Floorplans and VIMS Layouts
   - [redacted] (CP-23-01) Floorplan and VIMS Layout
   - (CP-23-02) Floorplan and VIMS Layout
   - (CP-23-03) Floorplan and VIMS Layout
   - (CP-23-04) Floorplan and VIMS Layout
   - (CP-23-05) Floorplan and VIMS Layout
7. [redacted] (CP-024) Floorplan and VIMS Layout
8. [redacted] (CP-027) Floorplan and VIMS Layout

SECTION 4

VIMS Remedial Design Process

This section provides information on the tasks performed during the CPBRD process and presents a schedule of activities.

4.1 Diagnostic Testing

Diagnostic testing was conducted at select properties to collect relevant data to prepare the VIMS CPBRD. In July 2019, an evaluation of four of the commercial/industrial structures was conducted at proposed VIMS locations. Evaluations of the roof areas for structural details were not conducted for the roof-mounted RadonAway HS2000 fans. However, if Contingency 1 described in Section 7 is implemented, a structural evaluation may be needed for larger blowers. Work was conducted under access agreements obtained by EPA and has included assessments of the following:

- Foundation type
- Overall building layout, construction, and roof type
- Interior and exterior finishes
- Heating and cooling systems
- Electrical wiring type and location of panel box
- Options for placement of ventilation piping
- Soil type and ground surface conditions

The current access agreement includes VIMS installation and startup.

Diagnostic (negative pressure-field extension) testing was conducted at four of the structures.

- Commercial Property (CP)-016
- CP-017
- CP-018
- CP-024

At these four locations, diagnostic testing was conducted to (1) provide representative data regarding concrete slab and basement foundation types within the area and (2) assess the negative pressure communication below the buildings. For each diagnostic test, a shop vacuum was used to induce a vacuum within a small pit at one or more locations inside each building. In addition, long-term indoor-to-outdoor differential pressure monitoring was conducted in 3 of the 4 buildings tested during diagnostic testing to evaluate typical building conditions. The results are shown in Charts 1 through 5. No continual negative pressures that could potentially effect VIMS operations were observed during data collection.

One or more subslab pressure monitoring points (Vapor Pins) were used to evaluate the following:

- The pressure differential that could be supported between the subslab and occupied space
- Whether measurable pressure response occurred across the concrete floor slab between separate building addresses within one commercial structure
- Whether the subslab was sealed sufficiently such that the required pressure differential could be generated using a given applied vacuum and associated soil vapor flow rate

The results of the diagnostic testing are detailed in Section 5 and factored into the VIMS designs provided in Section 6.

4.2 Conceptual Performance-Based Remedial Design

The CPBRD includes the following elements:

- Project description and relevant chemical of concern data
- Design operating parameters
- Conceptual basis of design
- Conceptual drawings and specifications for the 8 structures, including 18 commercial locations, identified for VIMS
- Operations and maintenance recommendations
- Preliminary RA cost estimate

4.3 Remedial Action Contractor Tasks

Several key tasks will be required prior to RA implementation, and these actions include meeting all requirements of the RA contractor, which will include a VIMS installation and startup and commissioning activities. Appendix A contains the preliminary Statement of Work for this remedy.

4.4 Engineering During Construction

The RA contractor will provide construction inspections necessary to certify that the RA has been implemented in accordance with approved standards, plans, and specifications, and in such a manner that it meets the performance requirements. In addition, the RA contractor will prepare as-built drawings, and a report, if requested by EPA, at the end of the construction phase. Appendix B contains the conceptual design details, cutsheets, and applicable fan performance curves for this remedy.

4.5 Final Inspection, Startup, and Commissioning

A final inspection will be conducted after the selected remedy has been implemented to confirm that all installation-related tasks, including punch-list items, have been completed. The review process may also take place throughout the construction phase as certain elements are completed and require review (for example, confirmation of pressure differentials between the subslab and indoor air). As-built drawings will be reviewed during this phase of the RA. After installation is completed, the VIMS will be turned on, and baseline sampling and measurements will be completed.

4.6 Five-Year Reviews

The Comprehensive Environmental Response, Compensation, and Liability Act Section 121(c) requires review of an RA where hazardous substances, pollutants, or contaminants remain at the site, no less than every 5 years after initiation of the RA. The goal of the 5-year review is to evaluate the RA for the following:

- Continuing protectiveness of public health and the environment
- Function (as designed)
- Degree to which remedial action objectives have been or are being achieved
- Operations and maintenance performance (as necessary)

The 5-year review process is triggered by the start of the first RA, which includes the VIMS under Operable Unit 3. Because the expected duration of the overall site cleanup process is greater than

5 years, contaminants will remain in place until the overall site remedy has been completed. For the site, the 5-year review will include review of the effectiveness of this RA, institutional controls, and the Long-Term Monitoring Program.

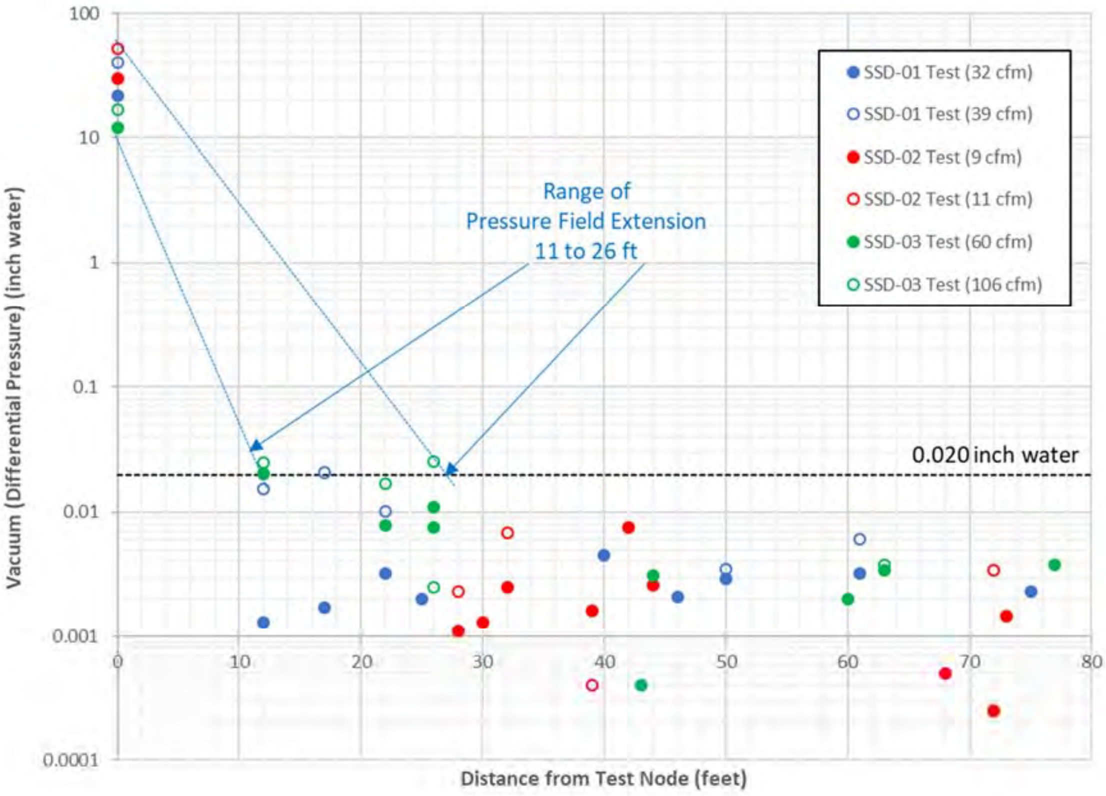
Basis of Design

The basis of design is based on the results of the diagnostic testing conducted during July 2019. Findings and recommendations for each of the eight targeted structures, which includes 18 business addresses, are provided in the following subsections. Appendix C contains building surveys from the evaluation of each structure. Section 6 provides implementation details.

5.1 [redacted] (CP-002)

CP-002 is a 28-foot by 48-foot slab-on-grade structure with one commercial address. The building has a block construction foundation wall and peaked wood shingle roof. Appendix C contains full building details.

The results of subslab diagnostic testing performed on CP-018 were extrapolated for use in preparing the CP-002 VIMS layout due to its close proximity and similar subslab material. For each tested building, diagnostic testing results were plotted on a vacuum versus distance plot. This was used to calculate the minimum, maximum, and average radius of influence. The average radius of influence was used for system layouts at the buildings where testing was not conducted, and modified when diagnostic testing data were available at a specific building. The average radius of influence at CP-018 was 19 feet (Graph 1). CP-018 diagnostic testing results are plotted on Graph 1, and data are presented in Table 1. Based on previous subslab probe installation and nearby soil borings, the material directly below the subslab is a compacted mix of silt, sand, and gravel.



Note: Measured vacuum (differential pressure) at subslab soil gas monitoring port as a function of the distance from the monitoring location to the test node. Open symbols represent data collected after adding an additional shop vac extraction vacuum to the test node.

Graph 1. CP-018 Diagnostic Testing Results

CP-002 Recommendation: Two systems, consisting of two fans and a total of five suction nodes. Each fan in CP-002 will be installed in the attic, and exhaust will be vented to the outdoors above the roofline in compliance with state and local requirements. Figure 8 shows the conceptual system layouts.

5.2 [redacted] (CP-013-01, CP-013-02, and CP-013-03)

CP-013 includes three business addresses (Figure 9). CP-013-01 is a 63-foot by 23-foot structure with a crawlspace. CP-013-02 is a 67-foot by 38-foot slab-on-grade structure. CP-013-03 is a 38-foot by 31-foot slab-on-grade structure. The three buildings have a block construction foundation wall. Appendix C contains full building details.

The results of subslab diagnostic testing performed on CP-018 were extrapolated for use in preparing the CP-013 system layout due to its close proximity. CP-018 diagnostic testing results are plotted on Graph 1, and data are presented in Table 1. Based on the diagnostic testing results from CP-018, an average radius of influence of 19 feet was assumed.

CP-013-01 Recommendation: No VIMS is currently planned at this based on the results of the human health risk assessment (CH2M 2019). Figure 10 shows the floorplan.

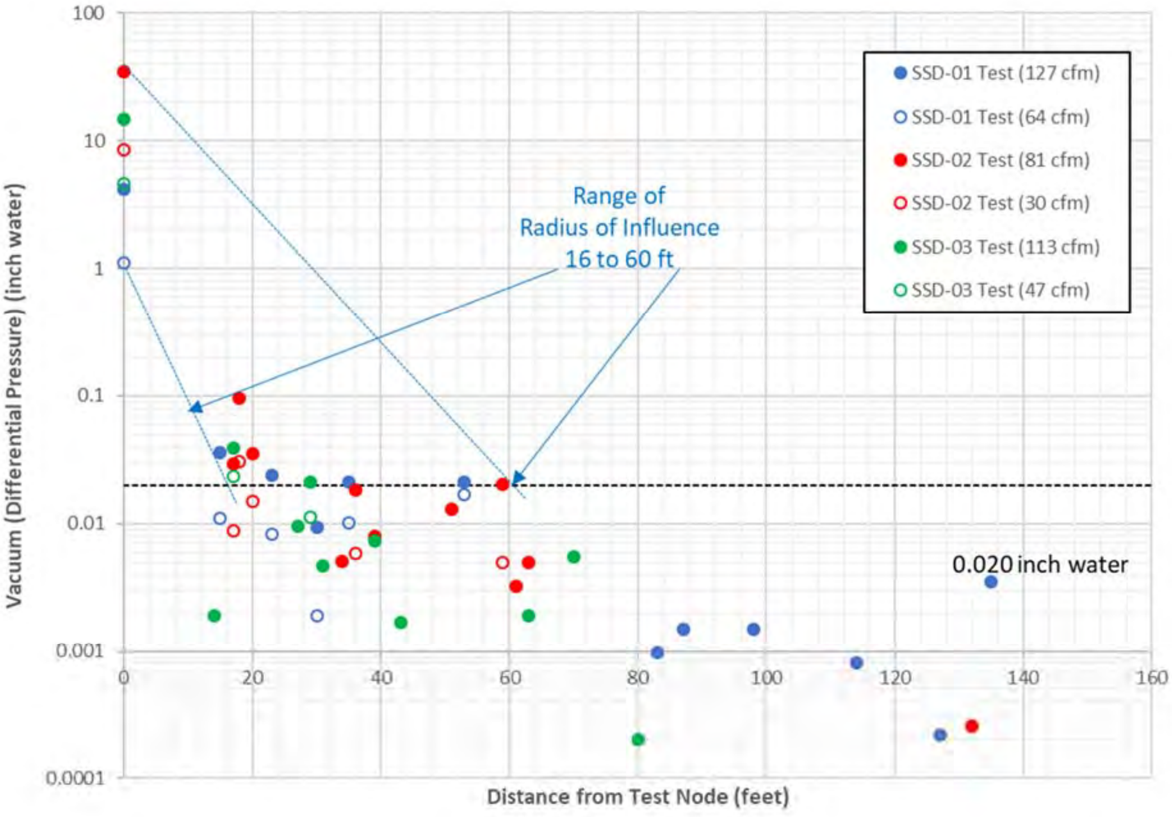
CP-013-02 Recommendation: Two systems, consisting of two fans and a total of six suction nodes. Each fan will be installed on the roof, and exhaust will be vented in compliance with state and local requirements for all buildings, except CP-002. Figure 11 shows the conceptual system layouts.

CP-013-03 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 12 shows the conceptual system layout.

5.3 [redacted] (CP-016-01, CP-016-02, CP-016-03, CP-016-04, CP-016-05, and CP-016-06)

CP-016 includes six commercial addresses (Figure 13). CP-016-01 is a 59-foot by 59-foot slab-on-grade structure. CP-016-02 is a 59-foot by 80-foot slab-on-grade structure. CP-016-03, CP-016-04, CP-016-05, and CP-016-06 are 59-foot by 36-foot slab-on-grade structures. The buildings have block construction foundation walls. Appendix C shows full building details.

Subslab diagnostic testing was performed on CP-016. The average radius of influence was 38 feet. CP-016 diagnostic testing results are plotted on Graph 2, and data are presented in Table 2. Based on previous subslab probe installation and nearby soil borings, the material directly below the subslab is a compacted mix of silt, sand, and gravel.



Note: Measured vacuum (differential pressure) at subslab soil gas monitoring port as a function of the distance from the monitoring location to the test node. Closed symbols represent data collected after adding an additional shop vac extraction vacuum to the test node.

Graph 2. CP-016 Diagnostic Testing Results

CP-016-01 Recommendation: No VIMS is currently planned at this based on the results of the human health risk assessment (CH2M 2019). Figure 14 shows the floorplan.

CP-016-02 Recommendation: Two systems, consisting of two fans and a total of six suction nodes. Figure 15 shows the conceptual system layouts.

CP-016-03 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 16 shows the conceptual system layout.

CP-016-04 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 17 shows the conceptual system layout.

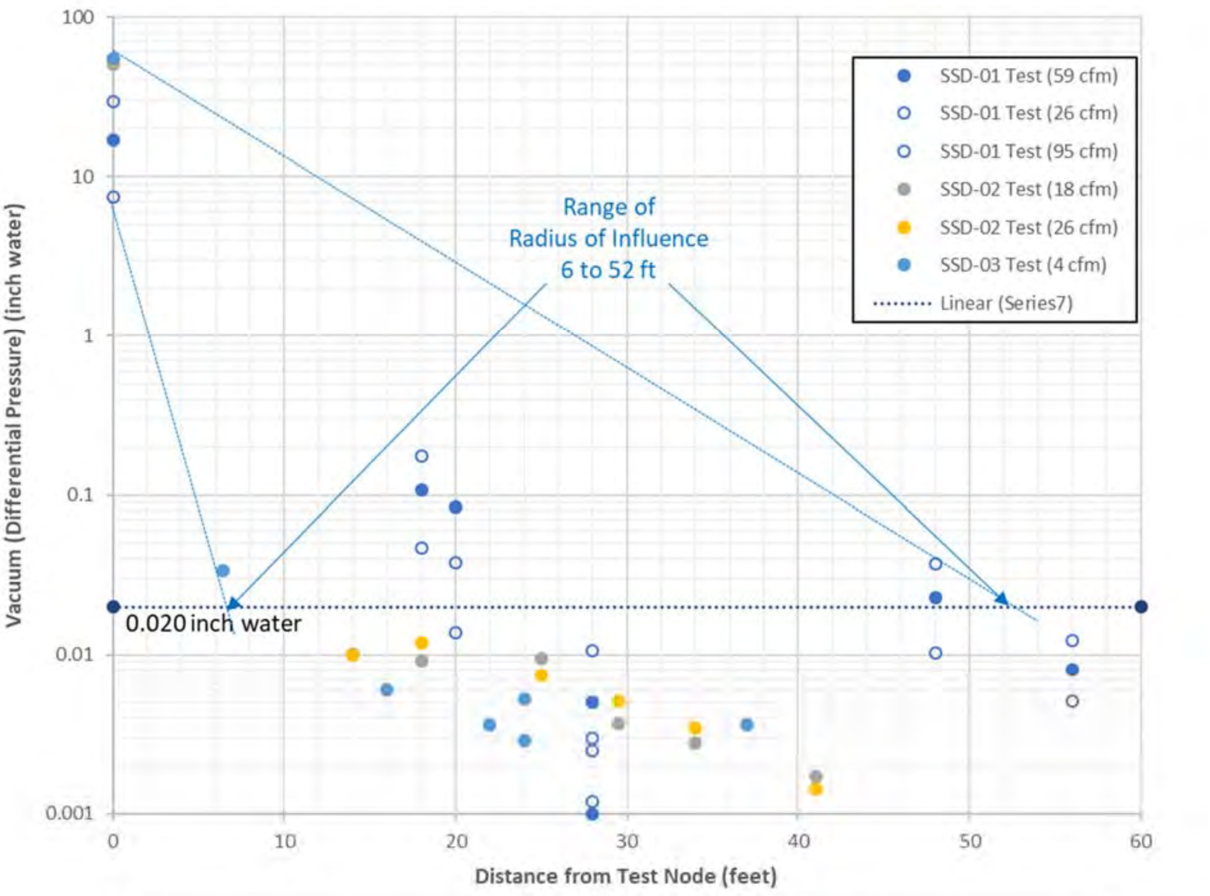
CP-016-05 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 18 shows the conceptual system layout.

CP-016-06 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 19 shows the conceptual system layout.

5.4 [redacted] (CP-017-01, CP-017-02, and CP-017-03)

CP-017 includes three commercial addresses (Figure 20). CP-017-01 is a 68-foot by 222-foot slab-on-grade structure. CP-017-02 is a 66-foot by 20-foot slab-on-grade structure with a partial basement. CP-017-03 is a 66-foot by 20-foot slab-on-grade structure. The buildings have block construction foundation walls. Appendix C shows full building detail.

Subslab diagnostic testing was performed on CP-017. The average radius of influence was 29 feet. CP-017 diagnostic testing results are plotted on Graph 3, and data are presented in Table 3. Based on previous subslab probe installation and nearby soil borings, the material directly below the subslab is a compacted mix of silt, sand, and gravel.



Note: Measured vacuum (differential pressure) at subslab soil gas monitoring port as a function of the distance from the monitoring location to the test node. Open symbols represent data collected after adding an additional shop vac extraction vacuum to the test node.

Graph 3. CP-017 Diagnostic Testing Results

CP-017-01 Recommendation: One system, consisting of one fan and a total of two suction nodes. Figure 21 shows the conceptual system layout.

CP-017-02 Recommendation: One system, consisting of one fan and a total of three suction nodes. Two of the nodes will depressurize below the slab on grade, and one node will extend into the basement to depressurize the basement subslab. Figure 22 shows the conceptual system layout.

CP-017-03 Recommendation: One system, consisting of one fan and a total of two suction nodes. Figure 23 shows the conceptual system layout.

5.5 [redacted] (CP-018)

CP-018 is a 71-foot by 112-foot slab-on-grade structure with one commercial address. The building has a block construction foundation wall. Appendix D contains full building details.

Subslab diagnostic testing was performed on CP-018. The average radius of influence was 19 feet; however, in the northwest portion of the building, only an 11-foot radius of influence was observed. CP-018 diagnostic testing results are plotted on Graph 1, and data are presented in Table 1. Based on previous subslab probe installation and nearby soil borings, the material directly below the subslab is a compacted mix of silt, sand, and gravel.

CP-018 Recommendation: One system, consisting of one fan and a total of 12 suction nodes. Figure 24 shows the conceptual system layouts.

5.6 [redacted] (CP-023-01, CP-023-02, CP-023-03, CP-023-04, and CP-023-05)

CP-023 includes five commercial addresses (Figure 25). CP-023-01, CP-023-02, CP-023-03, CP-023-04, and CP-023-05 are all approximately 75-foot by 28-foot slab-on-grade structures. The buildings have block construction foundation walls. Appendix D contains full building details.

The results of subslab diagnostic testing performed on CP-018 were extrapolated for use in preparing the CP-023 system layouts due to its close proximity and similar surface layer material. CP-018 diagnostic testing results are plotted on Graph 1, and data are presented in Table 1. The average radius of influence was 19 feet. Based on previous subslab probe installation and nearby soil borings, the surface layer material directly below the subslab is a compact mix of silt, sand, and gravel.

CP-023-01 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 26 shows the conceptual system layout.

CP-023-02 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 27 shows the conceptual system layout.

CP-023-03 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 28 shows the conceptual system layout.

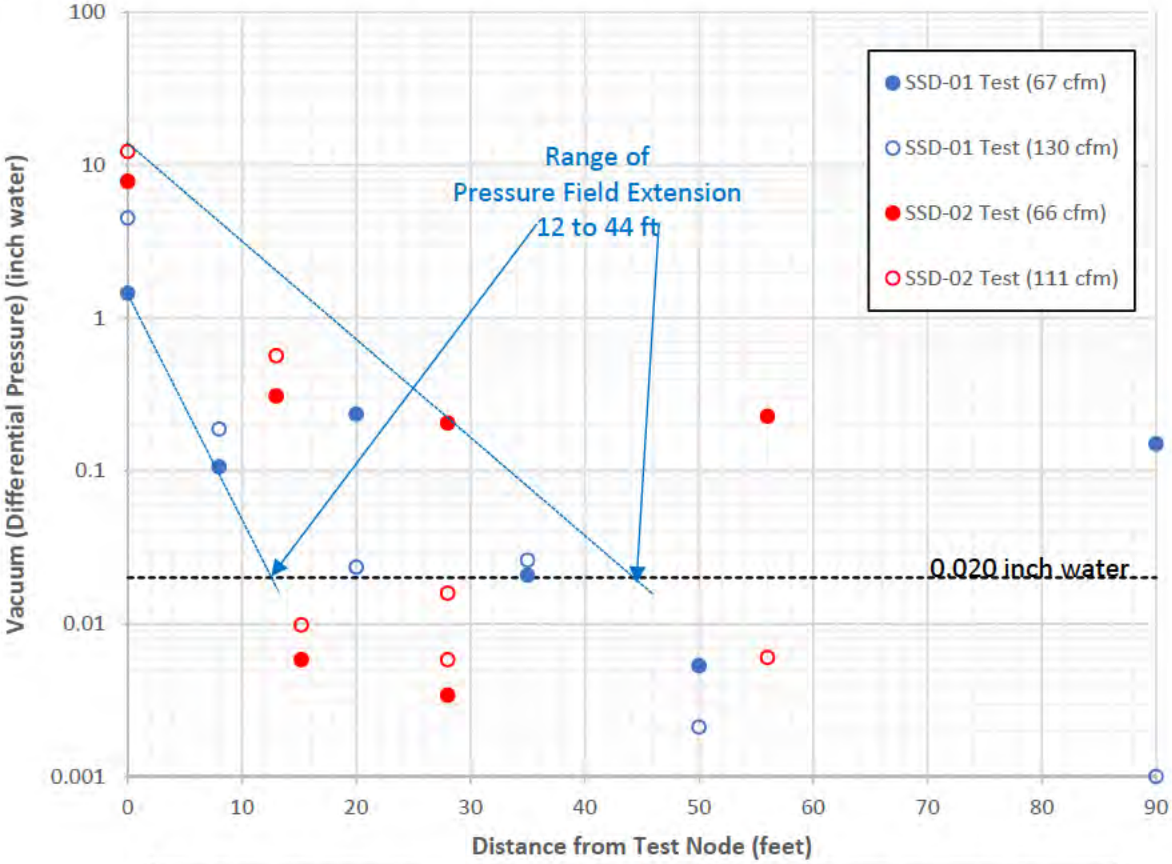
CP-023-04 Recommendation: One system, consisting of one fan and a total of three suction nodes. Figure 29 shows the conceptual system layout.

CP-023-05 Recommendation: One system, consisting of one fan and a total of two suction nodes. Figure 30 shows the conceptual system layout.

5.7 Building CP-024

CP-024 is a 70-foot by 82-foot slab-on-grade structure with one commercial address. The building has a block construction foundation wall. Appendix C contains full building details.

Subslab diagnostic testing was performed on CP-024. The average radius of influence was 33 feet. CP-024 diagnostic testing results are plotted on Graph 4, and data are presented in Table 4.



Note: Measured vacuum (differential pressure) at subslab soil gas monitoring port as a function of the distance from the monitoring location to the test node. Open symbols represent data collected after adding an additional shop vac extraction vacuum to the test node.

Graph 4. CP-024 Diagnostic Testing Results

CP-024 Recommendation: Four systems, consisting of 4 fans and a total of 13 suction nodes. Each fan will be installed on the roof, and exhaust will be vented in compliance with state and local requirements. Figure 31 shows the conceptual system layouts.

5.8 [redacted] (CP-027)

CP-027 is a 87-foot by 42-foot slab-on-grade structure with one commercial address. The building has a block construction foundation wall. Appendix C contains full building details.

The results of the subslab diagnostic testing performed on CP-016 were extrapolated for use in preparing the CP-027 system layout due to its close proximity and similar surface layer material. CP-016 diagnostic testing results are plotted on Graph 2, and data are presented in Table 2. The average radius of influence was 38 feet. Based on previous subslab probe installation and nearby soil borings, the surface layer material directly below the subslab is a compact mix of silt, sand, and gravel.

CP-027 Recommendation: Two systems, consisting of two fans and a total of six suction nodes. Figure 32 shows the conceptual system layouts.

SECTION 6

Remedy Implementation

This section includes pre-implementation activities, elements of the VIMS RA, post-RA implementation activities, and performance metrics and contingency planning for the 8 commercial buildings, including 18 commercial locations, identified for VIMS installation.

6.1 Preliminary Activities

6.1.1 Post-Award Submittals

Before mobilizing personnel and equipment to the site, the RA contractor will perform administrative, contractual, and logistical activities. All issues related to health and safety, permitting, private property access, supply delivery, underground utility surveys, vendor and subcontractor agreements, financials, and insurance will be addressed by the RA contractor. Project deliverables and schedules critical to the success of the project will be prepared and submitted to EPA for review as applicable. The project deliverables are as follows:

- Site-specific health and safety plan
- Construction quality assurance/quality control plan (not included within CPBRD cost estimate)
- Sampling and analysis plan (not included within CPBRD cost estimate)

Revisions to existing documents may be made where possible. The RA contractor will mobilize personnel, equipment, and supplies to the project site once the documents have been approved by EPA.

6.1.2 Site Access Agreements

Signed access agreements are already in place for each of the 8 structures, including 18 commercial addresses, where the VIMS will be installed during the initial RA.

6.1.3 Coordination with Owners and Occupants

The installation of the VIMS is very intrusive to the occupants of the structures. The RA contractor will meet with the occupants prior to the start of construction to discuss the following:

- Scope of work for the VIMS that will be installed at their business
- Length of time needed to install the VIMS
- Options for final placement of VIMS components, based on reasonable owner and occupant preferences
- System aesthetics and homeowner preferences regarding materials or final finishes
- Potential for minor system noise, and methods for its minimization
- Post-construction operation of the VIMS and owner responsibilities
- Viable schedule for the construction of the VIMS at their residence

This information will be used to complete the final project schedule and VIMS construction sequence. It is anticipated that several visits to the site and numerous telephone calls will be required.

6.2 Mobilization

This task will consist of the mobilization of personnel and equipment to the work site and the establishment of temporary facilities, consisting primarily of equipment laydown and storage areas/trailers and possibly portable sanitary facilities.

6.2.1 Site Setup

VIMS are proposed are in commercial properties, where no extra site security procedures will be put in-place. In cases where the occupants are not present during VIMS construction, the RA contractor and subcontractor personnel will secure the property when leaving the site for supplies, lunch breaks, and at the end of each workday. This will be discussed with the owners and occupants during the site access and coordination phase of the project.

6.2.2 Health and Safety

The construction of the VIMS must meet site-specific health and safety plan requirements for Occupational Safety and Health Administration 40-Hour Hazardous Waste Operations and Emergency Response training, and onsite air monitoring.

6.2.3 Existing Condition Video and Photo Documentation

Prior to beginning construction at each of the locations where VIMS are to be installed, the RA contractor personnel will videotape the interior and exterior of the structures. Also, the readily accessible portions of the buildings with crawlspaces and basements will be videotaped. In addition, photographs will be taken during construction at each of the residences to generally document the construction process.

6.3 Vapor Intrusion Remedy Implementation

The tasks required for the installation of the VIMS at each specific structure are described in this section. Appendix B contains design details, cutsheets, and fan performance curves. Appendix C contains representative building surveys.

6.4 General Installation Requirements

The following requirements apply to each of the VIMS designed for the site.

- The VIMS installation shall be done so as to coordinate with other building components especially those that require maintenance or clearance of any type. All system components shall be installed to facilitate servicing, maintenance, and repair or replacement of other equipment components in or outside the building. Where mounting heights are not detailed or dimensions given, system materials and equipment shall be installed to provide the maximum headroom or side clearance as is possible. All systems, materials and equipment shall be installed level, plumb, parallel or perpendicular to other building systems and components unless otherwise specified.
- Every possible precaution shall be taken to avoid any damage to existing utilities located anywhere in the building or those located in or below the slab floor.
- The RA contractor will be responsible for covering or finishing any piping or electrical conduit that is exposed. All penetrations through foundation walls or floors shall be sealed. There will be no piping or conduit placed that would inhibit maintenance activities in any areas.

- Foreign materials shall not be left or drawn into the system piping or fan, which might at a later period interfere with or in any way impair the VIMS performance.
- Entire system shall have Underwriters Laboratory or equivalent ratings for both individual components and the entire system as applicable.
- For each suction node, the Subcontractor shall cut a 5-inch core through the concrete and remove a minimum of 5 gallons of subslab material. Four-inch diameter polyvinyl chloride (PVC) schedule 40 coupling shall be secured in the top of each suction hole. Concrete-filled steel bollards will be installed around nodes in high traffic areas.
- All horizontal pipe runs shall ultimately be routed with at least 1/8-inch slope back towards the suction hole for each foot of horizontal pipe run. All vertical pipe runs shall be installed plumb. In no case shall the piping be installed so as to create a possible water trap in the piping.
- All horizontal pipe runs shall have a support with an appropriate device within 2 feet of each fitting and a maximum distance between supports of 8 feet as per BOCA National Plumbing Code. Galvanized conduit channel with pipe clamps shall be used outdoors to support PVC.
- The pipe shall be supported at least every 6 feet of horizontal run and at least every 8 feet of vertical run.
- Any visible expansion joints or cracks in the slab areas being mitigated that have 1/16-inch or greater opening shall be sealed. Any cracks to be sealed shall be vacuumed to prepare them for installation of gun-grade urethane caulk sealant. Cracks or open expansion joints in the concrete floor shall be sealed by applying a bead of urethane caulk on top of the joint. The gun-grade caulk shall then be mechanically pressed down into the crack in order to maximize its seal. Sealants that spill over or drip onto the existing carpet or floor shall be scraped off immediately and then wiped thoroughly with a solvent and a rag. Any openings into the slab such as may occur around conduit pipe penetrations through the slab shall be cleaned and sealed with gun-grade urethane caulk.
- The subcontractor shall install a disconnect switch within 3 feet of each fan and a second switch accessible from the ground. The switch accessible from the ground will also have an indicator light to determine if the fan is operating. All wiring will comply with current National Electrical Code requirements.
- The subcontractor shall use outdoor-rated flexible conduit from each switch box to the fan. Wiring from the power source to the fan shall be a gauge wire no smaller than allowed for the circuit from which the power is wired. A dedicated breaker is not required.
- All mitigation systems that have exposed piping inside the building shall have a magnehelic gauge installed for each system in the vertical section of the pipe inside the building that is the closest vertical pipe to the fan location. All nodes and fans installed shall have a pressure gauge using a magnehelic gauge reading 0 to 30 inches of water column pressure that is installed on each node and at the fan location, inside a weatherproof electrical box that is mounted to the exterior wall near the fan.
- All pressure gauge locations shall contain a label with the RA contractor name, telephone number, installation date, and final installation pressure readings. All labels must be readable from 3 feet away. A label shall be installed at each fan disconnect location, and on the main panel electrical disconnect switch that says “Soil Gas Fan” or equivalent.
- The subcontractor shall measure the pressure difference between the subslab or membrane and the space above at the test holes indicated on the mitigation system drawings. The subcontractor shall record the system u-tube readings and the final pressure readings between the subslab and the space above on a copy of each mitigation system drawing. The measurements shall be made with a

digital micromanometer capable of reading in units of 0.001-inch or 0.1 pascal. A copy of these final measurements, including the u-tube measurements, will be maintained by the RA contractor and the owner.

- Appendix D contains a general materials list, including fan performance curves, for material and equipment specified for the individual designs.
- Following VIMS installation, the owners will be responsible for protecting and repairing any damage to VIMS infrastructure.

The following subsections discuss the tasks required for the installation of the VIMS at each specific structure.

6.4.1 PVC Piping Installation

As shown in the design drawings in Appendix B, a 4-inch PVC coupling shall be secured to the slab and then sealed with urethane caulking. Then, 4-inch schedule 40 PVC piping shall be routed through the drywall ceiling into the attic for peaked roofs or on the roof for flat roofs. Exhaust will be vented in accordance to state and local guidance. Penetrations shall be sealed with off-white urethane caulking. PVC piping secured against wood framing shall have a piece of backer rod placed between the pipe and the framing to minimize fan vibration transfer to the wood framing. A rubber boot shall be used to connect the PVC piping to the fan. Common roof pipe flashing and screened cap will be installed in accordance with state and local guidance.

6.4.2 System Performance Indicator Installation

A magnehelic gauge shall be installed on the PVC in a location accessible from the ground in each node. A hole shall be drilled in the PVC piping below the top of the magnehelic gauge to minimize water entry into the tubing. A flexible tube shall be routed from the magnehelic gauge to the hole in the PVC piping.

6.4.3 Fan Installation

In the attic for each building with peaked roofs, a RadonAway HS2000 fan or equivalent shall be in a vertical position on the PVC piping using rubber plumbing connection boots. For buildings with flat roofs, a RadonAway HS2000 fan or equivalent shall be installed in a vertical position on the PVC piping using rubber plumbing connection boots on the roof. A single electrical gang box with a single pole switch (labeled “Soil Gas Fan”) shall then be installed within eyesight of the fan. The electrical source shall be obtained from each building.

6.4.4 Post-Implementation Pressure Field Testing

After the fan is activated and all slab sealing has been completed, the pressure difference shall be measured between the subslab and the unit using a digital micromanometer. The pressure readings on the PVC nodes shall be recorded. If the pressure difference under the slab is less than negative 0.005 inch of water column, the measurements will be re-collected after a minimum of 72 hours. This will ensure that system performance is not temporarily disrupted by an irregular condition, such as an unusually high water table. If the pressure difference under the slab is less than negative 0.020 inch of water column during the second event, Contingency 1 described in Section 7 may be implemented, and pressure field testing shall repeated. The final differential pressure shall be reported in the construction completion report.

6.4.5 Subslab Depressurization System Installation

VIMS will be installed based on the recommendations in Section 5 and system layouts presented in Figures 8 through 32. Locations may be modified based on reasonable owner/occupant request or if operations would be disrupted. If operating parameters are not met, Contingency plans 1 and 2 may be implemented as needed.

6.5 VIMS Startup and Commissioning

Once the systems have been constructed, the fans will be turned on and the VIMS will begin to draw soil gas from the negative-pressure side of subslab. This is the only step that is required to activate the VIMS.

Following construction, the systems shall be turned on and allowed to operate for an initial operating period of 72 hours. Following this initial operating period, performance monitoring shall be performed to monitor the system effectiveness. This testing shall be performed by monitoring the pressure differences between the indoor occupied spaces and the subslab.

Should this performance monitoring identify that any of the VIMS are not achieving the designed pressure difference, system upgrades shall be required to meet depressurization requirements for each structure.

Once the performance monitoring has determined that the VIMS are operating as designed, exhaust air sampling will be performed. A Tedlar bag will be collected from each VIMS node and screened with a photoionization detector before collecting the exhaust sample. The exhaust sample will be analyzed by TO-15 SIM to demonstrate CVOCs removal from the subsurface.

6.5.1 Compliance with Applicable or Relevant and Appropriate Requirements

Data will be used along with the differential pressure readings and other lines to evidence to evaluate whether the system is disconnecting the VI pathway and preventing subsurface vapor intrusion. It is anticipated that following VIMS implementation and, if necessary, contingency implementation, that the Applicable or Relevant and Appropriate Requirements (ARARs) will be met (EPA 2018a).

6.5.2 Remedial Action Completion Report

After completion of field activities and demonstration to EPA that the remedy has met the ARARs at all structures, as-builts and other requirements will be prepared and submitted to EPA in the remedial action completion report. The remedial action completion report will contain applicable elements described in Exhibit 2-3 of EPA's guidance *Closeout Procedures for NPL Sites* (EPA 2000), document the activities performed to implement the selected remedy, and include a narrative of work activities, as-built construction drawings, design changes and deviations, photographs, laboratory analyses, performance testing results, and construction costs with estimates of operation and maintenance of the conceptual RA.

SECTION 7

VIMS Contingency Planning

This section describes the contingency planning. Costs for these post-implementation items have not been included in the cost estimates.

7.1 VIMS Contingency Planning

Some degree of uncertainty exists within all environmental restoration projects. The recognition and planning for these uncertainties are critical for maintaining the project schedule and remaining within budget. Using the current VIMS designs, there are expected conditions and potential deviations that may occur during installation, startup, and commissioning of the preemptive VIMS RA. "Expected condition" is defined as any physical, chemical, technical, or regulatory condition that reasonably might be encountered during the RA. The objective of contingency planning is to ensure that there is a process for identifying deviations from expected conditions and for modifying the RA (with EPA approval) to account for the deviation. The level of pre-response contingency planning for each of the potential contingencies will need to be determined by EPA. The following are the expected conditions for the VIMS RA:

- The number of suction points may be insufficient to obtain the required negative pressure drop of 0.020 inch of water column beneath the entire structure.
- The fan size may be insufficient to obtain the required negative pressure drop of 0.020 inch of water column beneath the entire structure.

Two contingency measures have been developed that may be implemented in the event that the pressure drop beneath the entire structure is insufficient to obtain negative 0.020 inch of water column.

7.1.1 Contingency 1

The fan size will be increased to a larger fan. If this does not provide the necessary negative-pressure response of 0.020 inch of water column from the VIMS, then contingency 2 will be implemented.

7.1.2 Contingency 2

The number of suction nodes beneath the structure will be increased as needed. This will have the effect of allowing the negative pressure to be applied more uniformly beneath the structure. Once the placement of additional suction nodes is complete, the negative pressure field will be re-evaluated by collecting additional measurements. More than one additional suction node may be required to obtain the negative pressure field distribution. The ultimate fan size required will depend on the radius of influence of each suction node and the ability to obtain the negative 0.020 inch of water column. Other contingencies may be required should neither of the two expected contingencies provide sufficient negative pressure drop beneath a given structure. These potential contingencies will be evaluated on a case-by-case basis.

7.2 Long-Term Operations, Performance Monitoring, and Maintenance

7.2.1 VIMS Operations

Once the VIMS have been turned on and initial testing and indoor air sampling has been completed, the VIMS operation will be turned over to the property owners. The property owners will be given a fact sheet regarding the key physical attributes and operating principles of their systems. The owners will be instructed that periodic checks of the fan operation should be made and that any access to attics or basements should take care to not upset the components associated with the VIMS. Property owners or their tenants are responsible for electrical costs associated with operating the VIMS fan. The property owners will be given contact information for EPA Region 5 personnel should problems occur with the VIMS.

7.2.2 Performance Monitoring

Following implementation of the VIMS and compliance with ARARs, periodic collection of pressure differential readings may be required. Performance monitoring is not included in this CPBRD.

7.2.3 Maintenance

The only moving part of the VIMS is the fan. It is anticipated that this fan will have a service life of at least 5 years. However, should a property owner or occupant identify a failed fan or other VIMS component, they will need to contact EPA to determine an appropriate course of action to restore the VIMS to full operational status.

Remedial Design Cost Estimate

Appendix D, Table D-1 shows the estimated cost to implement the VIMS remedy at the site. The cost estimate is expected to be accurate within plus 50 percent and minus 30 percent (EPA 2018a). The cost estimate includes the following construction, commissioning, reporting, and capital cost components:

- Subcontracted VIMS installation
- Subcontracted services during construction (not including oversight)
- Startup and Commissioning activities
- Laboratory analyses
- Coordination, preparation, and shipment of laboratory samples
- Project closeout

The cost estimate presented in Table D-1 specifically excludes the following:

- Maintenance, repair, and component replacement costs
- Electricity to operate the VIMS (property owner responsibility)
- Subcontractor costs to obtain payment and performance bonding

A summary of estimated VIMS construction costs for the conceptual performance based remedial design is provided in Appendix D, Table D-1, with the estimated cost for VIMS construction at individual structures provided in Appendix D, Table-D-2. The following subsections discuss additional cost assumptions used to generate the cost estimate.

8.1 VIMS Installation Cost Estimate Assumptions

The subcontracted installation cost estimate included in Table D-1 is based on the cost estimate provided by the VIMS design subcontractor, as detailed in Tables D-2.

8.2 Laboratory Analyses Cost Estimate Assumptions

The subcontracted laboratory analyses cost estimate included in Table D-1 is based on the following assumptions:

- 110 exhaust samples (including quality control samples) will be submitted for analysis by Method TO-15 SIM.

- Shipping of the sample containers to the project site and back to the analytical laboratory will be required.

References

CH2M HILL (CH2M). 2019. *Remedial, Enforcement Oversight, and Non-Time Critical Removal Activities at Sites of Release or Threatened Release of Hazardous Substances in Region 5, Keystone Corridor Groundwater Contamination Site, Marion County, Indiana*. June.

U.S. Environmental Protection Agency (EPA). 2000. *Closeout Procedures for NPL Sites*.

U.S. Environmental Protection Agency (EPA). 2018a. *Proposed Plan, Keystone Corridor Groundwater Contamination Site, Operable Unit 3, Indianapolis, Indiana*. March.

U.S. Environmental Protection Agency (EPA). 2018b. EPA Superfund Program, Record of Decision, Keystone Corridor Groundwater Contamination Site, Indianapolis, Marion County, Indiana. September.

Figures

MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\E\EPA\681301_KEYSTONECORRIDOR\MAPS\REPORT\REMEDIAL_INVESTIGATION\FIGES-1_1 SITE LOCATION MAP REDACTED.MXD JHANSEN1 5/30/2019 2:26:25 PM

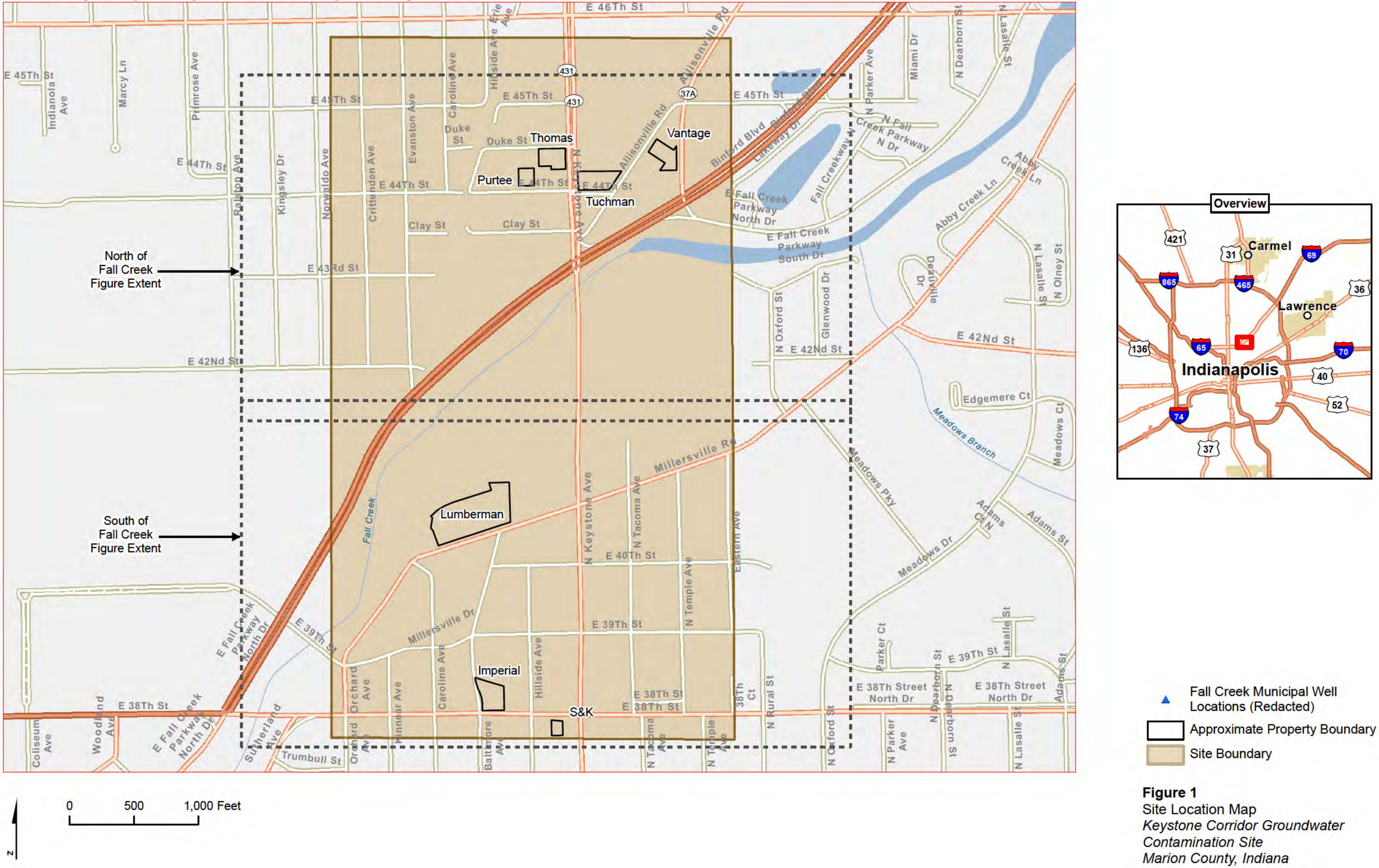
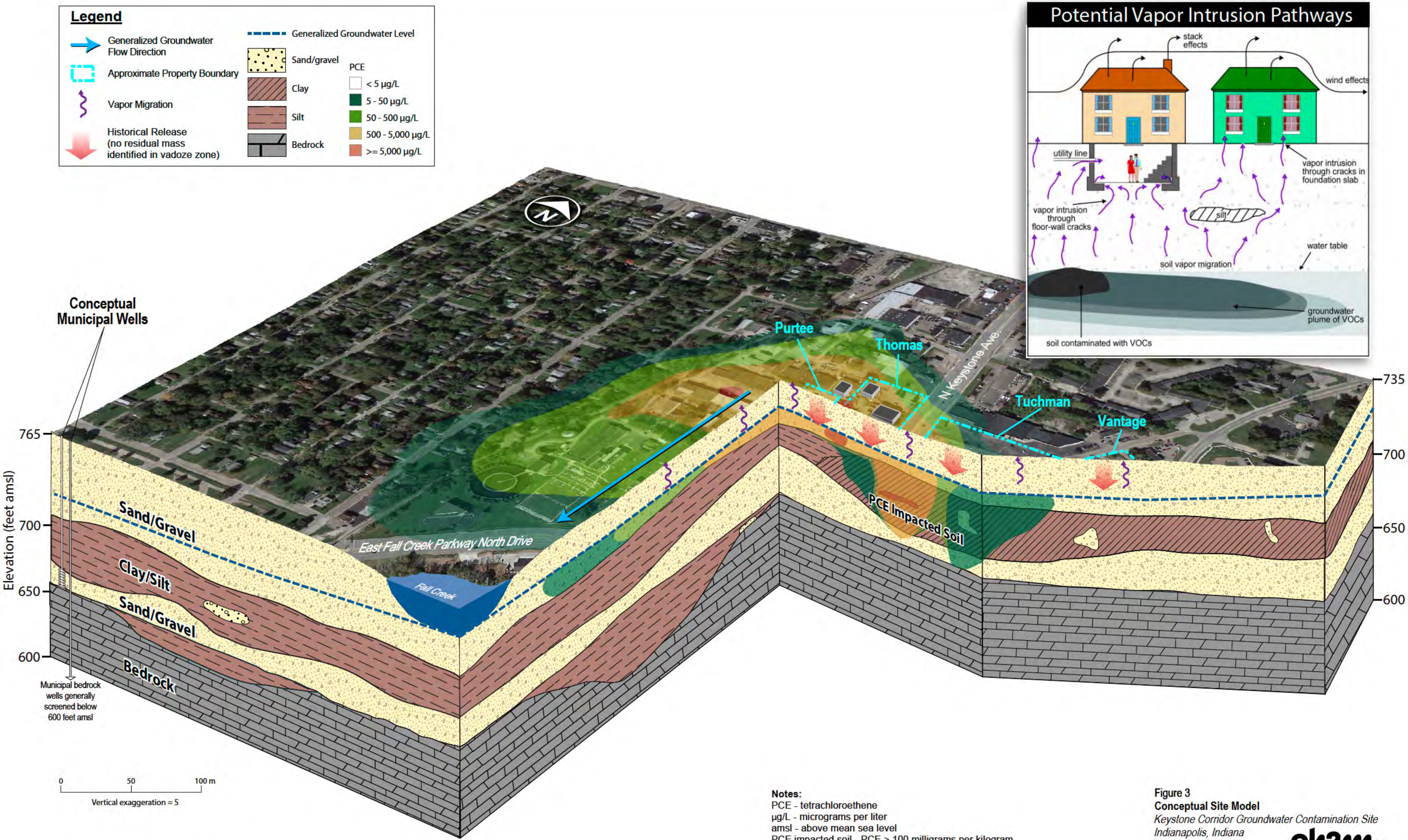


Figure 1
Site Location Map
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

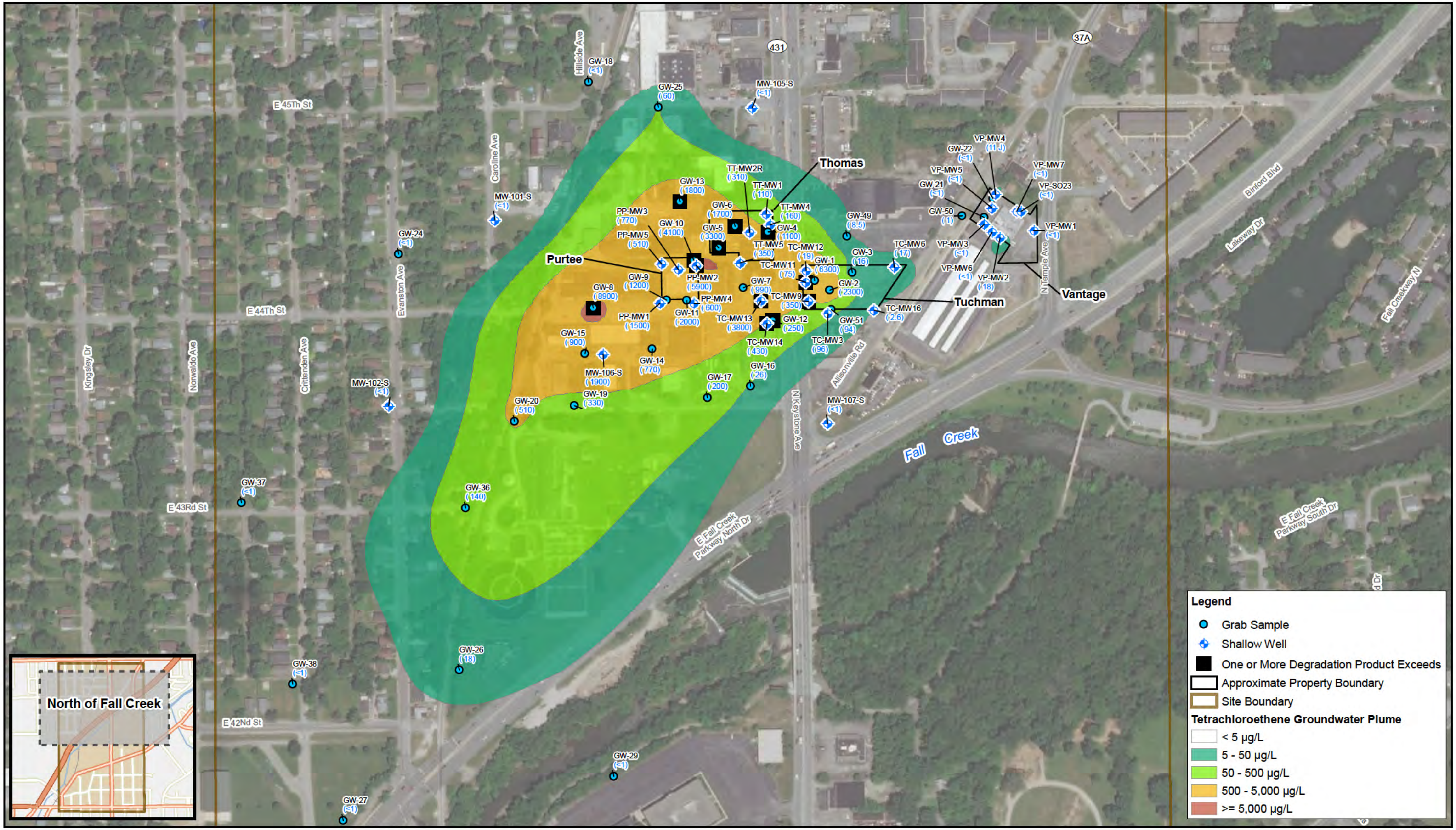


Notes:
PCE - tetrachloroethene
µg/L - micrograms per liter
amsl - above mean sea level
PCE impacted soil - PCE > 100 milligrams per kilogram

Figure 3
Conceptual Site Model
Keystone Corridor Groundwater Contamination Site
Indianapolis, Indiana

ch2m:

PR0908171328DAY WA_251_Keystone_CSM_v10.ai 1-12-2018 DCD



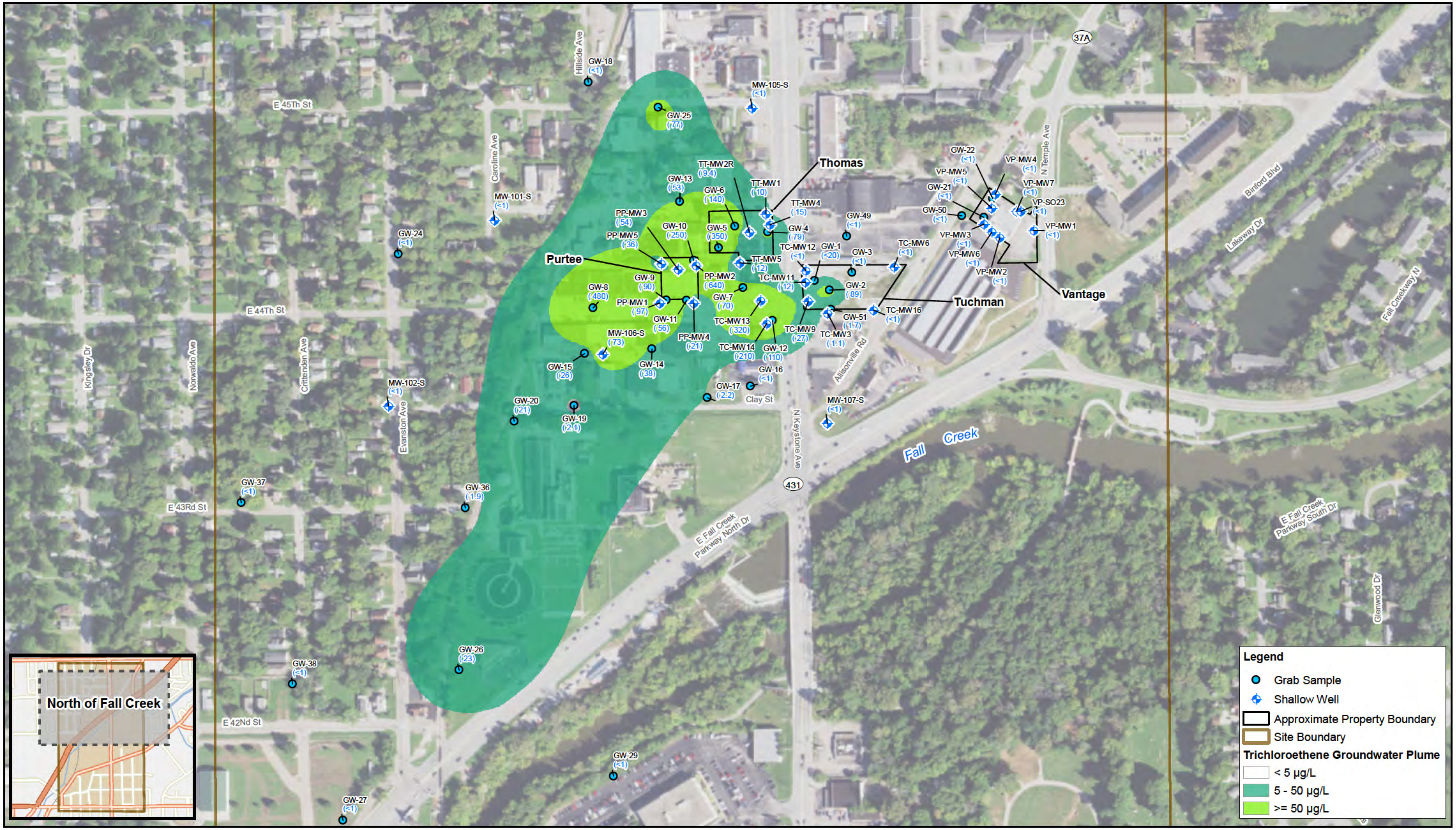
N

0 250 500 Feet

Imagery: USDA FSA NAIP, October 2014

Notes:
1. Results presented in micrograms per liter (µg/L).
2. < indicates chemical not detected; the reporting limit is shown.
3. The EPA MCL for tetrachloroethene is 5 µg/L.
4. EPA = U.S. Environmental Protection Agency
5. MCL = maximum contaminant level
6. PCE = tetrachloroethene
7. Degradation products include cis-1,2-dichloroethene and vinyl chloride; results are summarized in Table 4-3.
8. J - the value is estimated.

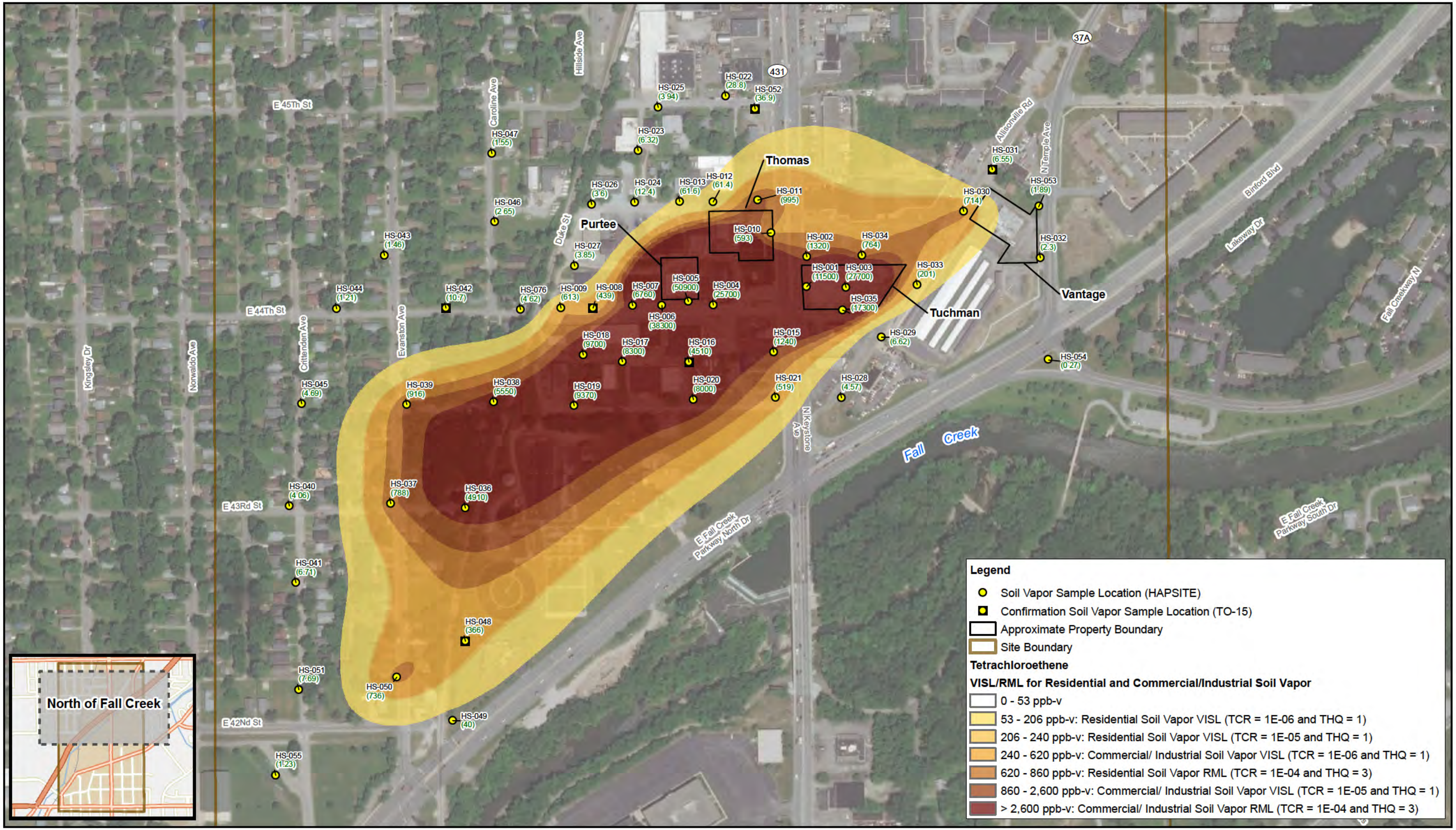
Figure 4-2
Shallow Groundwater PCE Concentrations North of Fall Creek
Keystone Corridor Groundwater
Contamination Site
Marion County, Indiana



Imagery: USDA FSA NAIP, October 2014

Notes:
1. Results presented in micrograms per liter (µg/L).
2. < indicates chemical not detected; the reporting limit is shown.
3. The EPA MCL for trichloroethene is 5 µg/L.
4. EPA = U.S. Environmental Protection Agency
5. MCL = maximum contaminant level
6. TCE = trichloroethene

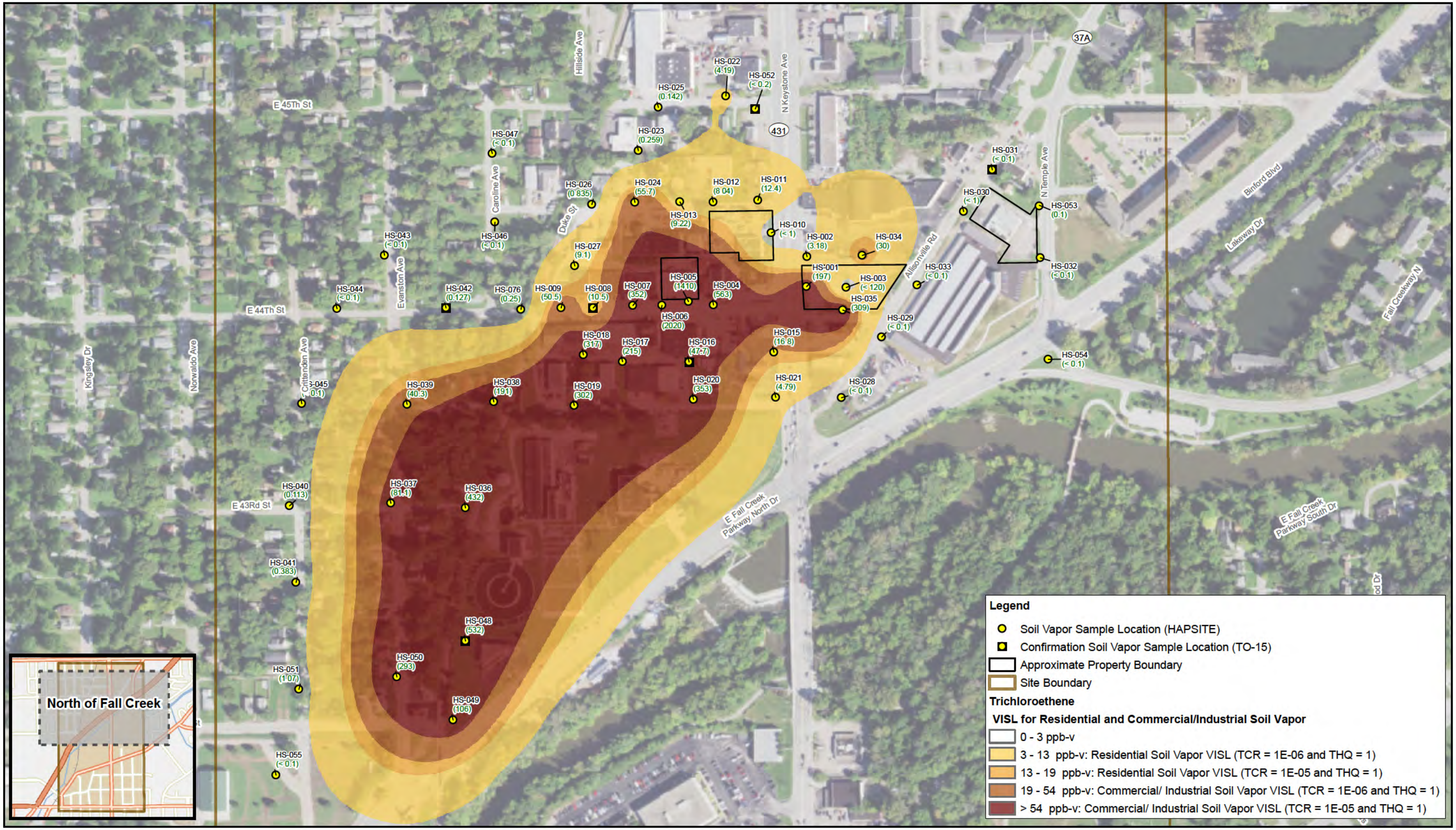
Figure 4-3
Shallow Groundwater TCE Concentrations North of Fall Creek
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana



Imagery: USDA FSA NAIP, October 2014

Notes:
1. Results presented in parts per billion by volume (ppb-v)
2. TCR = Target Risk for Carcinogens
3. THQ = Target Hazard Quotient for Non-Carcinogens
4. VISL = Vapor Intrusion Screening Level
5. RML = Removal Management Level
6. PCE = Tetrachloroethene

Figure 4-11
PCE Soil Vapor Concentrations North of Fall Creek
Keystone Corridor Groundwater
Contamination Site
Marion County, Indiana



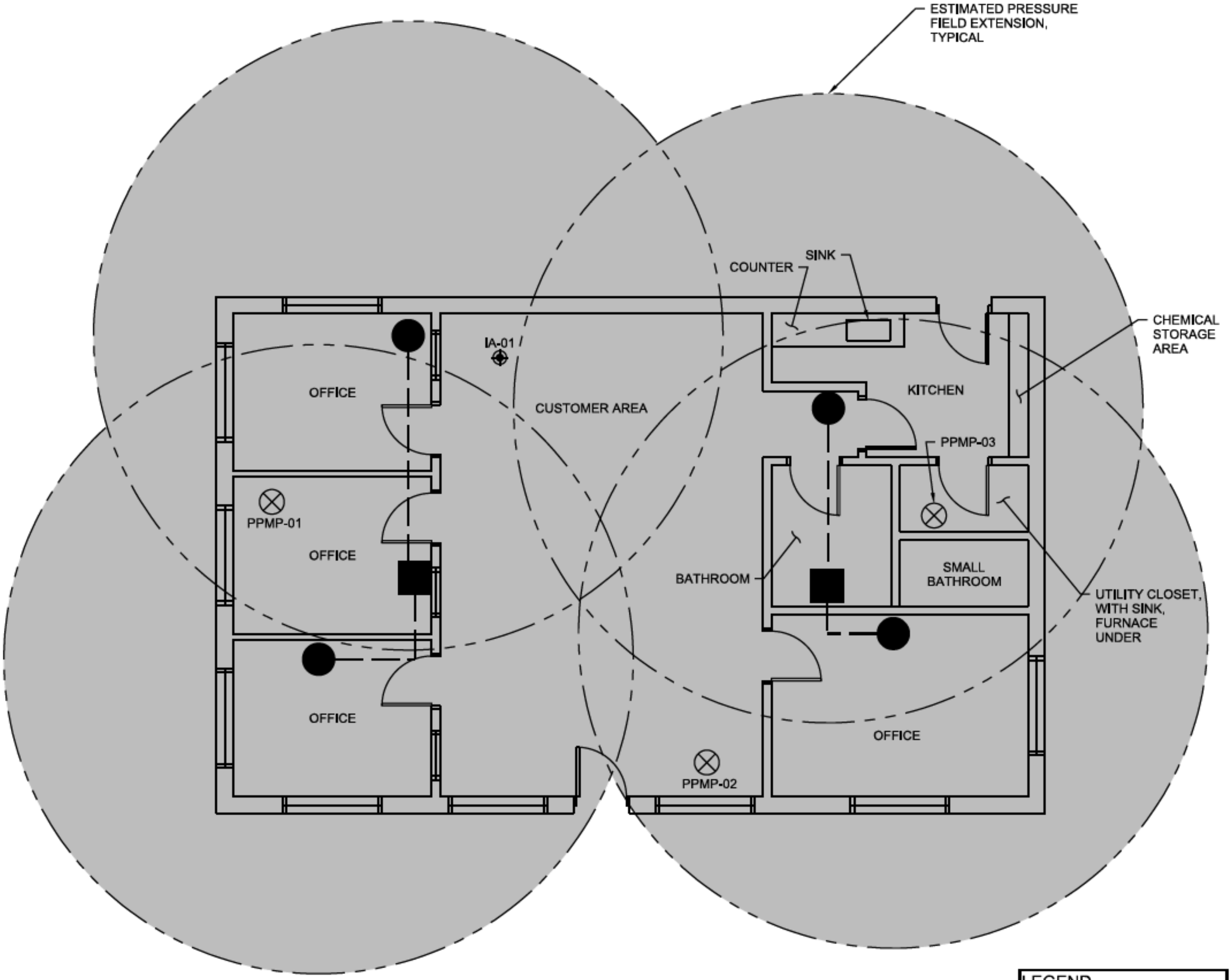
N

0 250 500 Feet

Imagery: USDA FSA NAIP, October 2014

Notes:
1. Results presented in parts per billion by volume (ppb-v)
2. TCR = Target Risk for Carcinogens
3. THQ = Target Hazard Quotient for Non-Carcinogens
4. VISL = Vapor Intrusion Screening Level
5. TCE = Trichloroethene

Figure 4-12
TCE Soil Vapor Concentrations North of Fall Creek
Keystone Corridor Groundwater
Contamination Site
Marion County, Indiana



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.
2. DROPPED CEILING THROUGHOUT ENTIRE BUILDING.
3. TILE FLOORS THROUGHOUT BUILDING.

Figure 8
[redacted] (CP-002)
Floor Plan and VIMS Layout

1"=10'

0 5' 10' 15'
1"=10'

N

LEGEND

PROPOSED

NODE: ●
FAN: ■
CONVEYANCE: - - - -
ESTIMATED PRESSURE FIELD EXTENSION: ▨
PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X ⊕
PRESSURE MONITORING POINT: PMP-0X ⊕
INDOOR AIR SAMPLE LOCATION: IA-0X ⊕

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS

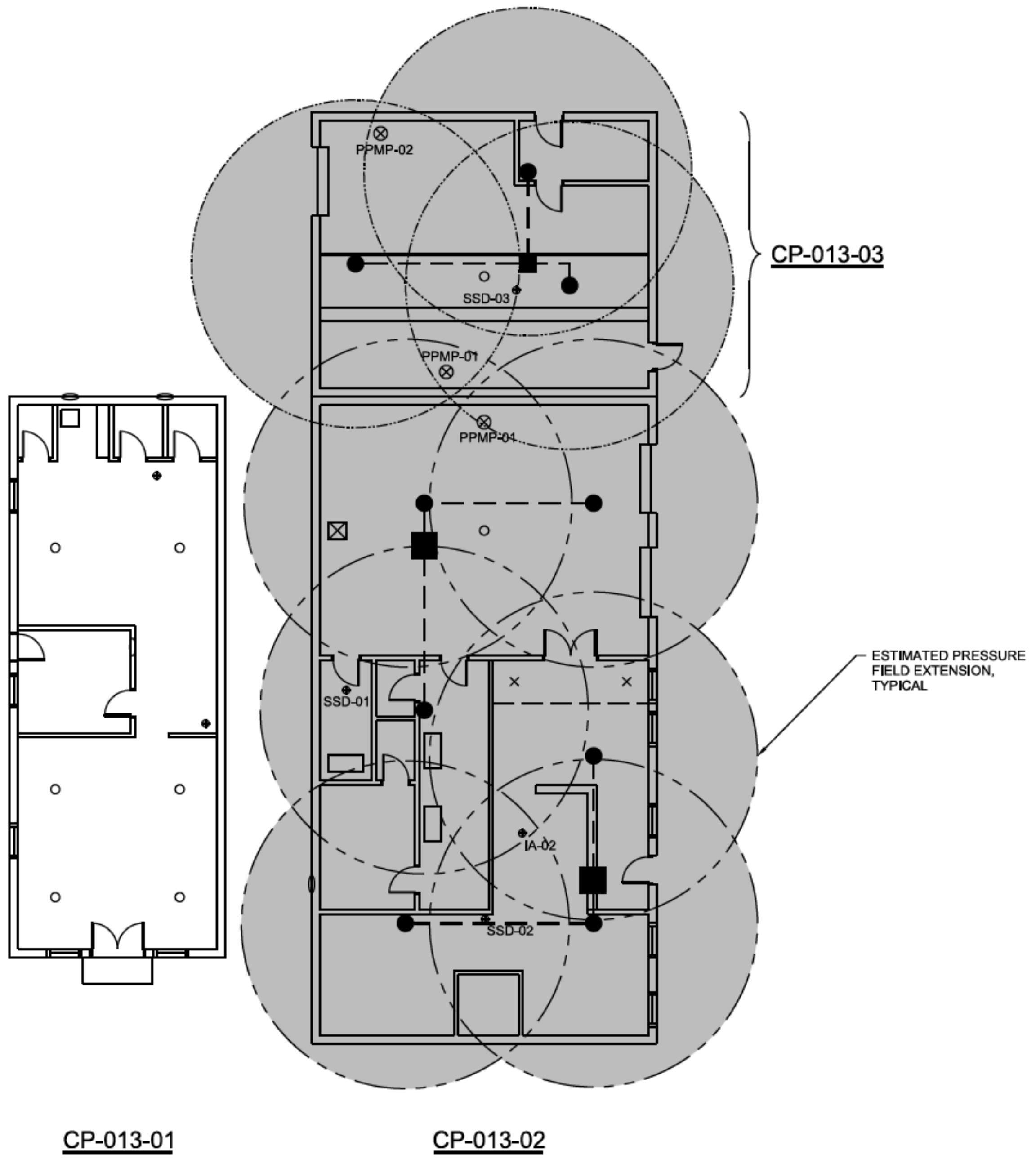


Figure 9

[redacted](CP-013-01)
[redacted](CP-013-02 & CP-013-03)
Floor Plan and VIMS Layout

1"=20'
0 10' 20' 30'
1"=20'
N

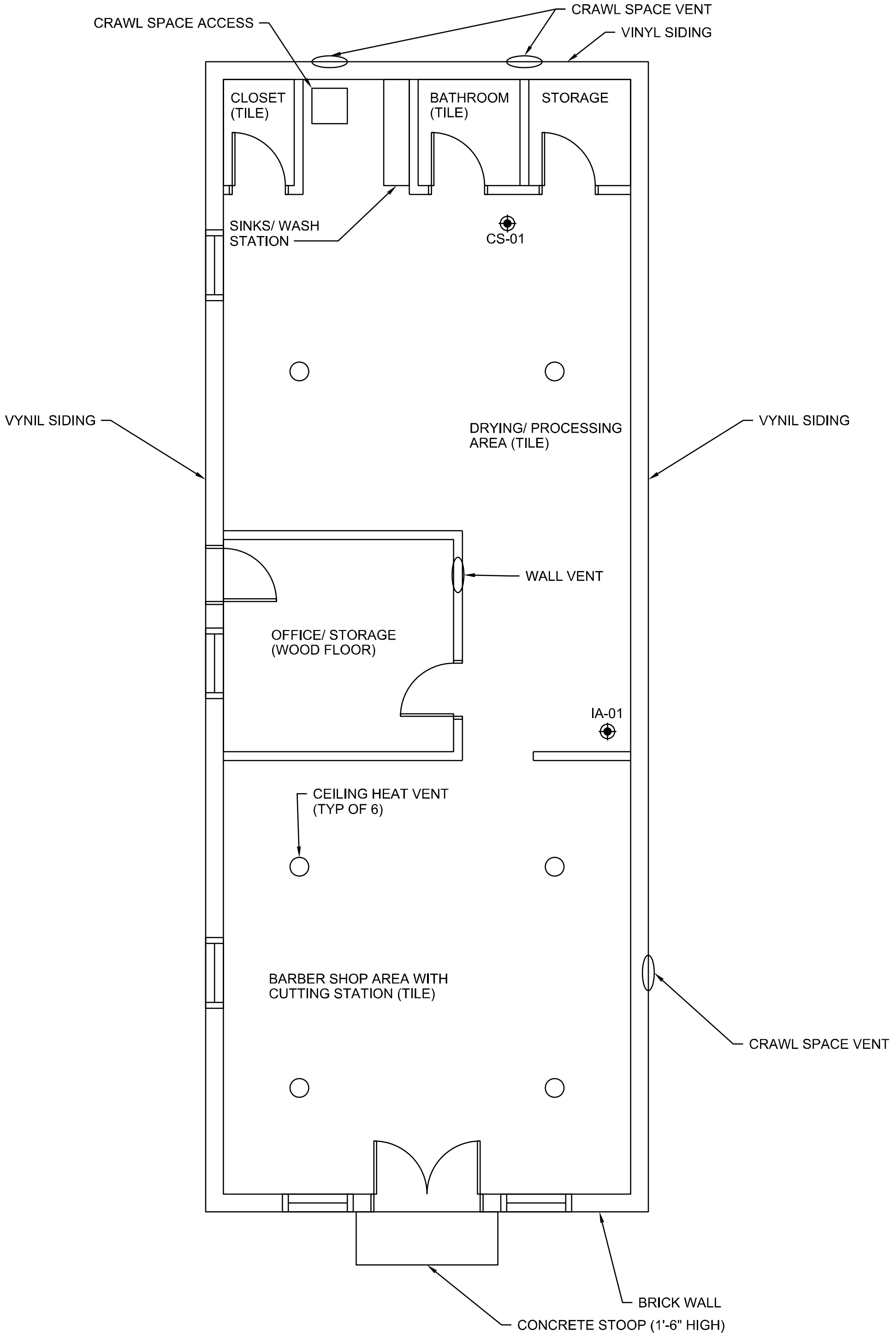
Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

LEGEND

PROPOSED
NODE: ●
FAN: ■
CONVEYANCE: — —
ESTIMATED PRESSURE FIELD EXTENSION: ▨
PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING
DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X ⌖
PRESSURE MONITORING POINT: PMP-0X ⌖
INDOOR AIR SAMPLE LOCATION: IA-0X ⌖

JACOBS



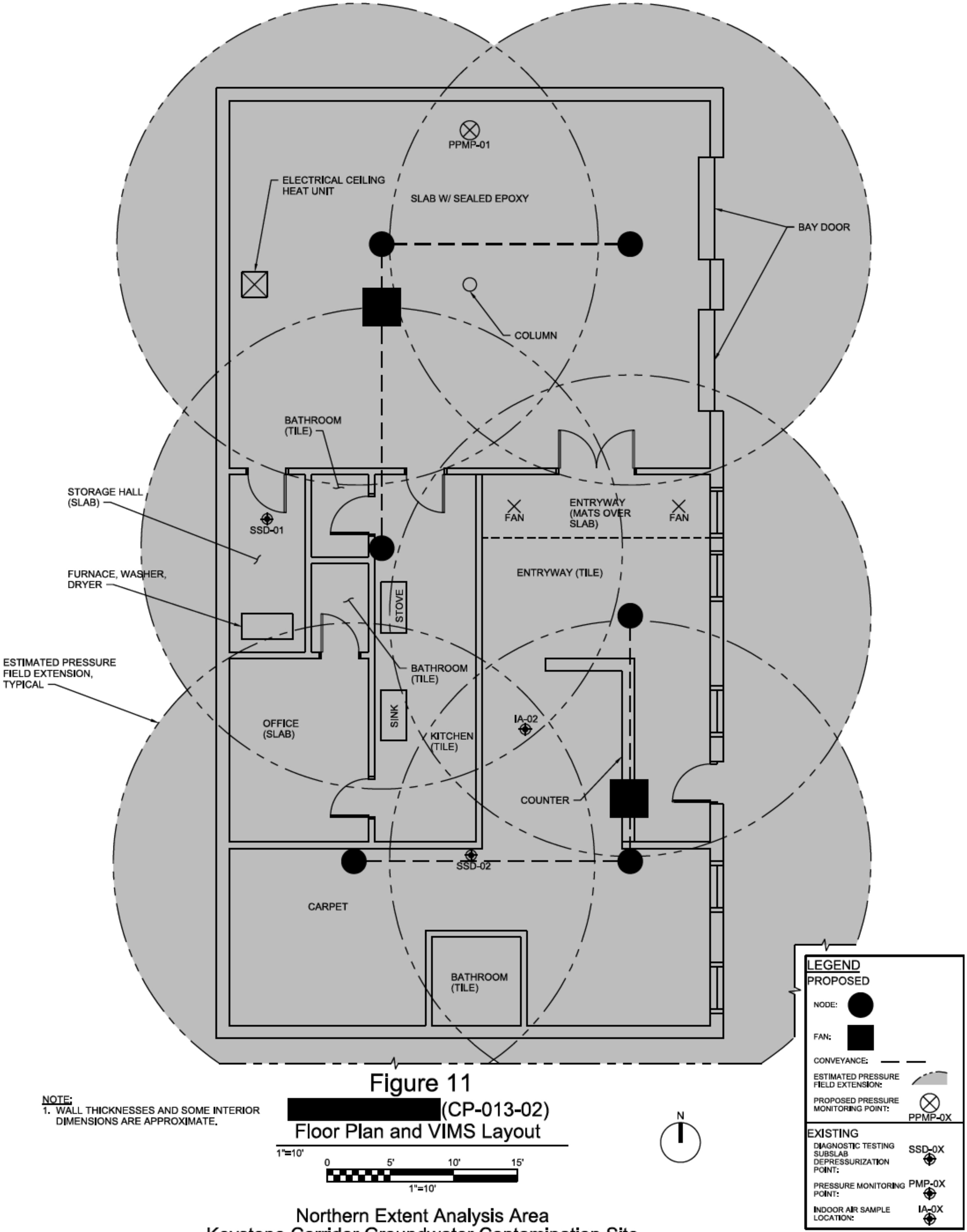
NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

FIGURE 10
[redacted] (CP-013-01)

1"=10'

N

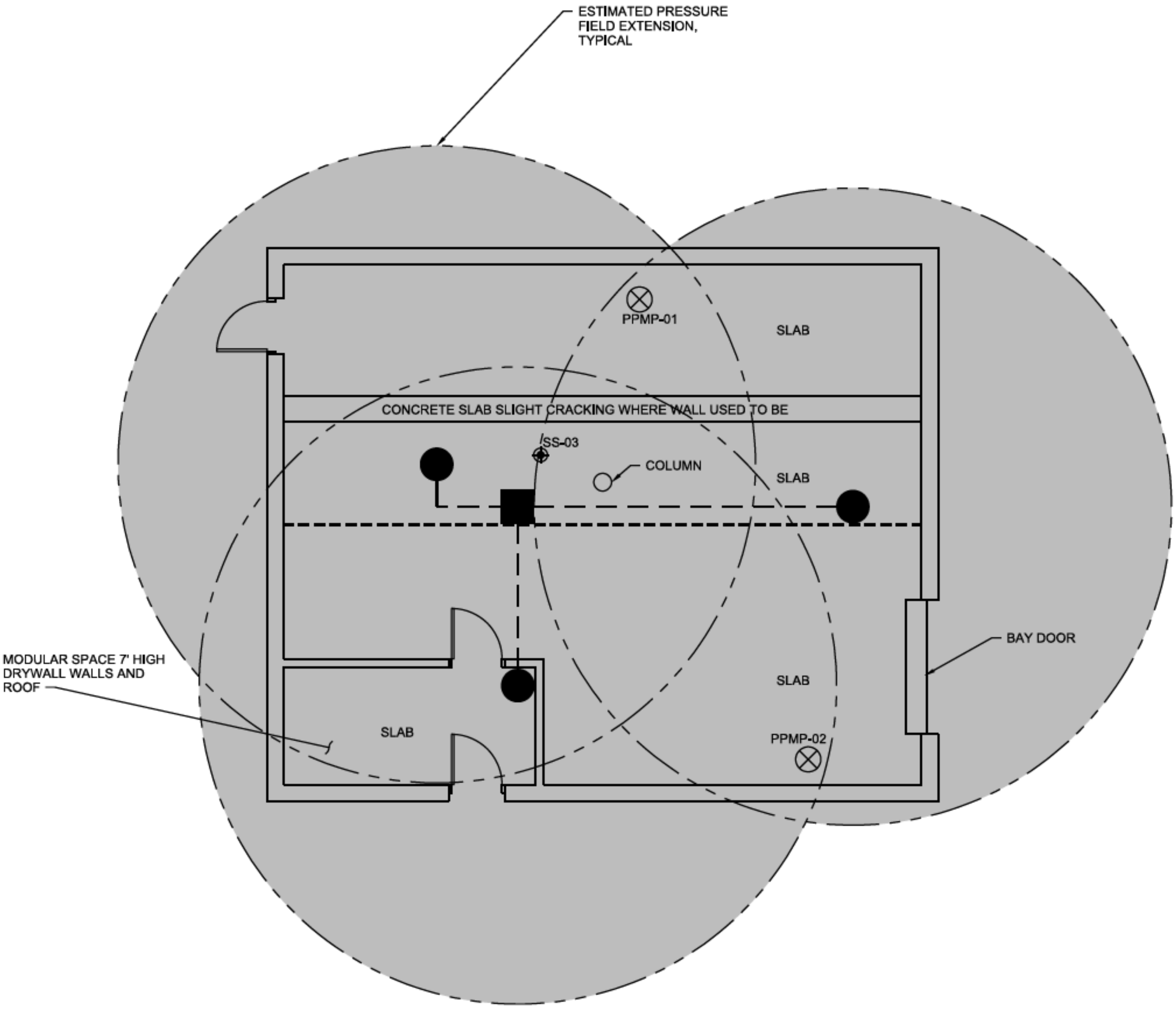
0 5' 10' 15'
1"=10'



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 11
[redacted](CP-013-02)
Floor Plan and VIMS Layout

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

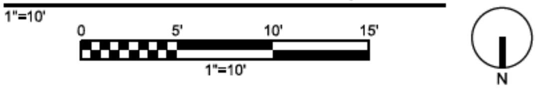


NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 12

[redacted] (CP-013-03)

Floor Plan and VIMS Layout



Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

LEGEND
PROPOSED
NODE: ●
FAN: ■
CONVEYANCE: — —
ESTIMATED PRESSURE FIELD EXTENSION:
PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X
EXISTING
DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X
PRESSURE MONITORING POINT: PMP-0X
INDOOR AIR SAMPLE LOCATION: IA-0X

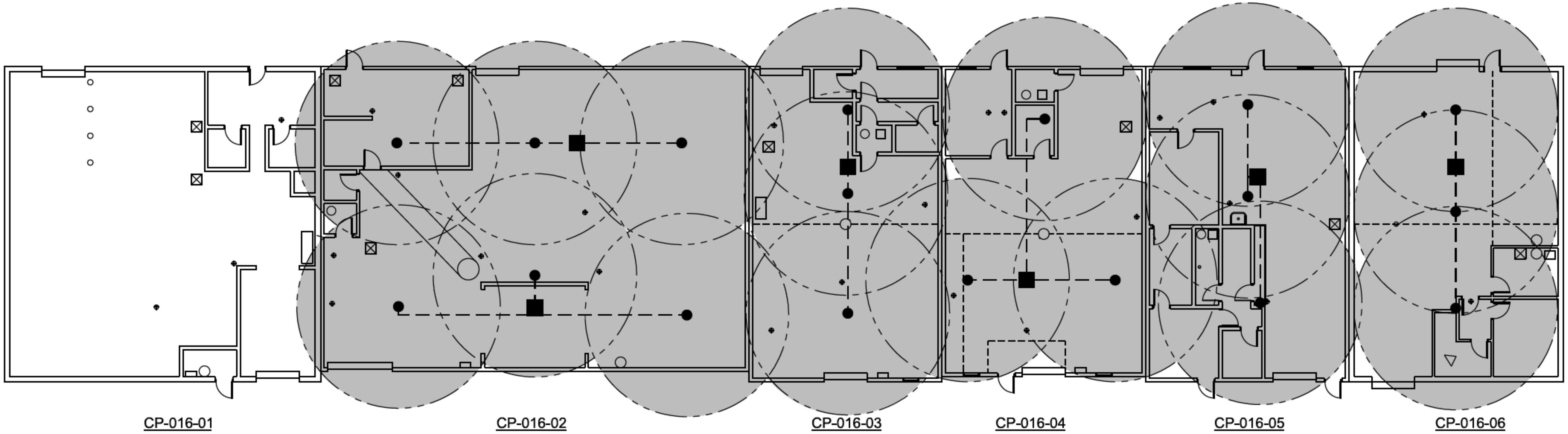
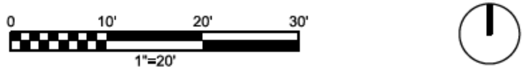
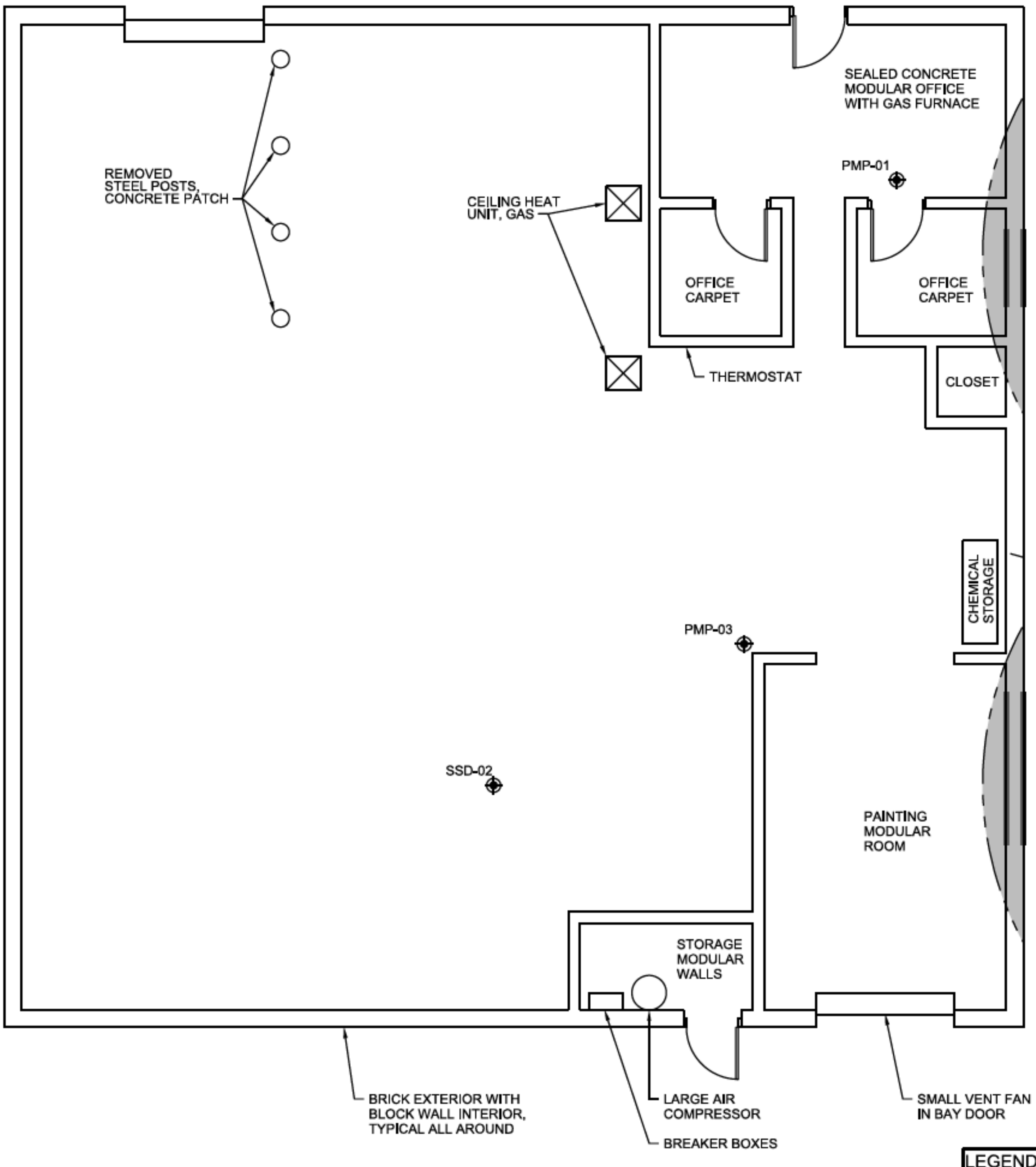


Figure 13

CP-016
[redacted] (CP-016-01)
(CP-016-02)
(CP-016-03)
(CP-016-04)
(CP-016-05)
(CP-016-06)
Floor Plan and VIMS Layout



Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana



LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: – – – –

ESTIMATED PRESSURE FIELD EXTENSION: ▨

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

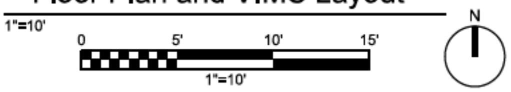
DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X ⊕

PRESSURE MONITORING POINT: PMP-0X ⊕

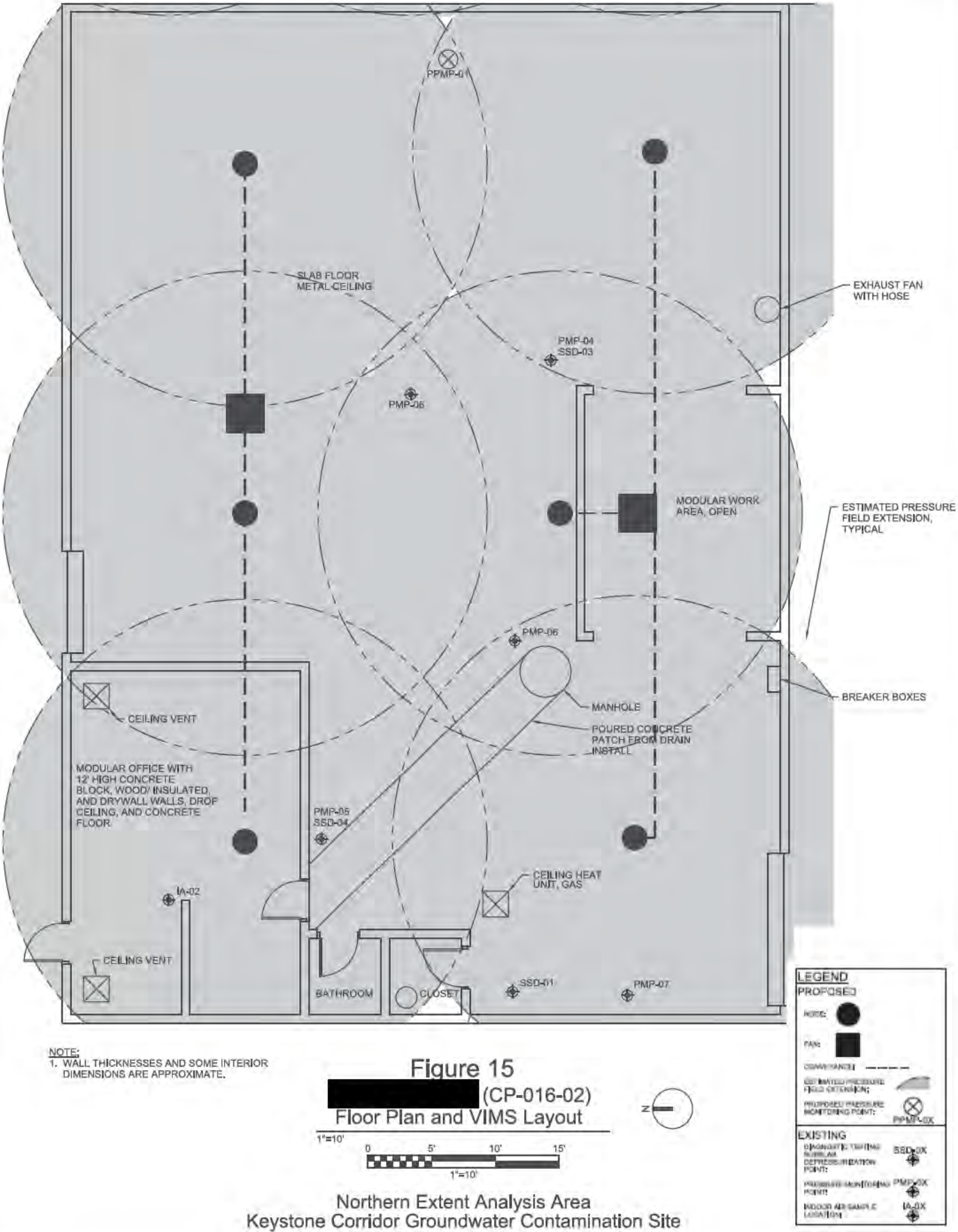
INDOOR AIR SAMPLE LOCATION: IA-0X ⊕

NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 14
[redacted] (CP-016-01)
Floor Plan and VIMS Layout



Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

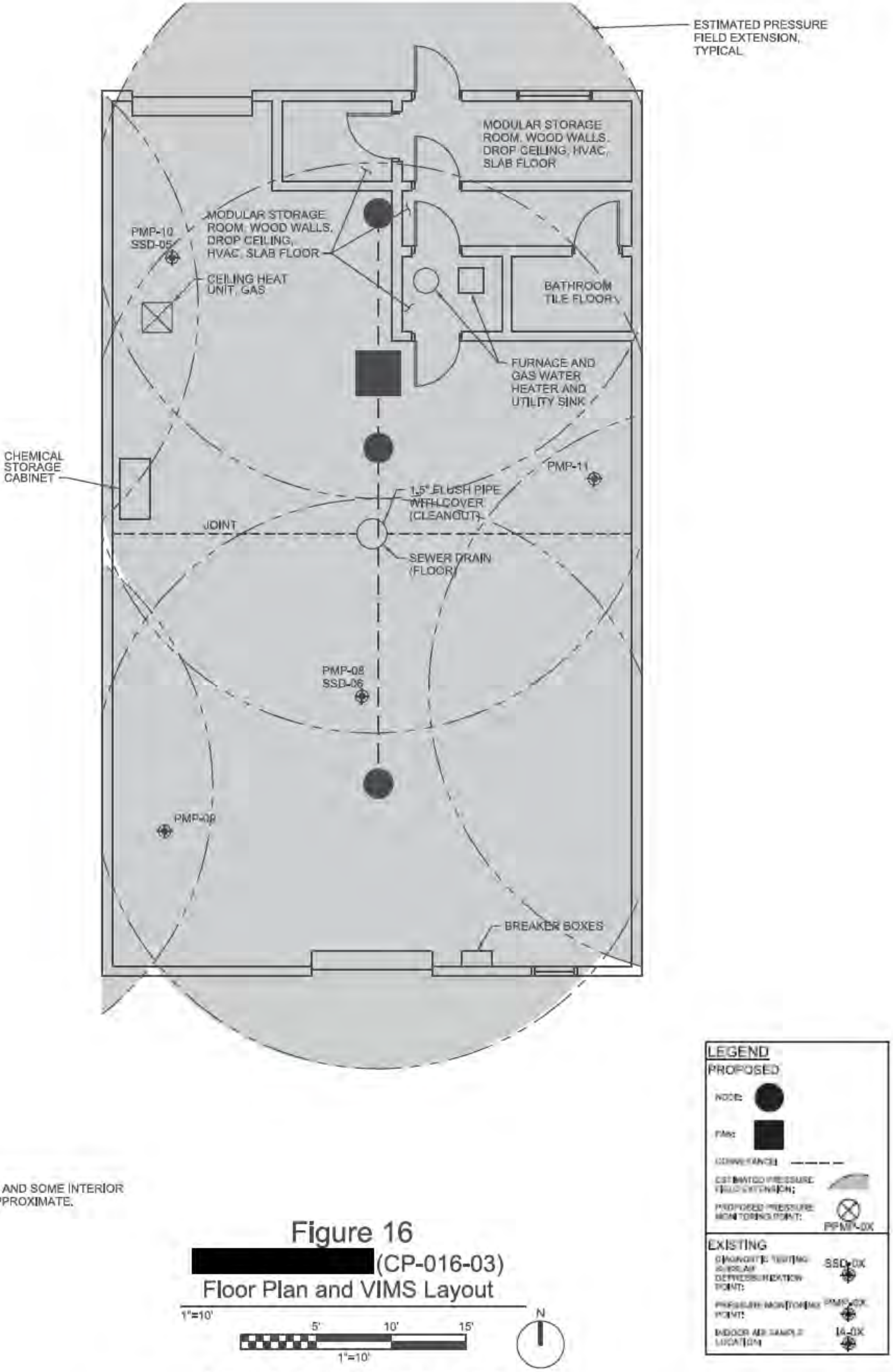


NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 15
[redacted] (CP-016-02)
Floor Plan and VIMS Layout

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS

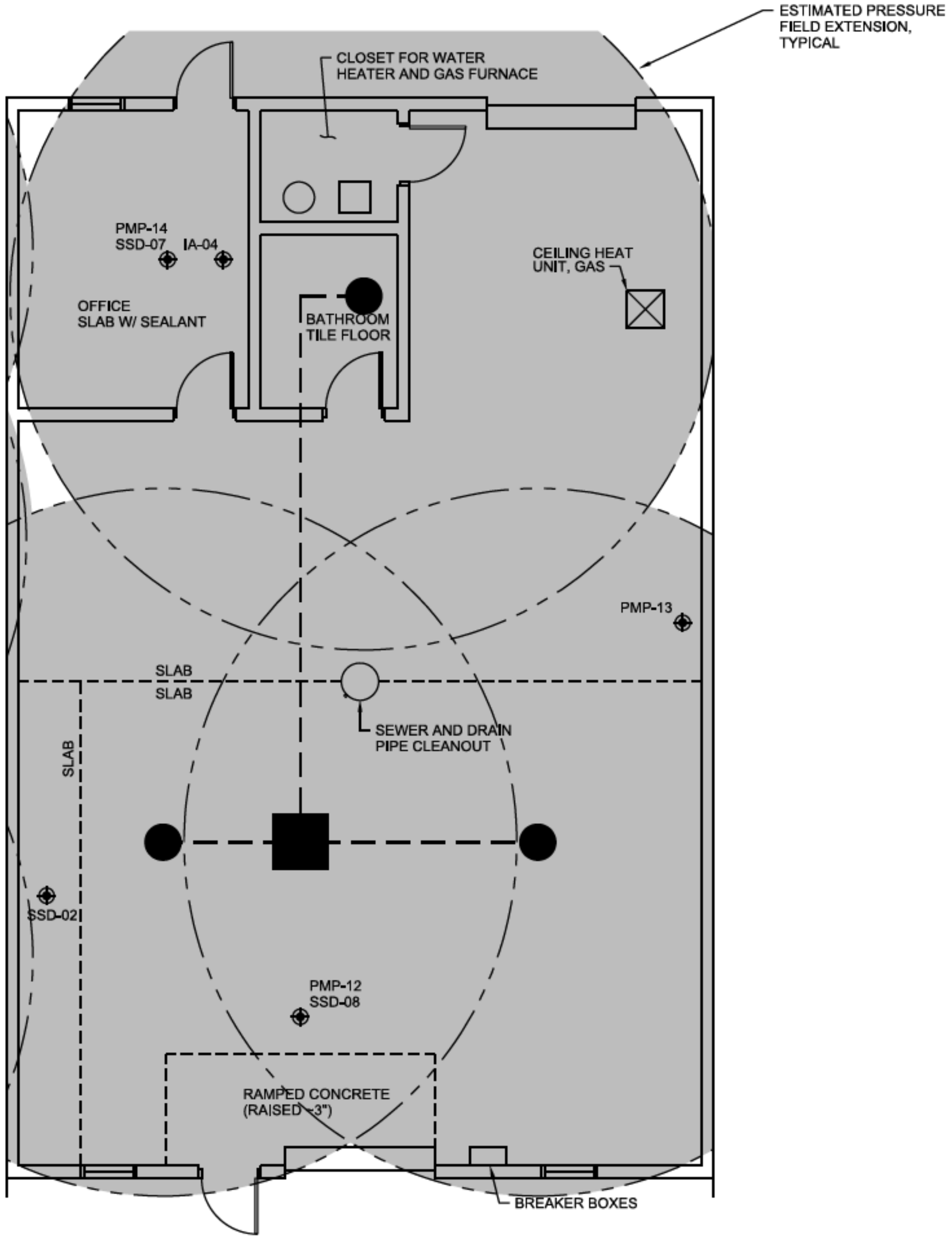


NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 16
[redacted] (CP-016-03)
Floor Plan and VIMS Layout

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 17
[redacted] (CP-016-04)
Floor Plan and VIMS Layout

1"=10'

0 5' 10' 15'

1"=10'

N

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: – – – –

ESTIMATED PRESSURE FIELD EXTENSION: ▨

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

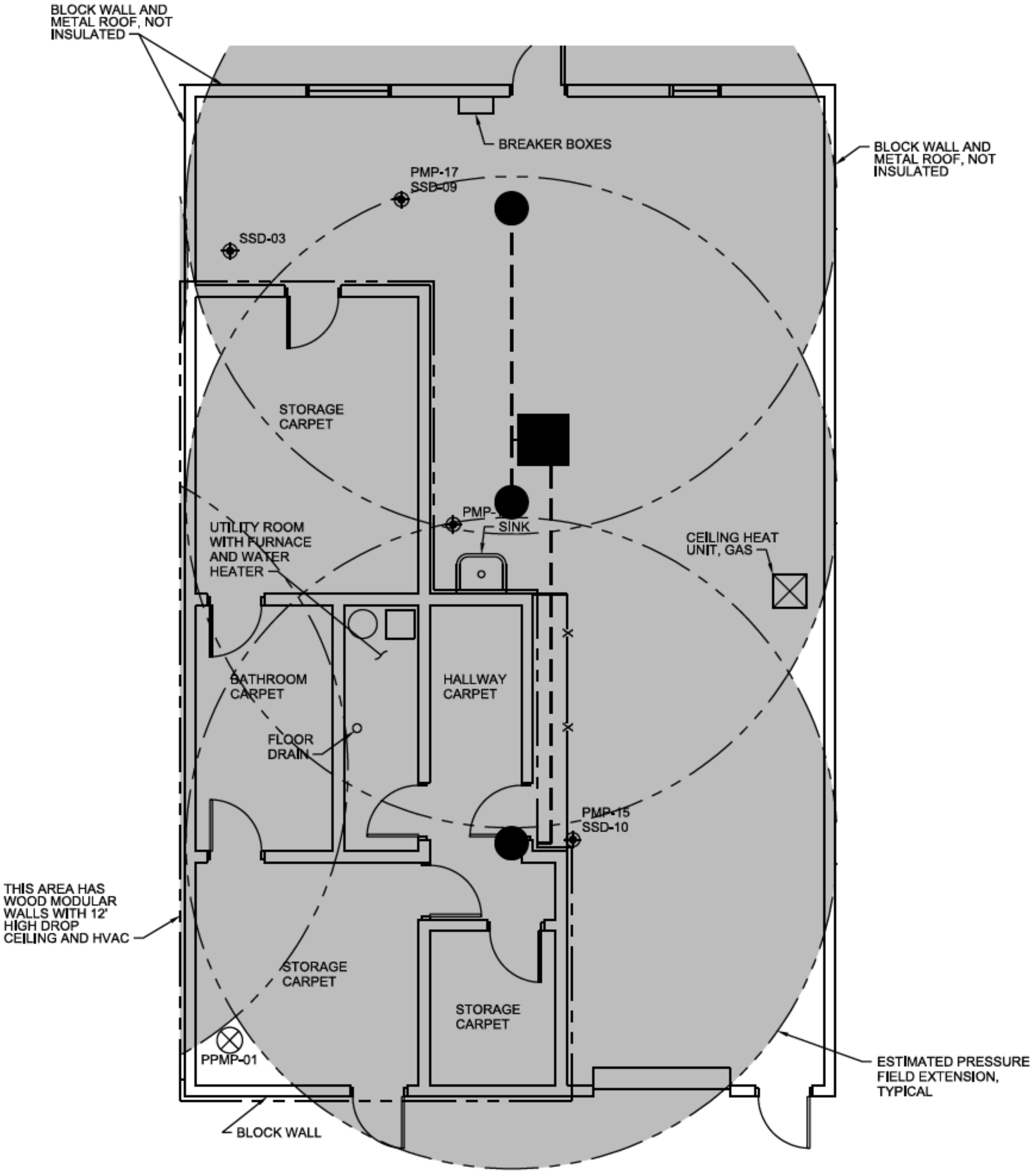
EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X ⌖

PRESSURE MONITORING POINT: PMP-0X ⌖

INDOOR AIR SAMPLE LOCATION: IA-0X ⌖

JACOBS

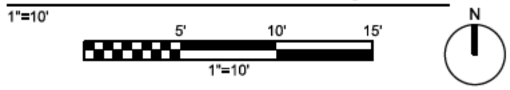


NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 18

[redacted] (CP-016-05)

Floor Plan and VIMS Layout



Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

LEGEND

PROPOSED

NODE:	●
FAN:	■
CONVEYANCE:	– – – –
ESTIMATED PRESSURE FIELD EXTENSION:	▨
PROPOSED PRESSURE MONITORING POINT:	⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT:	SSD-0X ⊕
PRESSURE MONITORING POINT:	PMP-0X ⊕
INDOOR AIR SAMPLE LOCATION:	IA-0X ⊕

JACOBS

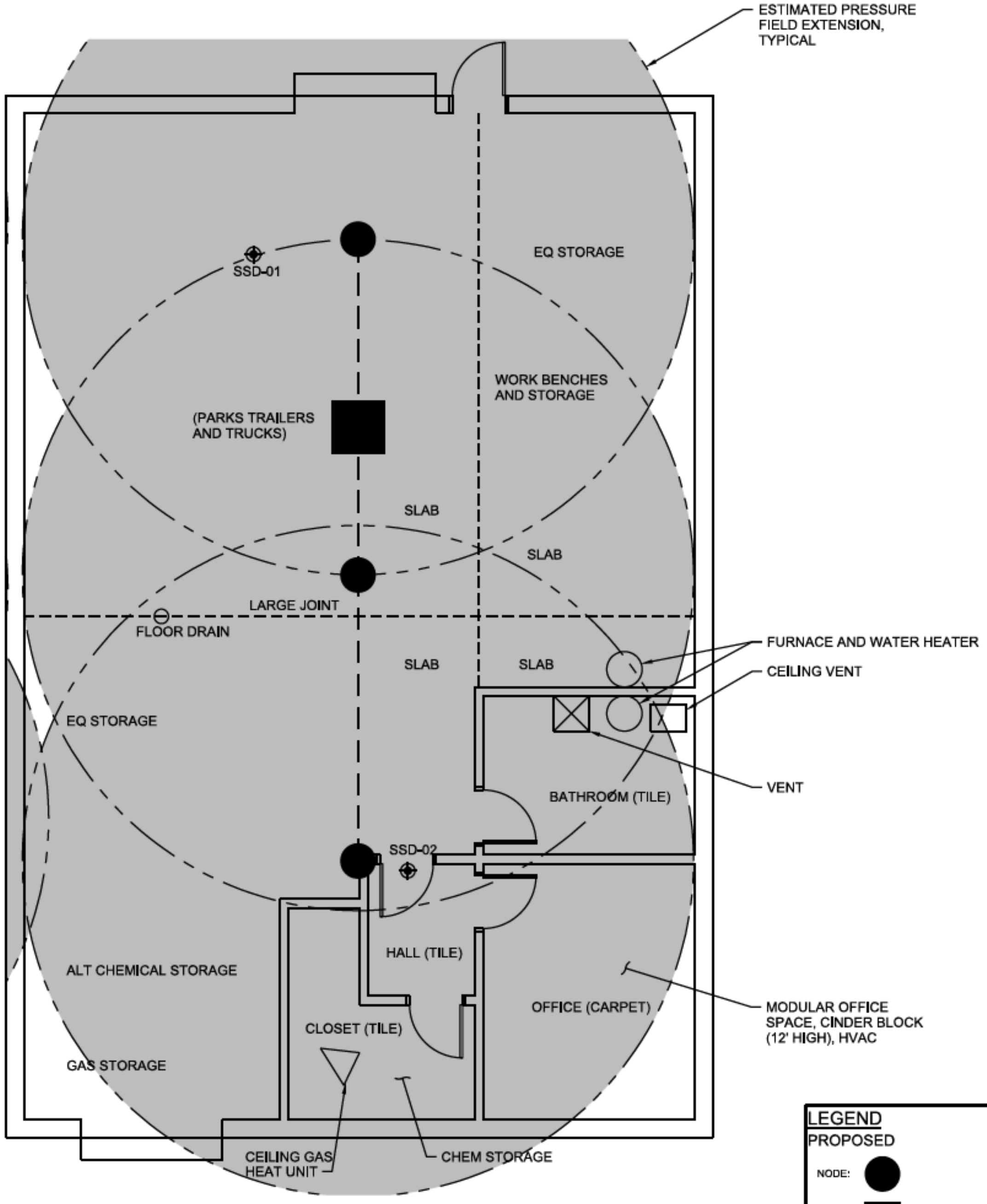


Figure 19

[redacted] (CP-016-06)

Floor Plan and VIMS Layout

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS

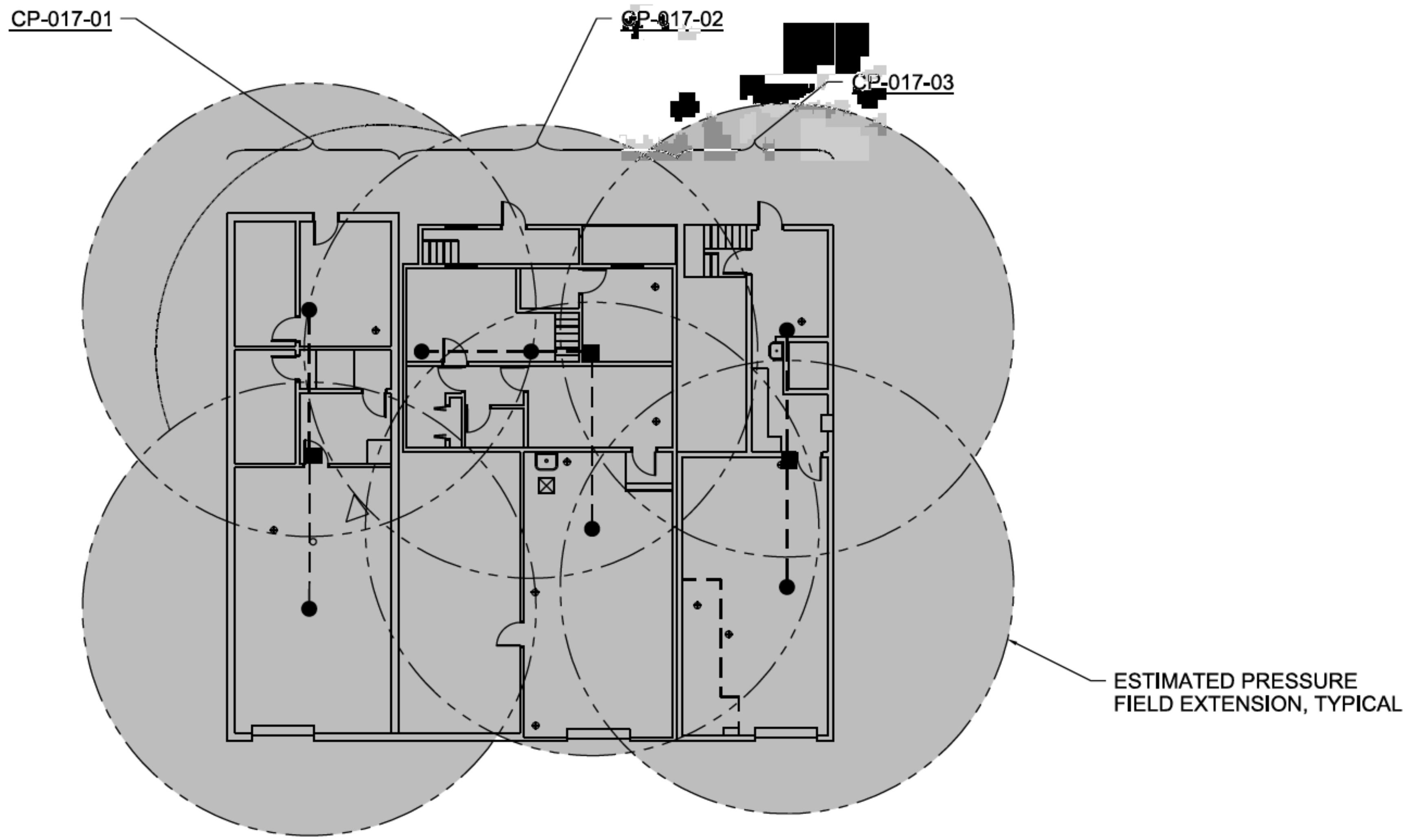


FIGURE 20

[redacted](CP-017)

Floor Plan and VIMS Layout

1"=20'

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: – – – –

ESTIMATED PRESSURE FIELD EXTENSION:

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

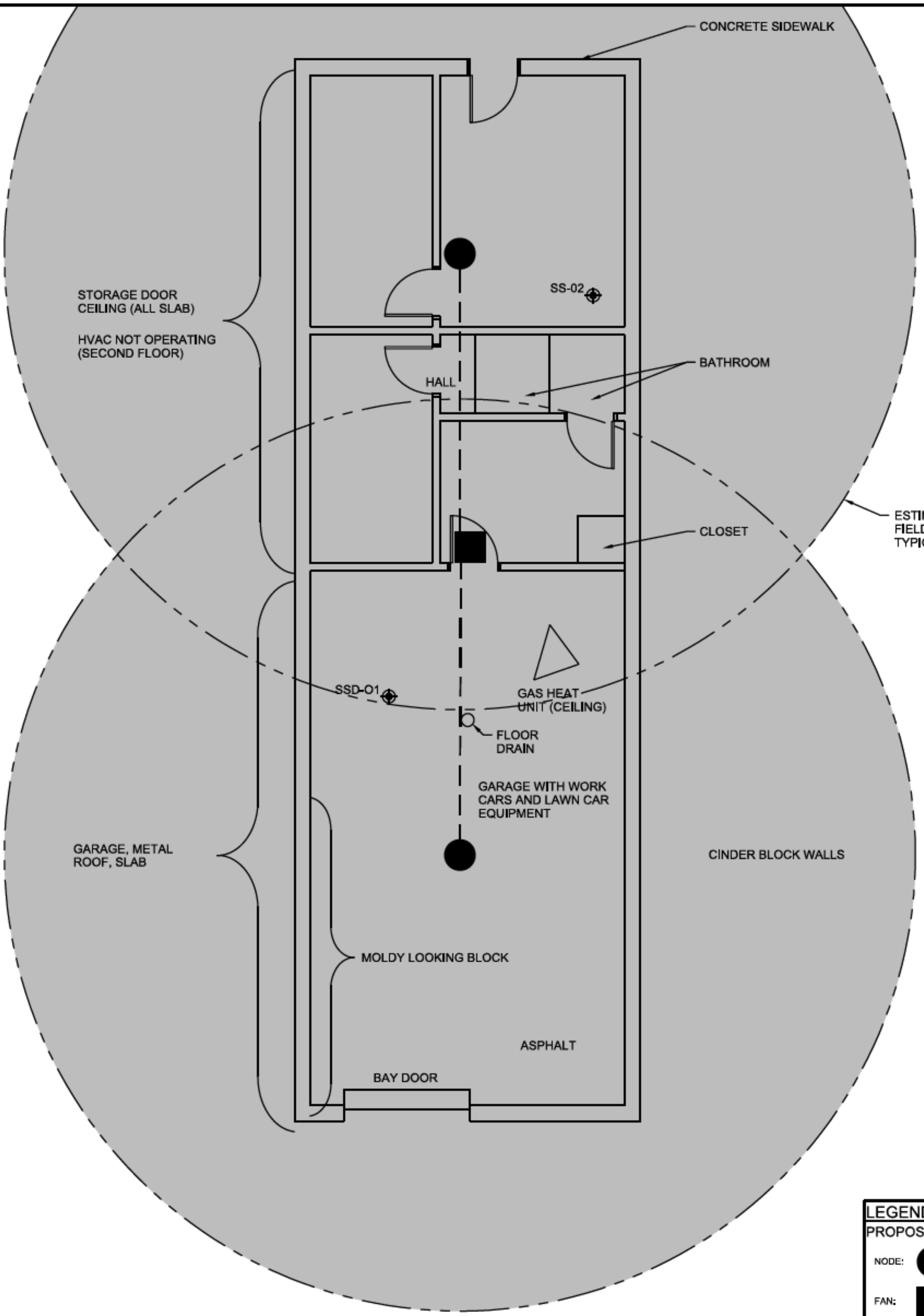
EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X ⌖

PRESSURE MONITORING POINT: PMP-0X ⌖

INDOOR AIR SAMPLE LOCATION: IA-0X ⌖

JACOBS



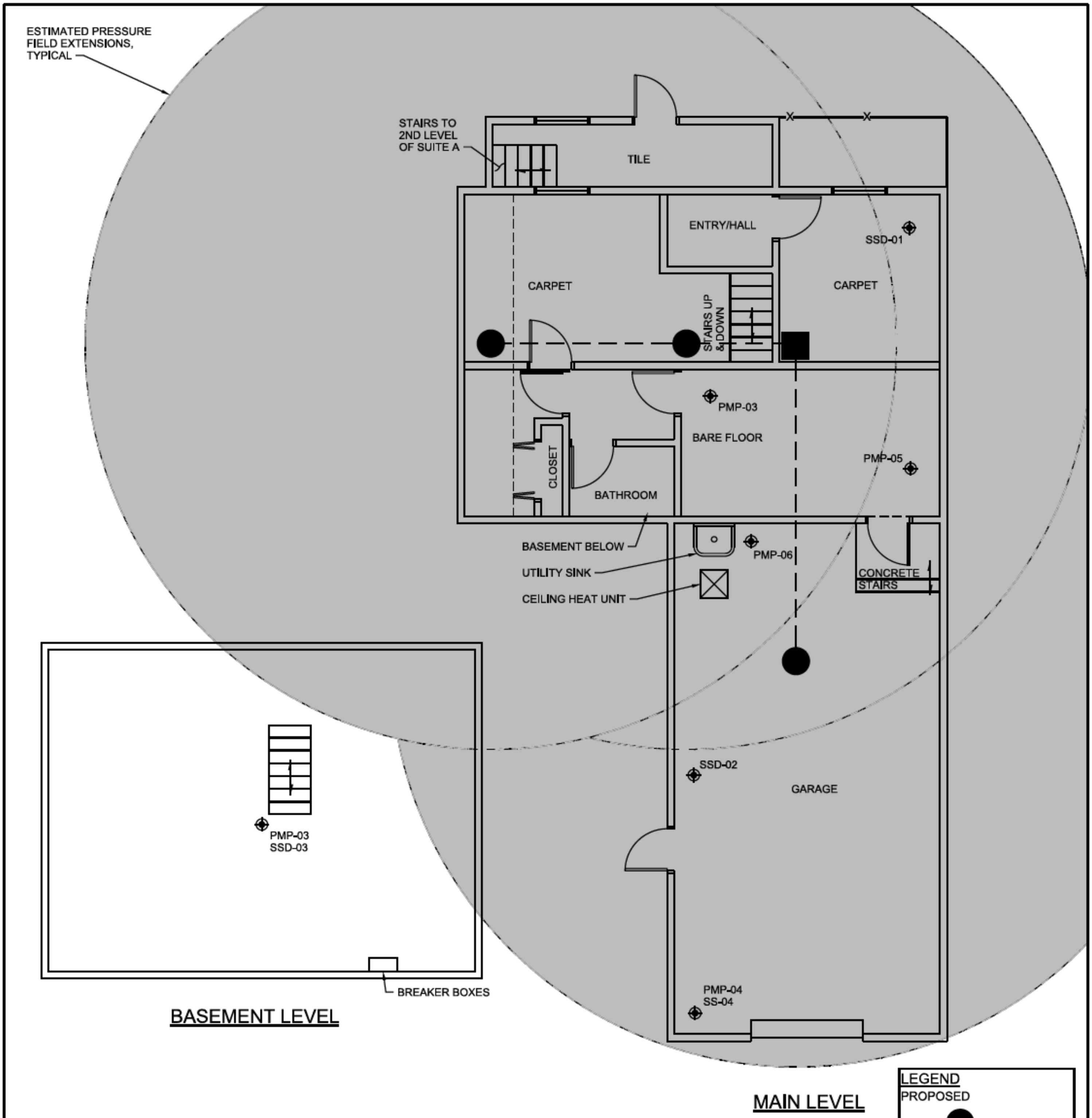
NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 21
[redacted] (CP-017-01)
Floor Plan and VIMS Layout

1"=10'
0 5' 10' 15'
1"=10'

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 22
[redacted] (CP-017-02)
Floor Plan and VIMS Layout

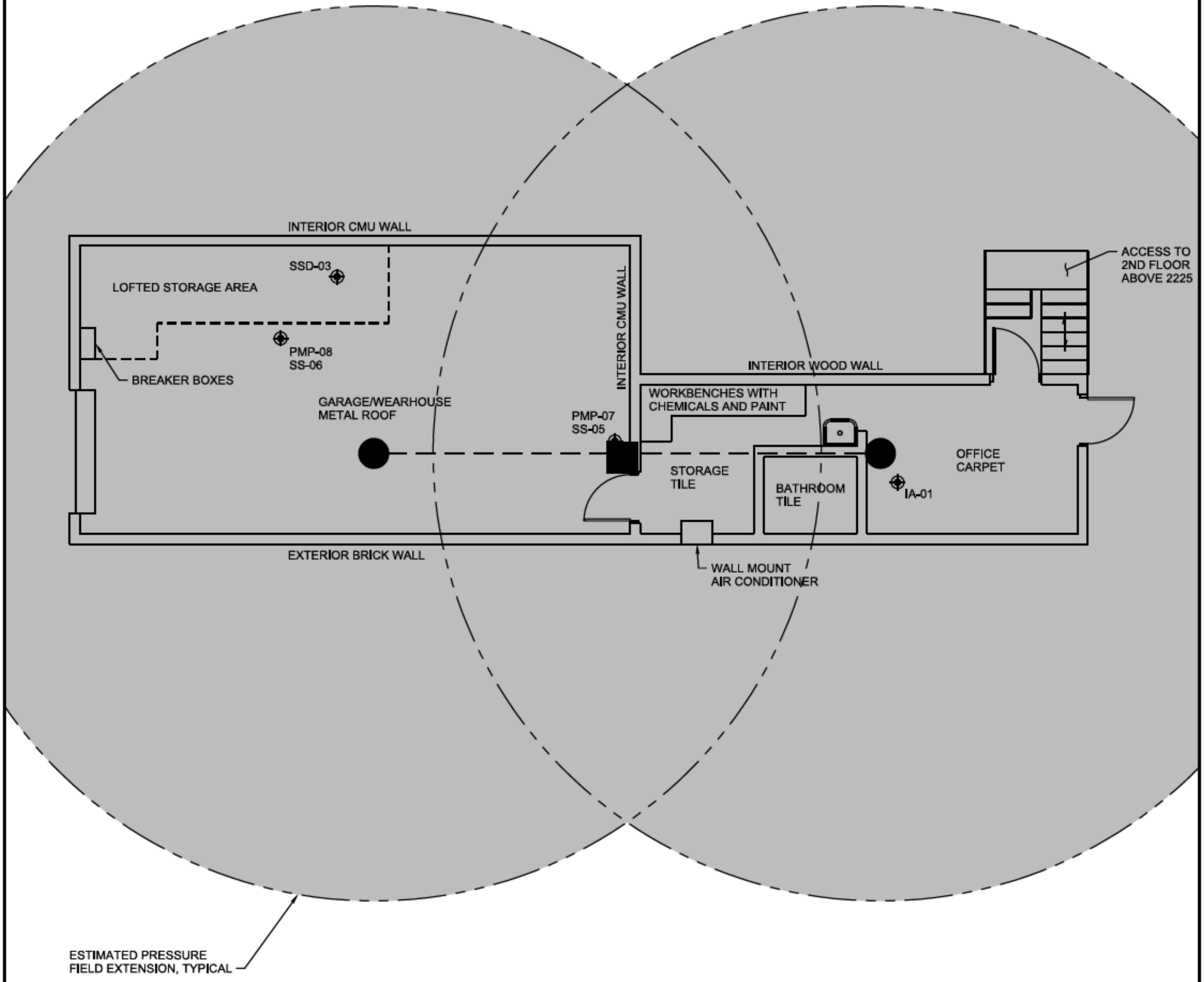
1"=10'

0 5' 10' 15'

1"=10'

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: — —

ESTIMATED PRESSURE FIELD EXTENSION:

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X

PRESSURE MONITORING POINT: PMP-0X

INDOOR AIR SAMPLE LOCATION: IA-0X

Figure 23

[redacted](CP-017-03)

Floor Plan and VIMS Layout

1"=10'

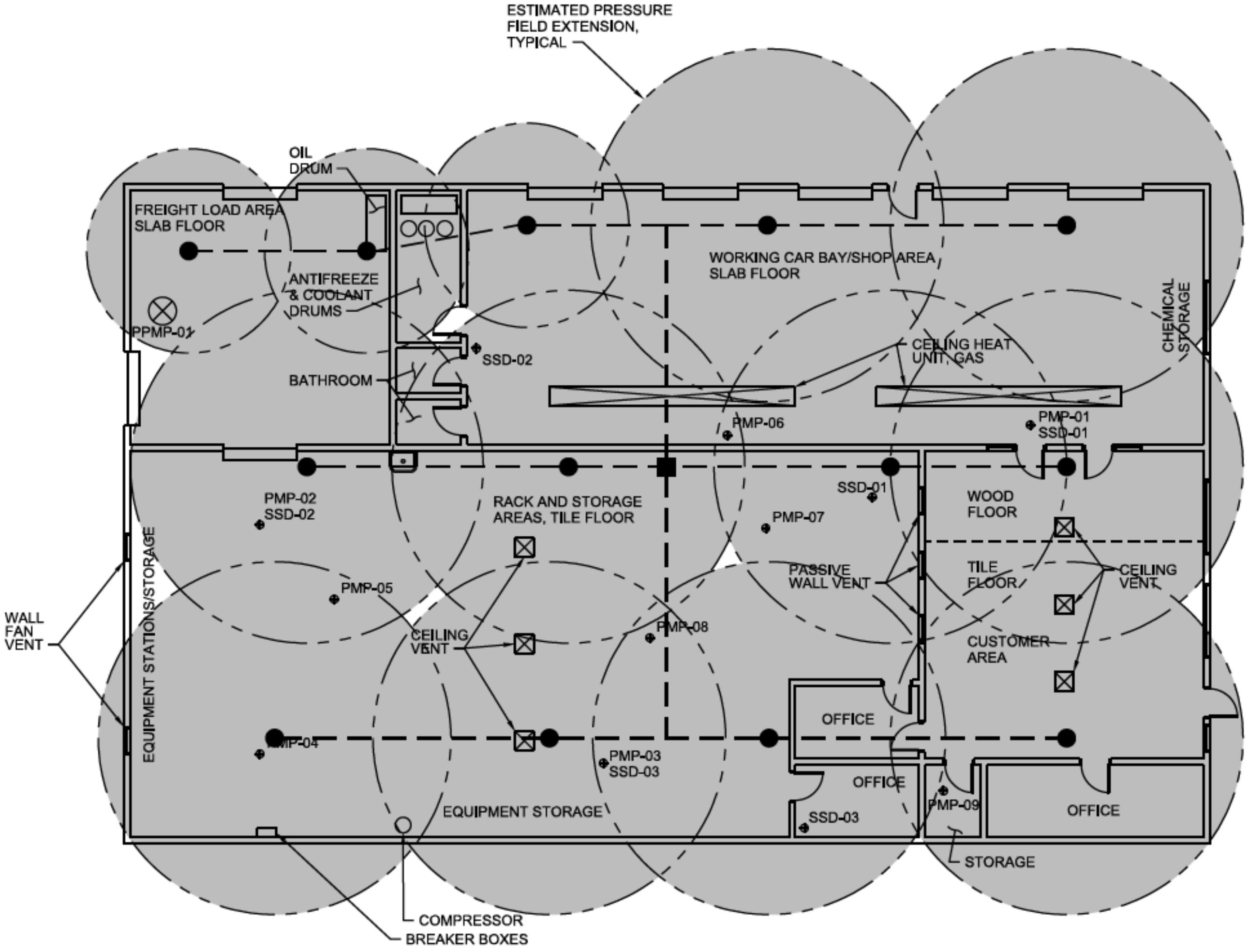
0 5' 10' 15'

1"=10'

N

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 24
[redacted] (CP-018)
Floor Plan and VIMS Layout

1"=20'

N

0 10' 20' 30'

1"=20'

LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: — —

ESTIMATED PRESSURE FIELD EXTENSION:

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X

PRESSURE MONITORING POINT: PMP-0X

INDOOR AIR SAMPLE LOCATION: IA-0X

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS

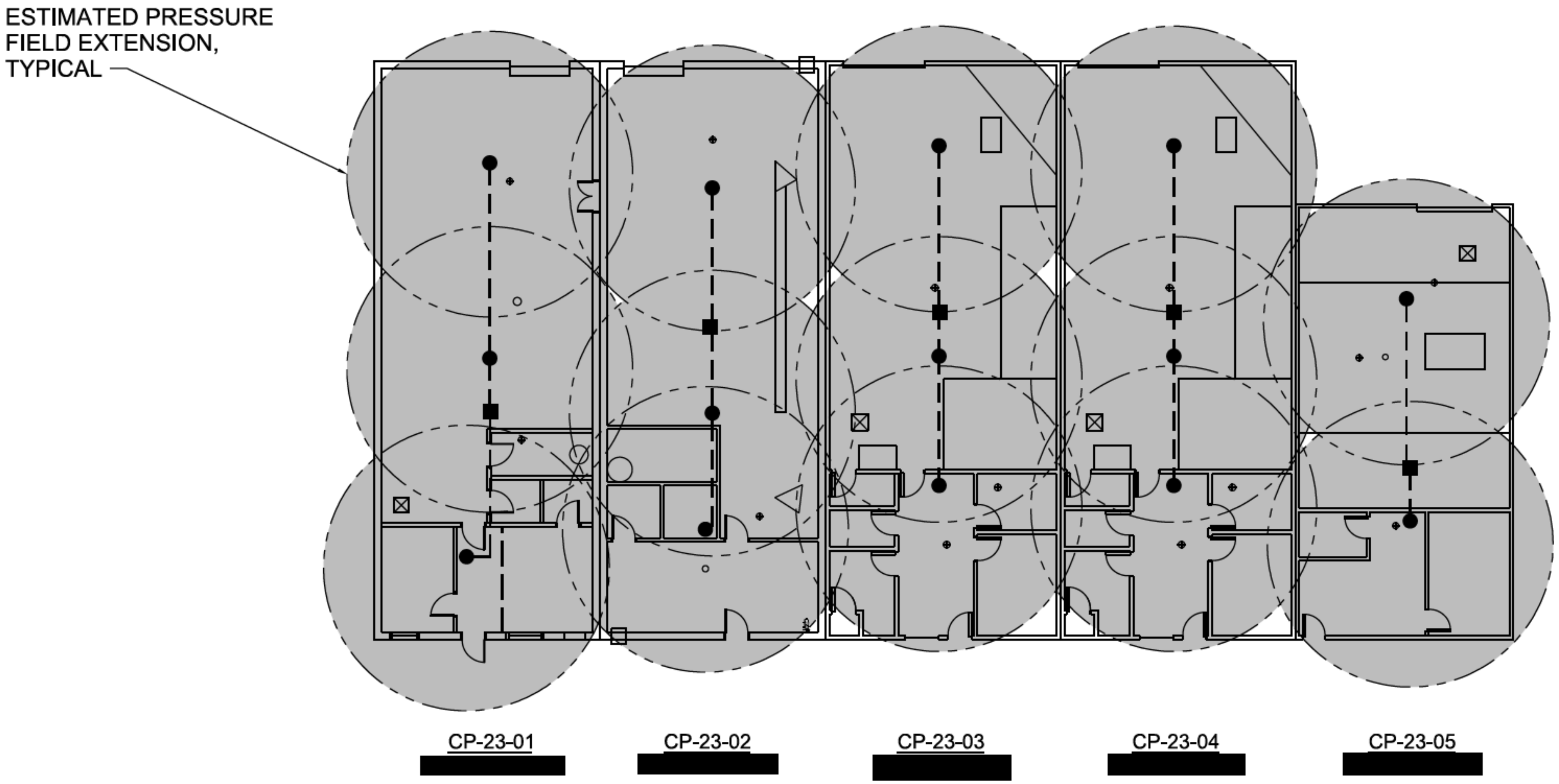
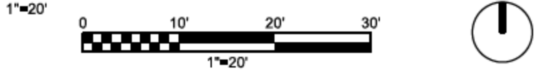


Figure 25
CP-023
Floor Plan and VIMS Layout



Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: — —

ESTIMATED PRESSURE FIELD EXTENSION:

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X ⌖

PRESSURE MONITORING POINT: PMP-0X ⌖

INDOOR AIR SAMPLE LOCATION: IA-0X ⌖

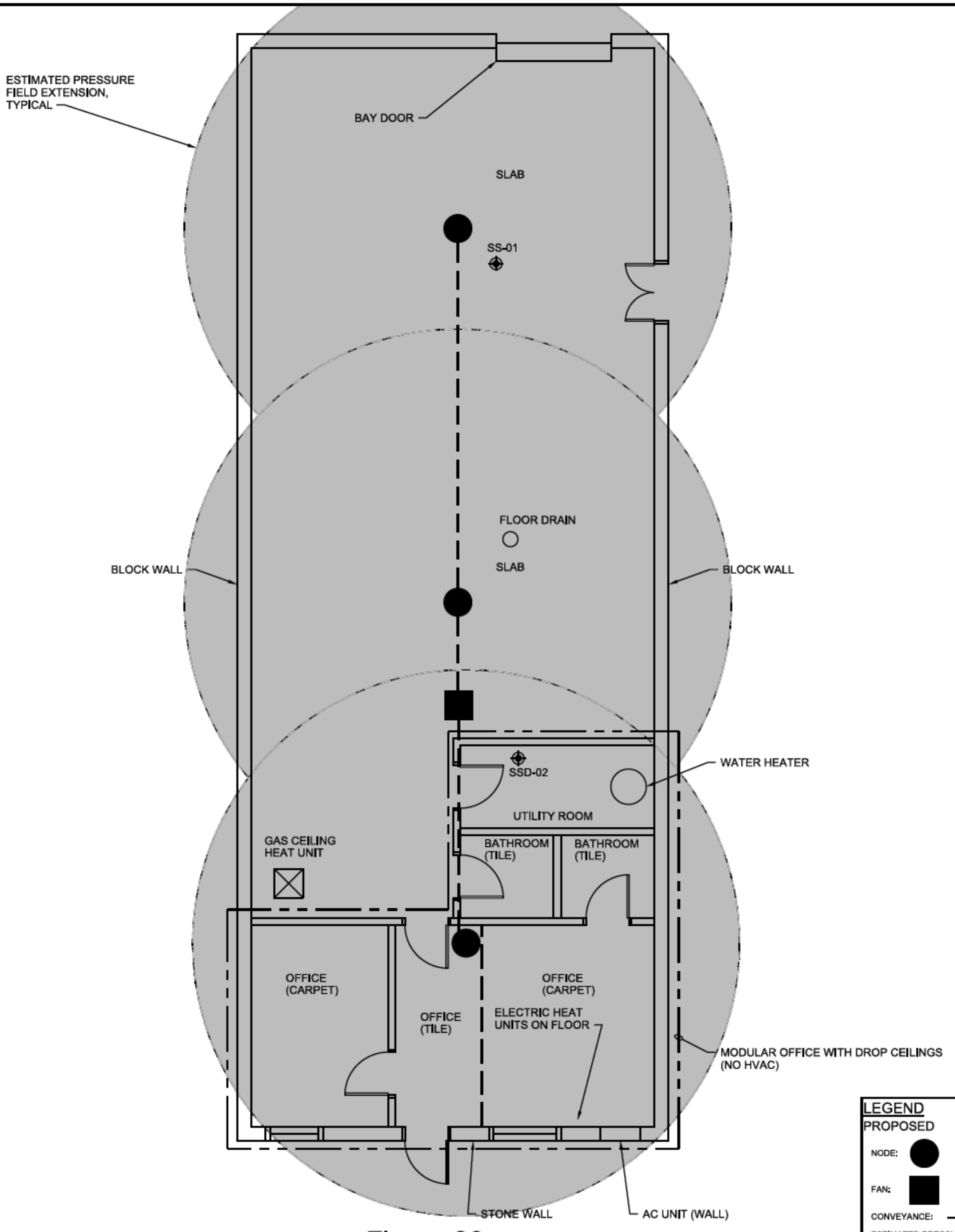
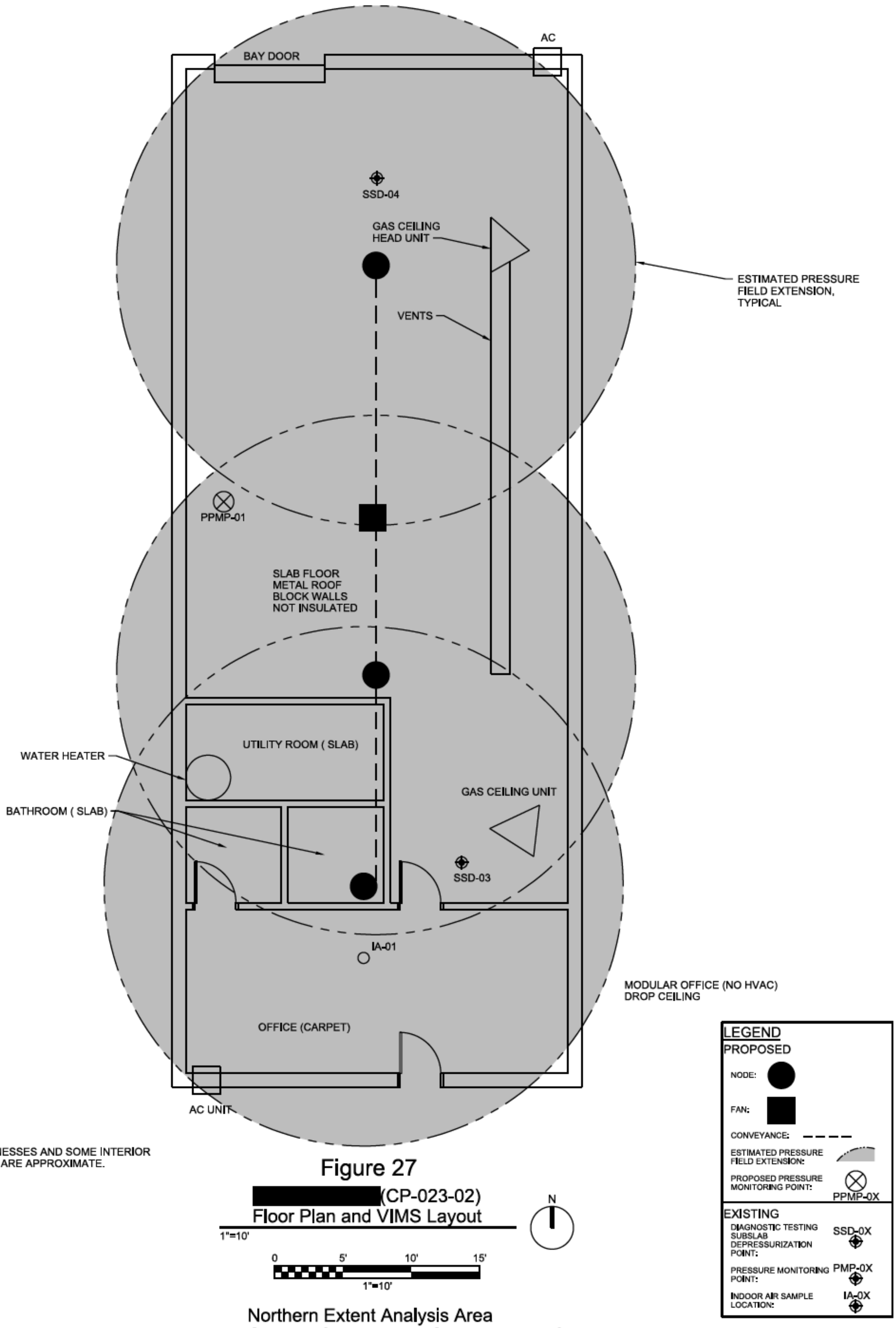


Figure 26
[redacted](CP-023-01)
Floor Plan and VIMS Layout

NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.
2. THIS BUILDING FEATURES A METAL ROOF.

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 27

[redacted](CP-023-02)

Floor Plan and VIMS Layout

1"=10'

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS

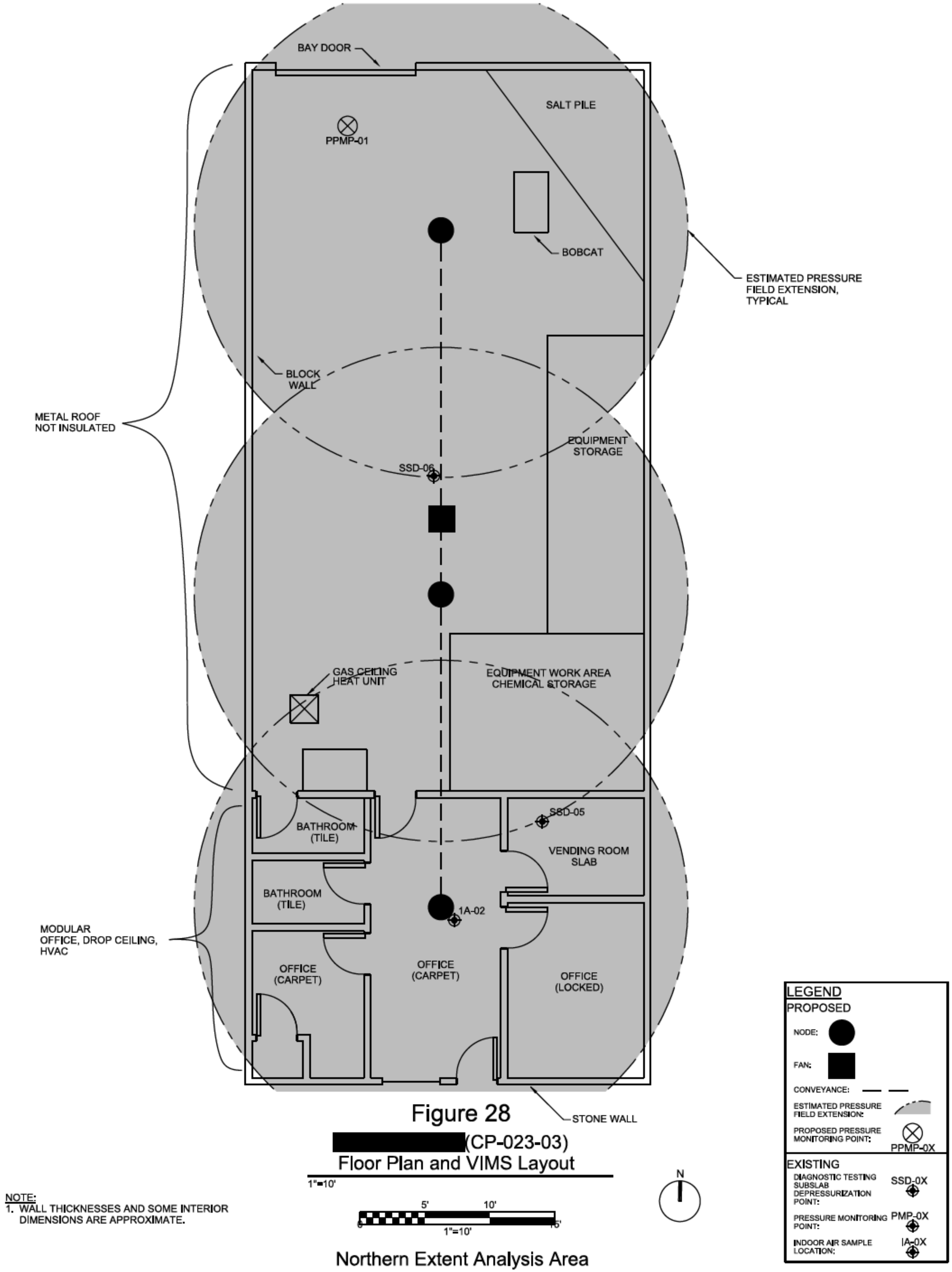


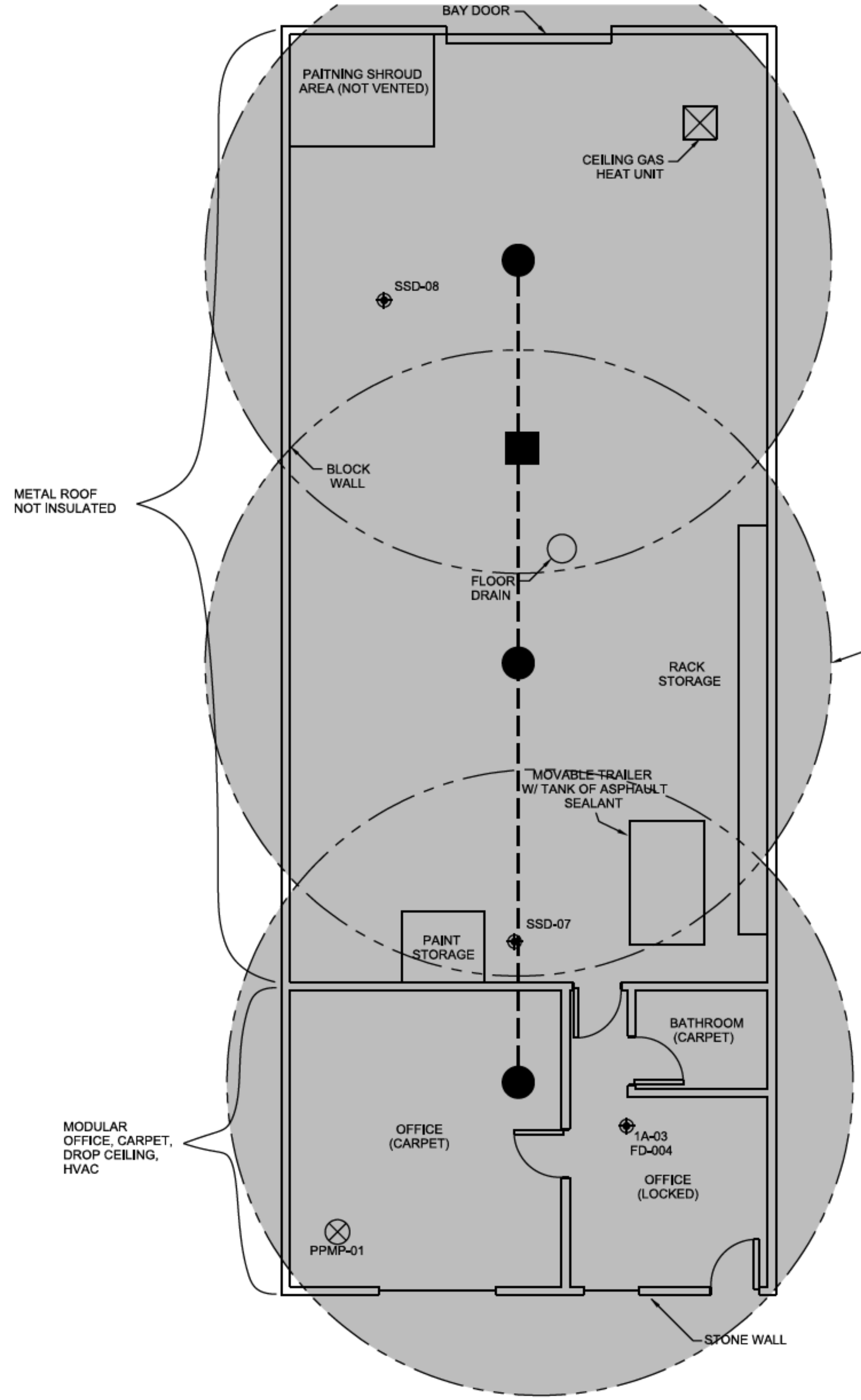
Figure 28

[redacted](CP-023-03)

Floor Plan and VIMS Layout

NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana



LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: – – – –

ESTIMATED PRESSURE FIELD EXTENSION:

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X

PRESSURE MONITORING POINT: PMP-0X

INDOOR AIR SAMPLE LOCATION: IA-0X

Figure 29

[redacted] (CP-023-04)

Floor Plan and VIMS Layout

1"=10'

0 5' 10' 15'

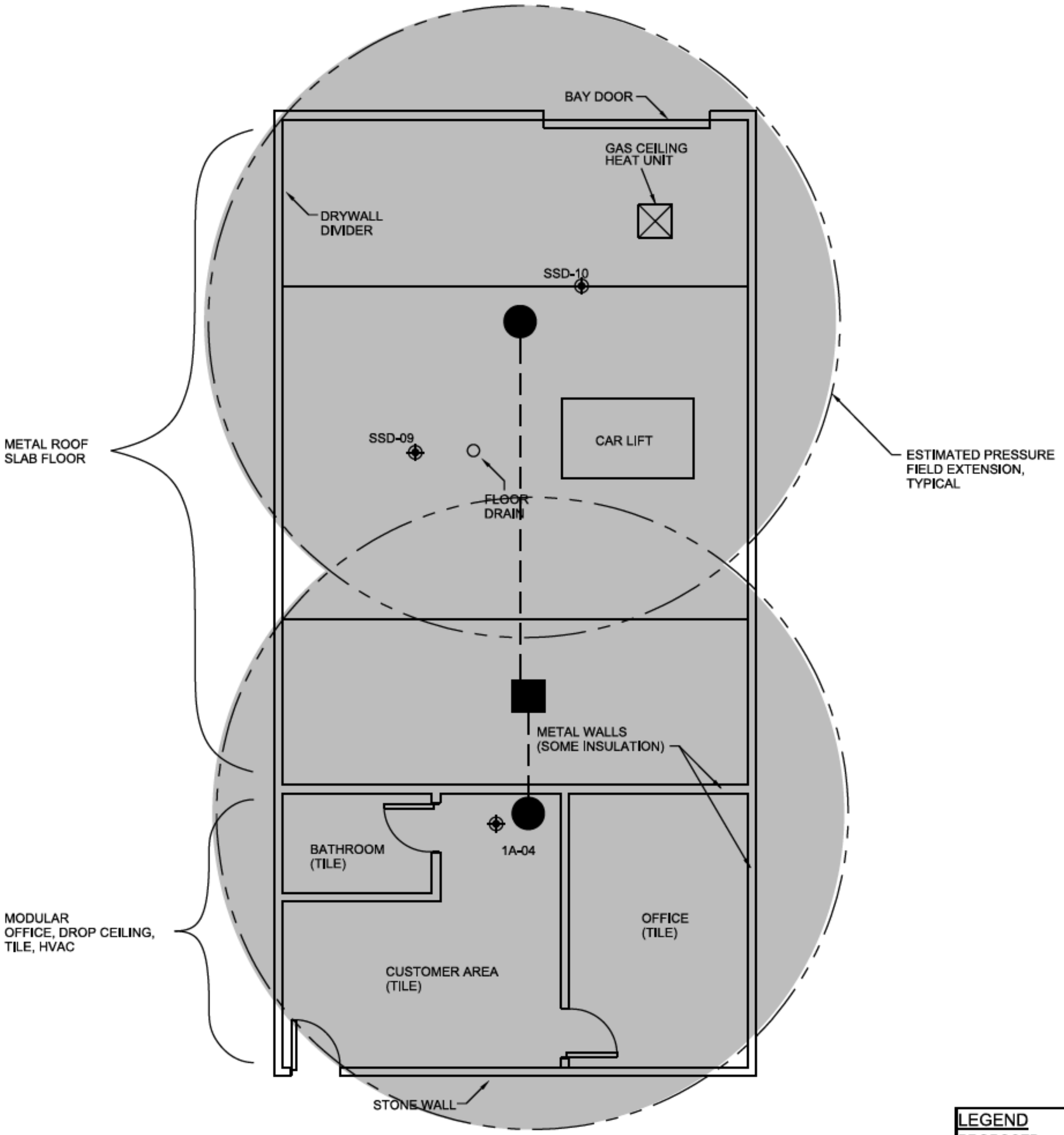
1"=10'

N

NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS



LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: — —

ESTIMATED PRESSURE FIELD EXTENSION:

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X

PRESSURE MONITORING POINT: PMP-0X

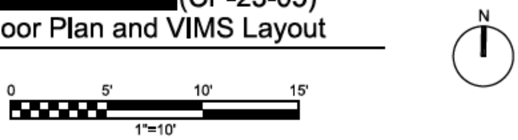
INDOOR AIR SAMPLE LOCATION: IA-0X

Figure 30

[redacted] (CP-23-05)

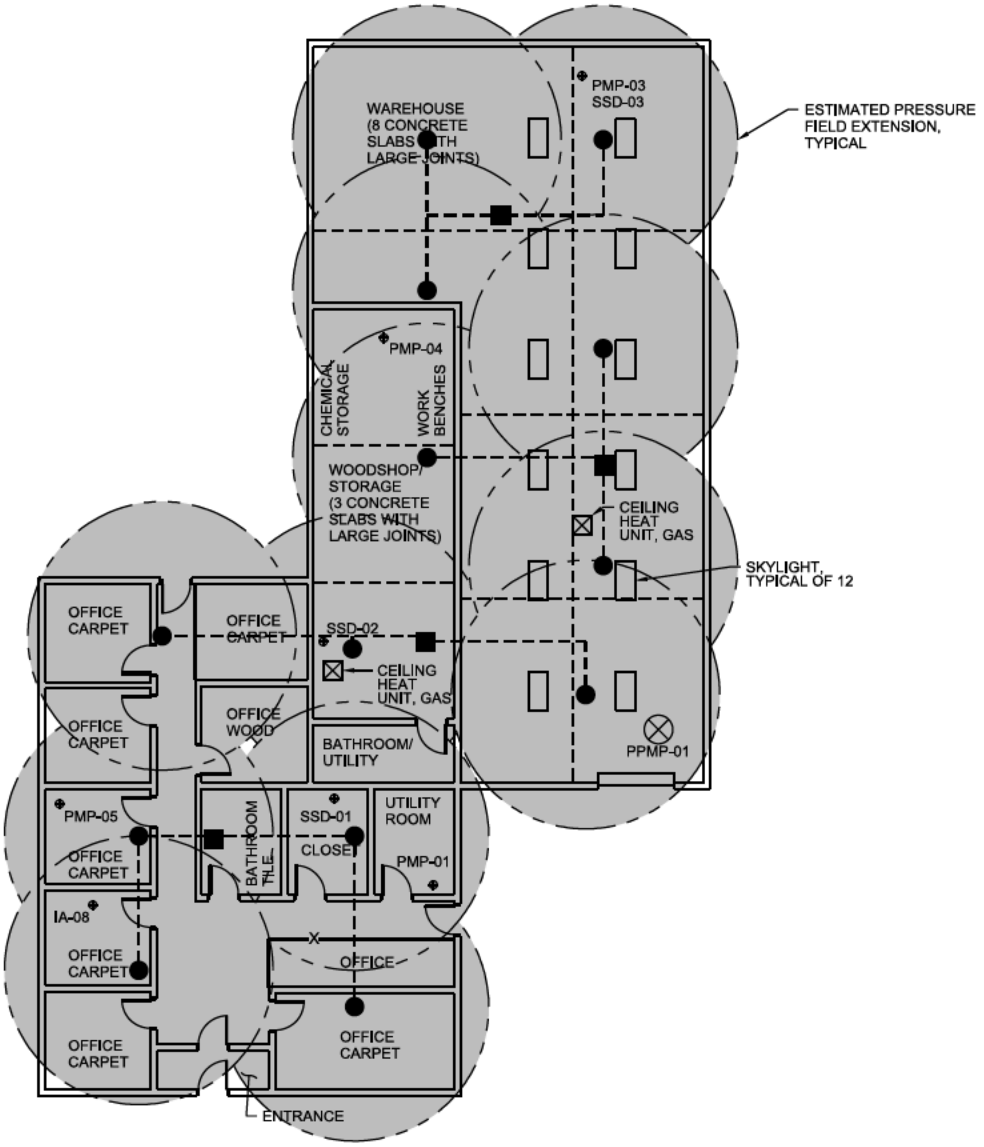
Floor Plan and VIMS Layout

1"=10'



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana



NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 31

[redacted](CP-024)

Floor Plan and VIMS Layout

1"=20'

N

0 10' 20' 30'

1"=20'

Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: - - - -

ESTIMATED PRESSURE FIELD EXTENSION:

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

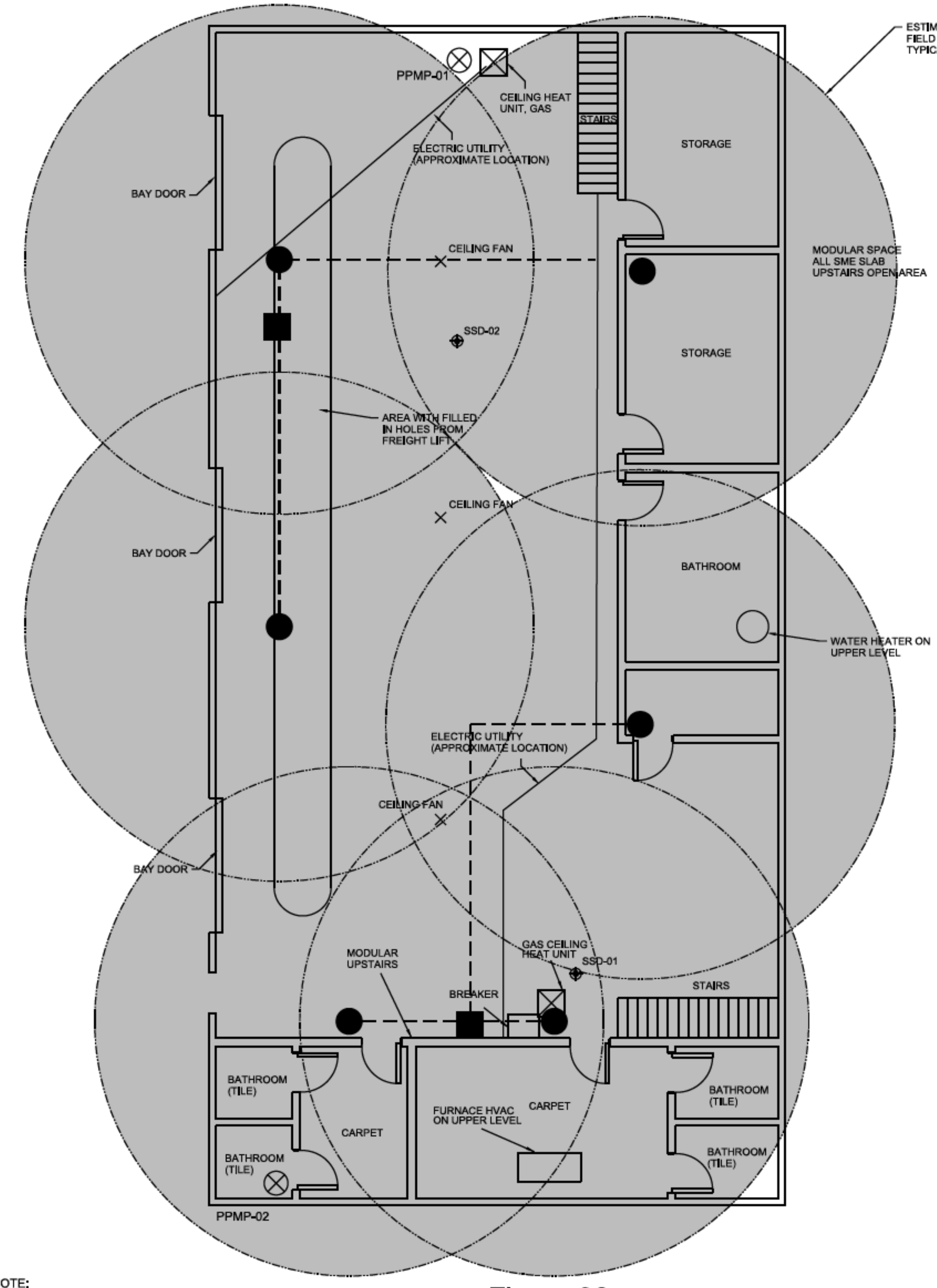
EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X ⊕

PRESSURE MONITORING POINT: PMP-0X ⊕

INDOOR AIR SAMPLE LOCATION: IA-0X ⊕

JACOBS



LEGEND

PROPOSED

NODE: ●

FAN: ■

CONVEYANCE: — —

ESTIMATED PRESSURE FIELD EXTENSION: ▨

PROPOSED PRESSURE MONITORING POINT: ⊗ PPMP-0X

EXISTING

DIAGNOSTIC TESTING SUBSLAB DEPRESSURIZATION POINT: SSD-0X

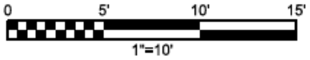
PRESSURE MONITORING POINT: PMP-0X

INDOOR AIR SAMPLE LOCATION: IA-0X

NOTE:
1. WALL THICKNESSES AND SOME INTERIOR DIMENSIONS ARE APPROXIMATE.

Figure 32
[redacted] (CP-027)
Floor Plan and VIMS Layout

1"=10'



Northern Extent Analysis Area
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

JACOBS

Tables

Table 1. July 2019 CP-016 Diagnostic Testing
Commercial Property 016
Keystone Corridor Contaminated Groundwater Site, Indianapolis, Indiana

Date	Time	Differential Pressure (in $H_2$0)	Temperature ˚Farenheit	Test Node Velocity (ft/min)				Flow Rate (cfm)	Vacuums (total)	PID Reading (ppmv)	Differential Pressure Measurements at Subslab Soil Gas Monitoring Probes (in $H_2$0)																
				Far Side Wall	Middle	Near Side Wall	Average				PMP-01	PMP-02	PMP-03	PMP-04	PMP-05	PMP-06	PMP-07	PMP-08	PMP-09	PMP-10	PMP-11	PMP-12	PMP-13	PMP-14	PMP-15	PMP-16	PMP-17
Distance from PMP to Node:																											
CP016-SSD-01											30		15	53	23	35		98	83	87	114	135	154	127			
31-Jul-19	13:40	-4.21	81.1	6535	5695	5285	5838	127	2	0.7	-0.0093	-0.020	-0.036	-0.021	-0.024	-0.021	-0.3100	-0.0015	-0.00098	-0.0015	-0.0008	-0.00353	0.00108	-0.00022			
	13:55	-4.21	81	6535	5695	5285	5838	127	2																		
	14:15	-1.12	81.2	3110	2790	2835	2912	64	1		-0.0019	-0.0072	-0.0110	-0.0168	-0.0083	-0.0102	-0.1410										
	14:30	-1.12	81	3110	2790	2835	2912	64	1																		
CP016-SSD-02											132		130					20	34	51	17	18	39	36	59	61	63
31-Jul-19	11:12	-35.08	79.2	3715	3835	3575	3708	81	2	10.1	-0.00026	-0.0025	0.00069					-0.0351	-0.00509	-0.013	-0.0296	-0.0965	-0.00796	-0.0185	-0.0205	-0.00326	-0.00499
	11:40	-35.05	79	3715	3835	3575	3708	81	2																		
	11:42	-8.58	78.8	1400	1345	1445	1397	30	1									-0.0150			-0.00887	-0.0308		-0.00583	-0.005		
	11:49	-3.75	79.1	735	725	715	725	16	1																		
	11:54	-8.55	78.7	1405	1345	1455	1402	31	1																		
	11:56	-3.75	79	735	725	710	723	16	1																		
CP016-SSD-03											164		170					63	80	70	43	39	14	31	29	27	17
31-Jul-19	10:26	-14.95	78.6	5490	5120	4985	5198	113	2	4.3	0.00261	0.0076	0.00434					-0.0019	-0.0002	-0.00551	-0.00168	-0.00738	-0.0019	-0.00469	-0.021	-0.0095	-0.0393
	10:45	-14.9	78.3	5495	5120	4980	5198	113	2																		
	10:46	-4.6	78.1	2370	2010	2095	2158	47	1																-0.0113		-0.0232
	10:55	-4.6	78.5	2370	2010	2095	2158	47	1																		

Notes:
Data collected on March 6, 2019 correspond to preliminary tests conducted at B137-SSD-02 and B137-SSD-03. No preliminary test was conducted at B137-SSD-01.
Test node vacuum and velocity measured in 2 inch inner diameter manifold. Velocity shown correspond to velocity in the center of the manifold.
in $H_2$0 = inches of water
ft/min = feet per minute
cfm = cubic feet per minute
ppmv = parts per million by volume
NR - No measurement collected
* Value of -8.30 in $H_2$0 corresponds to reading immediately prior to decreasing the shop vac extraction vacuum and flow velocity by mixing ambient air downgradient of the measurement manifold.
† Velocity measurements collected at the beginning and the end of the test.

Table 2. July 2019 CP-017 Diagnostic Testing

Commercial Property 017

Keystone Corridor Contaminated Groundwater Site, Indianapolis, Indiana

Date	Time	Differential Pressure (in H_20)	Temperature °Farenheit	Test Node Velocity (ft/min)				Flow Rate (cfm)	Vacuums (total)	PID Reading (ppmv)	Differential Pressure Measurements at Subslab Soil Gas Monitoring Probes (in H_20)							
				Far Side Wall	Middle	Near Side Wall	Average				PMP-01	PMP-02	PMP-03	PMP-04	PMP-05	PMP-06	PMP-07	PMP-08
Distance from PMP to Node:																		
CP017-SSD-01 (Basement)													**20**	**56**	**18**	**28**	**28**	**48**
30-Jul-19	09:25	-17	78.6	2560	2575	2995	2710	59	1	50.3			-0.084	-0.008	-0.108	-0.005	-0.001	-0.023
	10:12	-16.5	78.4	2770	2605	3115	2830	62	1									
	10:15	-7.5	78.1	1130	1225	1250	1202	26	1				-0.0379	-0.0051	-0.0472	-0.0025	-0.0012	-0.0103
	10:32	-7.5	78	1145	1235	1255	1212	26	1									
	10:40	-29.2	78.2	4450	4350	4235	4345	95	2				-0.0137	-0.0123	-0.1760	-0.0106	-0.0030	-0.0370
	10:55	-29.1	78	4455	4365	4250	4357	95	2									
CP017-SSD-02 (1st Floor)													**34**	**14**	**29.5**	**18**	**41**	**25**
30-Jul-19	11:10	-50.44	78.1	820	835	785	813	18	1				-0.0028	-0.0101	-0.0037	-0.0092	-0.0017	-0.0095
	11:28	-50.4	78	820	830	785	812	18	1									
	11:32	-53.7	78	1250	1200	1100	1183	26	2	9.3			-0.00344	-0.0100	-0.00509	-0.0120	-0.00143	-0.0074
	11:55	-56.01	78.3	950	1050	925	975	21	2					-0.0125		-0.0145		
CP017-SSD-03 (1st Floor)													**37**	**16**	**22**	**24**	**24**	**6.4**
30-Jul-19	12:30	-54.38	78	40	300	270	203	4	2	14.3			-0.0036	-0.0060	-0.0036	-0.0029	-0.0053	-0.0339
	12:45	-54.35	78	40	310	300	217	5	2									

Notes:

Test node vacuum and velocity measured in 2 inch inner diameter manifold. Velocity shown correspond to velocity in the center of the manifold.

in H_20 = inches of water

ft/min = feet per minute

cfm = cubic feet per minute

ppmv = parts per million by volume

NR - No measurement collected

Table 3. July 2019 CP-018 Diagnostic Testing

Commercial Property 018

Keystone Corridor Contaminated Groundwater Site, Indianapolis, Indiana

Date	Time	Differential Pressure (in $H_2$0)	Temperature °Farenheit	Test Node Velocity (ft/min)				Flow Rate (cfm)	Vacuums (total)	PID Reading (ppmv)	Differential Pressure Measurements at Subslab Soil Gas Monitoring Probes (in $H_2$0)								
				Far Side Wall	Middle	Near Side Wall	Average				PMP-01	PMP-02	PMP-03	PMP-04	PMP-05	PMP-06	PMP-07	PMP-08	PMP-09
Distance from PMP to Node:																			
CP018-SSD-01											12	61	46	75	50	22	17	25	40
26-Jul-19	09:55	-22	77.1	1420	1460	1575	1485	32	1	35.2	-0.0013	-0.0032	-0.0021	-0.0023	-0.0029	-0.0032	-0.0017	-0.0020	-0.0045
	10:25	-23.5	77.3	1555	1565	1590	1570	34	1	NR									
29-Jul-19	15:35	-40.1	80.2	1715	1770	1920	1802	39	2	NR	-0.0154	0.0060			-0.0035	-0.0101	-0.0208		
	15:55	-40	80	1730	1775	1925	1810	39	2	NR									
CP018-SSD-02											72	32	73	39	30	28	44	42	68
26-Jul-19	08:30	-30	73.7	397	408	455	420	9	1	31	-0.00025	-0.0025	-0.00145	-0.0016	-0.0013	-0.0011	-0.0026	-0.0075	-0.0005
	09:10	-30	77.5	410	420	450	427	9	1	NR									
	09:15	-13	77.3	180	240	193	204	4	1	NR		-0.00025					-0.00019		
29-Jul-19	14:48	-52.34	80.1	454	490	535	493	11	2	NR	-0.0034	0.0068		-0.0004		-0.0023			
	15:05	-52.34	80.2	459	510	535	501	11	2	NR									
CP018-SSD-03											44	77	22	63	60	43	26	26	12
26-Jul-19	10:48	-12	77.2	3010	2580	2650	2747	60	1	44.6	-0.0031	-0.0038	-0.0078	-0.0034	-0.0020	-0.0004	-0.0075	-0.0110	-0.0204
	11:30	-12	77.5	2935	2615	2930	2827	62	1	NR									
29-Jul-19	16:00	-17.13	80.5	4875	5115	4620	4870	106	2	NR			-0.0168	-0.0038			-0.0025	-0.0251	-0.0245
	16:15	-17.1	80.3	4870	5135	4625	4877	106	2	NR									

Notes:

Test node vacuum and velocity measured in 2 inch inner diameter manifold. Velocity shown correspond to velocity in the center of the manifold.

in $H_2$0 = inches of water

ft/min = feet per minute

cfm = cubic feet per minute

ppmv = parts per million by volume

NR - No measurement collected

Table 4. July 2019 CP-024 Diagnostic Testing

Commercial Property 024

Keystone Corridor Contaminated Groundwater Site, Indianapolis, Indiana

Date	**Time**	**Differential Pressure (in H_20)**	**Temperature °Farenheit**	**Test Node Velocity (ft/min)**				**Flow Rate (cfm)**	**Vacuums (total)**	**PID Reading (ppmv)**	**Differential Pressure Measurements at Subslab Soil Gas Monitoring Probes (in H_20)**				
				Far Side Wall	**Middle**	**Near Side Wall**	**Average**				**PMP-01**	**PMP-02**	**PMP-03**	**PMP-04**	**PMP-05**
Distance from PMP to Node:															
CP024-SSD-01											8	20	90	50	35
26-Jul-19	10:35	-1.45	82.1	3245	2980	3005	3077	67	1	12.1	-0.1060	-0.2340	-0.1500	-0.0053	-0.0207
	10:50	-1.47	80.9	3355	3255	3335	3315	72	1	NR					
1-Aug-19	09:40	-4.49	80.1	5985	5955	5925	5955	130	2	NR	-0.1870	-0.0234	-0.0010	-0.0021	-0.0260
	09:47	-4.49	80	5990	5955	5915	5953	130	2	NR					
	09:48	-1.28	80	3285	3150	3120	3185	69	1	NR	-0.0982	-0.0127			-0.0131
	09:55	-1.26	80	3285	3155	3120	3187	70	1	NR					
CP024-SSD-02											15.2	13	56	28	28
26-Jul-19	09:50	-7.8	80.7	3010	3095	2965	3023	66	1	14.5	-0.0058	-0.3080	-0.2270	-0.2050	-0.0034
	10:00	-7.8	80.5	3095	3075	2980	3050	67	1	0.6					
1-Aug-19	09:00	-12.24	80.2	5150	5115	5050	5105	111	2	NR	-0.0098	-0.5650	-0.0060	-0.0158	-0.0058
	09:12	-12.92	80.2	5150	5050	4955	5052	110	2	NR					
	09:15	-6.8	80.1	3220	3250	3150	3207	70	1	NR		-0.2880			

Notes:

Test node vacuum and velocity measured in 2 inch inner diameter manifold. Velocity shown correspond to velocity in the center of the manifold.

in H_20 = inches of water

ft/min = feet per minute

cfm = cubic feet per minute

ppmv = parts per million by volume

NR - No measurement collected

Charts

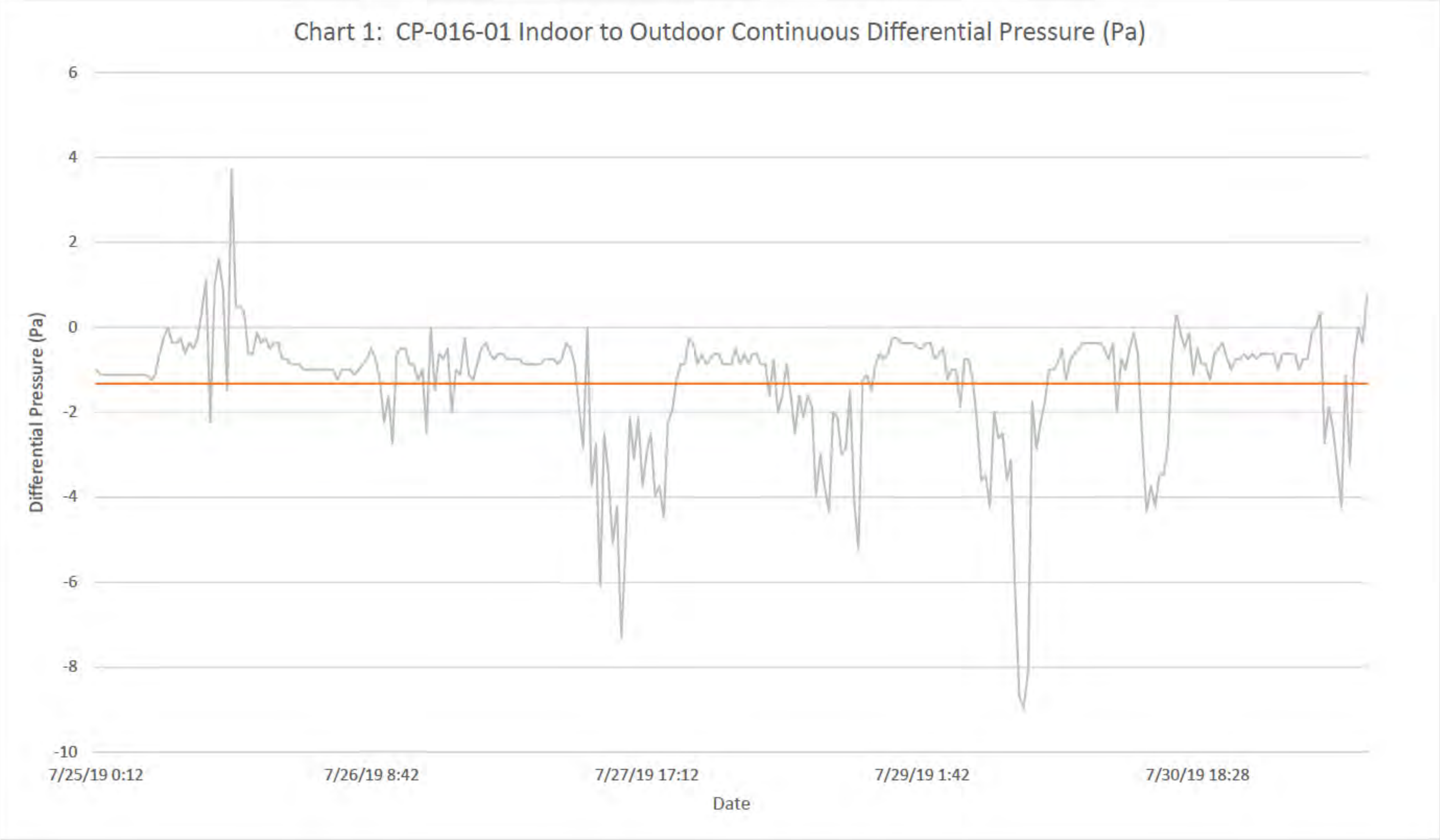


Chart 1: CP-016-01 Indoor to Outdoor Continuous Differential Pressure (Pa)
6
4
2
0
-2
-4
-6
-8
-10
Differential Pressure (Pa)
7/25/19 0:12
7/26/19 8:42
7/27/19 17:12
7/29/19 1:42
7/30/19 18:28
Date

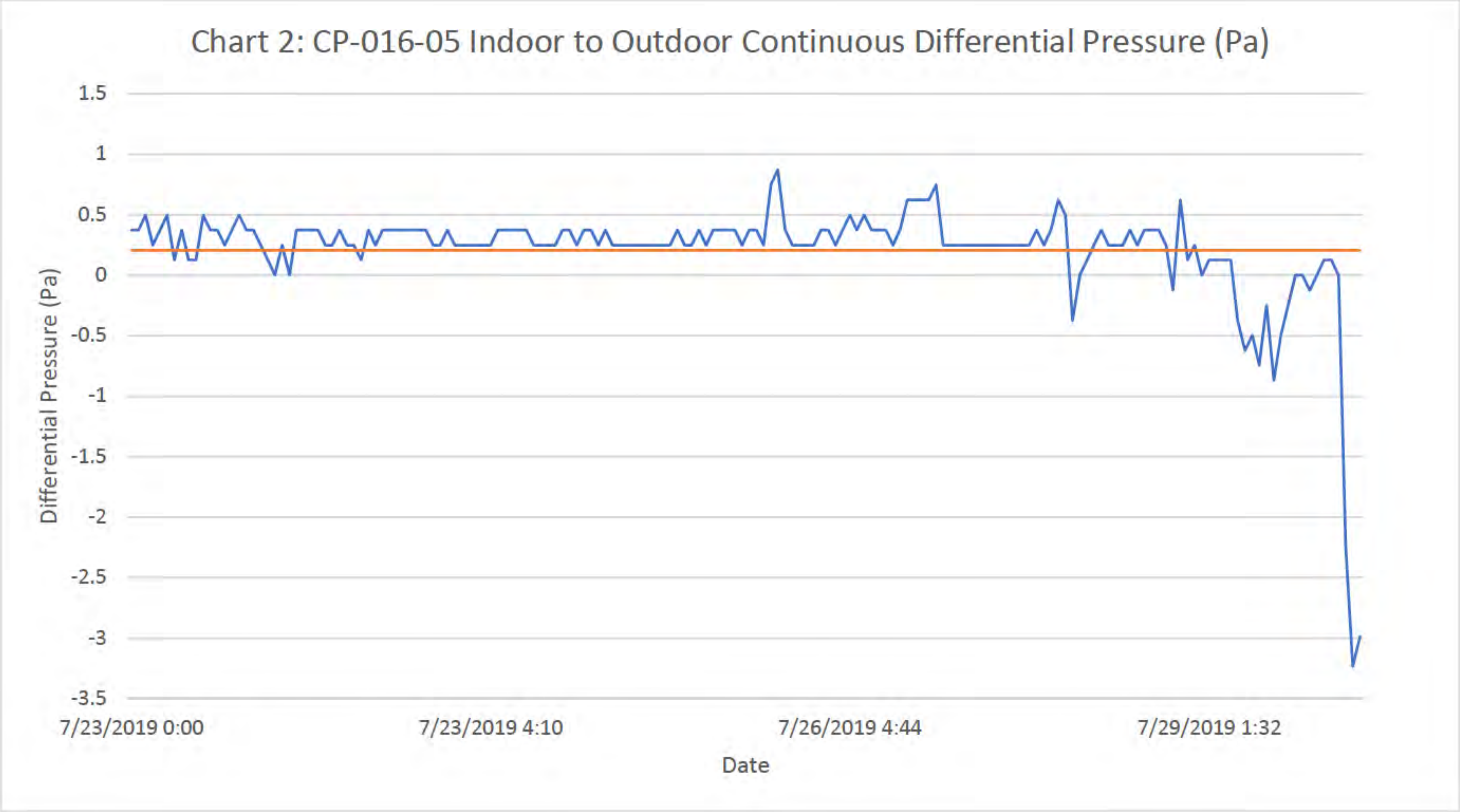


Chart 2: CP-016-05 Indoor to Outdoor Continuous Differential Pressure (Pa)
Differential Pressure (Pa)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
7/23/2019 0:00
7/23/2019 4:10
7/26/2019 4:44
7/29/2019 1:32
Date

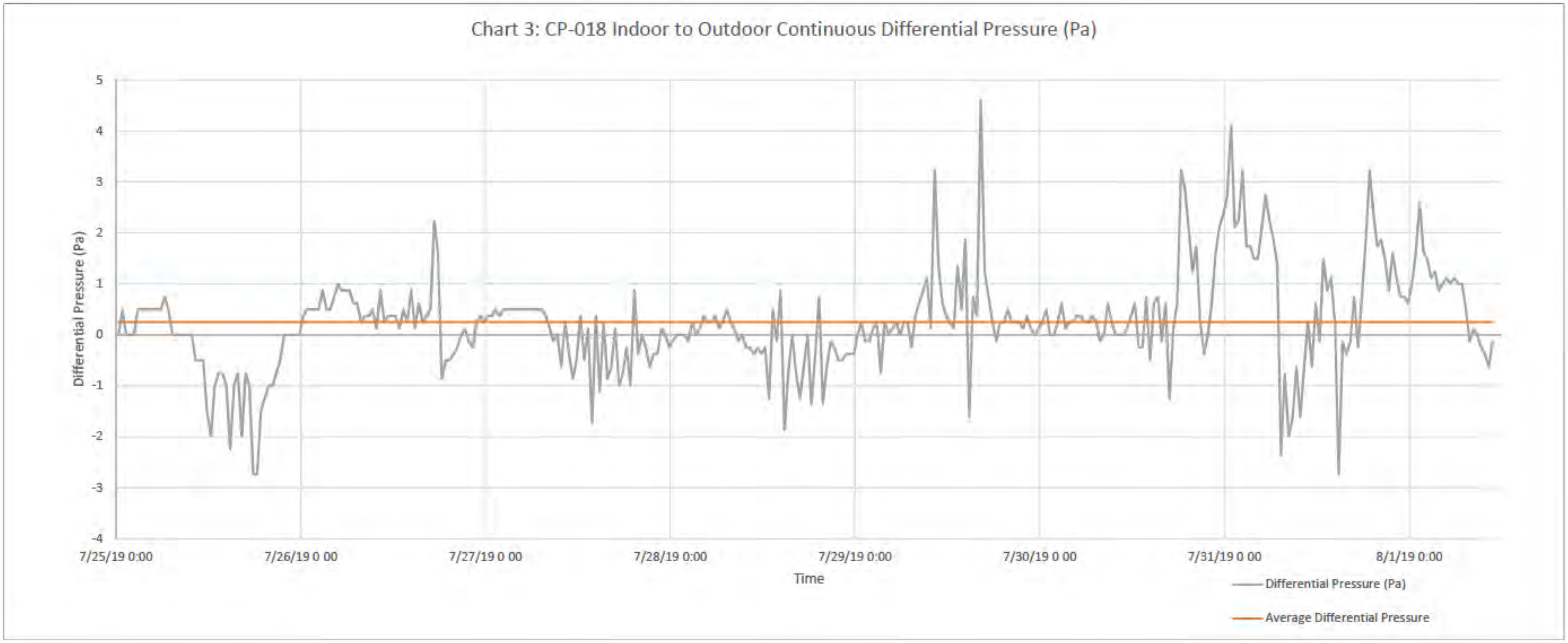


Chart 3: CP-018 Indoor to Outdoor Continuous Differential Pressure (Pa)
Differential Pressure (Pa)
5
4
3
2
1
0
-1
-2
-3
-4
7/25/19 0:00
7/26/19 0 00
7/27/19 0 00
7/28/19 0:00
7/29/19 0:00
7/30/19 0 00
7/31/19 0 00
8/1/19 0:00
Time
Differential Pressure (Pa)
Average Differential Pressure

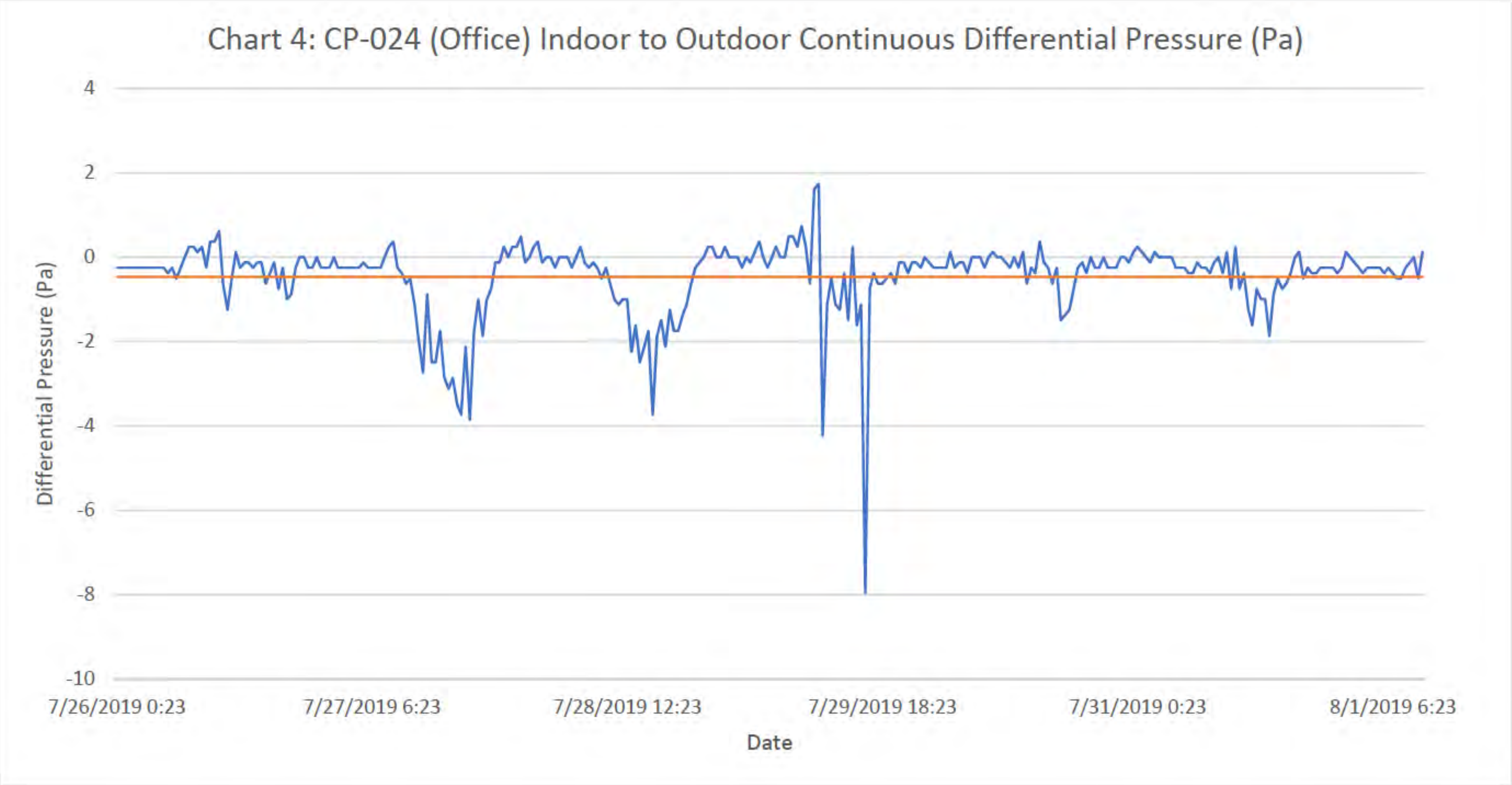


Chart 4: CP-024 (Office) Indoor to Outdoor Continuous Differential Pressure (Pa)
Differential Pressure (Pa)
4
2
0
-2
-4
-6
-8
-10
7/26/2019 0:23
7/27/2019 6:23
7/28/2019 12:23
7/29/2019 18:23
7/31/2019 0:23
8/1/2019 6:23
Date

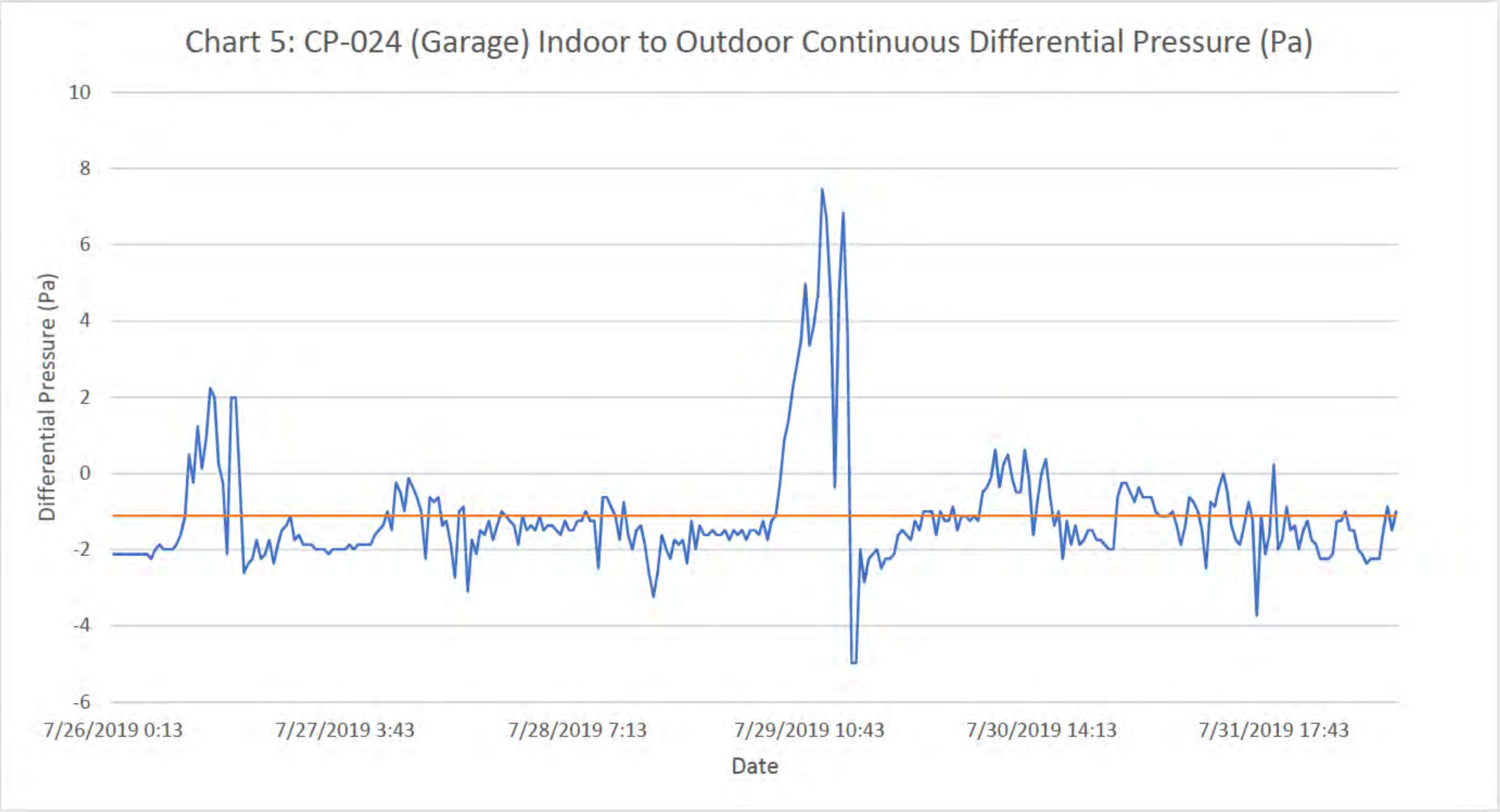


Chart 5: CP-024 (Garage) Indoor to Outdoor Continuous Differential Pressure (Pa)
Differential Pressure (Pa)
10
8
6
4
2
0
-2
-4
-6
7/26/2019 0:13
7/27/2019 3:43
7/28/2019 7:13
7/29/2019 10:43
7/30/2019 14:13
7/31/2019 17:43
Date

Appendix A
Statement of Work

Statement of Work
Vapor Intrusion Mitigation System Construction
Keystone Corridor Groundwater Contamination Site
Marion County, Indiana

1.0 Introduction

This Statement of Work (SOW) is for the construction of vapor intrusion mitigation systems (VIMS) for eight (8) commercial/industrial structures (including 18 commercial addresses) located at the Keystone Corridor Ground Water Contamination Site (herein referred to as "the Site"). This SOW is part of the Site Conceptual Performance-Based Remedial Design (CPBRD) being completed by CH2M HILL, Inc. (CH2M) on behalf of the United States Environmental Protection Agency (EPA) Region 5. The CPBRD was prepared to meet the requirements of the Record of Decision (ROD) for the which was issued by EPA in September 2018. In the ROD, EPA identified the installation of VIMS as a preemptive mitigation measure for vapor intrusion of chlorinated volatile organic compounds (CVOCs).

2.0 Site Description

The Keystone Corridor Ground Water Contamination Site is located in Indianapolis, Marion County, Indiana. The Site consists of a contaminated groundwater plume underlying both active and inactive industrial, commercial, and residential properties. As presently defined, the center of the Site is designated as the intersection of Keystone Avenue and East Fall Creek Parkway North Drive. The approximate boundaries are 45th Street on the north, Eastern Avenue on the east, 38th Street on the south, and Norwaldo Avenue on the west. The municipal Fall Creek Station Well Field, as well as multiple, independent potential sources of groundwater contamination, some of which is commingled, are located within the Site. The Site location is shown on Figure 1.

2.1 History of Investigations and Response Actions

IDEM began addressing soil and groundwater contamination along Keystone Avenue in 1989 when elevated levels of VOCs were detected in two soil borings collected near an underground tank on the former Tuchman Cleaners property located at 4401 North Keystone Avenue. The Tuchman Cleaners facility operated from 1952 through 2008 and used PCE, generated PCE waste, and had several PCE releases on the property. Due to elevated levels of contaminants found on the property, a contractor for the former property owner installed a soil vapor extraction system and groundwater pump and treat system in 1990, followed by a non-aqueous phase liquid (NAPL) recovery system in 2003 to remove PCE which had accumulated beneath the property.

Additional investigations were subsequently completed at the adjacent Vantage Point Cleaners property located at 4405 Allisonville Road, the Purtee Plating facility located at 2306 East 44th Street, and the Thomas Catering property located at 4440 North Keystone Road.

In early July 2008, National Drycleaners, Inc., the parent company of Tuchman and Tuchman Cleaners, Inc., declared Chapter 11 Bankruptcy. As of that date, all remedial efforts at the Tuchman Cleaners property ceased.

In October 2009, IDEM performed a Site Investigation for the Keystone Corridor Site during which elevated levels of PCE were detected in the groundwater and soil samples. In November 2011, IDEM conducted an Expanded Site Inspection across the Keystone Corridor Site. Elevated levels of PCE and TCE were detected in soil and groundwater samples. In addition, vinyl chloride was detected in one municipal drinking water well at the Fall Creek Station, which eventually resulted in that well being taken out of service.

As a result of the above investigations, the IDEM state cleanup program held numerous discussions with potentially responsible parties, including Tuchman Cleaners, Vantage Point Cleaners, Thomas Caterers, and Purtee Plating, regarding soils and groundwater contaminated with PCE and TCE. After the Tuchman Cleaners' parent company declared bankruptcy and the Fall Creek municipal drinking water well was found to be impacted, IDEM requested EPA's assistance with a removal action at Tuchman Cleaners.

From September 2012 to December 2014, EPA conducted a time-critical removal action at the former Tuchman Cleaners property. EPA excavated more than 2,550 tons of contaminated soil and two underground storage tanks from the property. Due to the historical presence of NAPL, the recovery of which was discontinued in July 2008, EPA also sampled soil vapor in the residential neighborhood to the east and conducted testing at more than 40 residential properties to determine if vapor intrusion was occurring. As a result, during the removal action EPA installed active vapor mitigation systems at 22 residential properties where vapor intrusion was found to be occurring. EPA recognized that chlorinated VOCs would continue to threaten the Fall Creek Station municipal well field and that a long-term response action was needed.

In December 2013, EPA added the Site to the National Priorities List (NPL). Listing on the NPL allows federal Superfund funding for investigation and remedial action cleanup work.
In June and July 2014, EPA enforcement personnel evaluated approximately 40 known users or handlers of chlorinated solvents located within the Fall Creek Station's well head protection area based on a modeled one-year time-of-travel in groundwater. Seven potential source properties were initially identified, and EPA obtained access to sample six of them: the former Vantage Cleaners, the former Tuchman Cleaners, Thomas Catering, Purtee Plating, Lumberman's Wholesalers, and S&K Laundry, which is located approximately 0.75 miles south of Tuchman Cleaners. The RI/FS work began in the fall of 2015 and was completed in 2019.

2.2 Vapor Intrusion Investigation During RI

From December 2015 to March 2017, EPA collected groundwater, soil vapor, subslab soil vapor, and indoor air (including crawl space) samples to characterize Site conditions and determine the nature and extent of contamination. The RI report included analytical results and multiple lines of evidence which demonstrated that several properties likely have a current complete vapor intrusion pathway or the potential for a future complete vapor intrusion pathway due to impacts from PCE and TCE in groundwater.

Based on multiple lines of evidence, the RI concluded that there is a potential for vapor intrusion of Site-related COCs from contaminated groundwater to indoor air to occur at the Site at concentrations that represent a potential threat to human health. A potential vapor intrusion area of concern was identified based on a conservative estimate using soil vapor sample results in excess of the residential soil vapor VISL.

Based on the RI, three residences in the area (RP-039, RP-047, and RP-49) were found to have both a complete vapor intrusion pathway and Site-related contamination in indoor air at concentrations exceeding RMLs. EPA decided that an immediate response action was warranted, and those three properties were addressed by an EPA time- critical removal action. Additionally, eight industrial/commercial multi-unit buildings were found to have Site-related contamination in indoor air and/or subslab samples at concentrations exceeding both VISLs and RMLs. These buildings were identified for pre-emptive mitigation as described in this conceptual remedial design.

To pre-emptively mitigate those eight industrial/commercial multi-unit buildings, EPA implemented an interim remedy. The interim remedy includes the additional sampling, testing, design, and installation of vapor intrusion mitigation systems. The Final ROD for OU-3, to address the vapor intrusion pathway, was issued in September 2018.

2.3 Conceptual Site Model

Contamination at the site is in the alluvium of the Fall Creek Valley that is characterized by predominantly three hydrostratigraphic units that include a shallow outwash interval (predominantly sand and gravel), an intermediate interval composed primarily of silt or clay and silt, and a deeper outwash interval (also primarily sand and gravel). These units are present above limestone bedrock that was not investigated as part of the RI, although the alluvium is hydraulically connected to the bedrock aquifer. Additionally, while groundwater grab samples were collected in the deeper interval, which found few impacts above screening levels, there are few groundwater monitoring wells in the deep interval, which limited a study of the interaction between the deep interval and bedrock at this time.

Contamination is present north and south of Fall Creek, which appears to act as a hydraulic barrier to groundwater flow in the shallow interval. The majority of contaminant mass (sum of all CVOCs detected in groundwater) is present in the area north of Fall Creek.

Impacts are primarily noted in the shallow interval outwash and as soil vapor located primarily above the shallow groundwater plumes extending several hundred feet up- and downgradient of the plumes. Impacts occurred due to releases of chlorinated solvents (DNAPL) that migrated vertically to groundwater then primarily laterally within the shallow interval. Downward vertical migration into the intermediate and deep intervals are generally impeded by the low-permeability of the intermediate silt or silt/clay interval and an upward vertical gradient noted between the intermediate and shallow interval. Portions of the intermediate interval were observed locally to be unsaturated, further indicating discontinuous limitations to vertical transport. However, concentrations of PCE and identified DNAPL screened in an outwash lens present in the intermediate clay beneath Tuchman, indicate that DNAPL may still be present and impacting groundwater in the intermediate and deep intervals primarily beneath and immediately downgradient of this property. While removal efforts were conducted on the Tuchman property prior to the RI, residual source material still appears to be present. In addition, concentrations of PCE in vadose zone soil were detected at each of the six sampled potential source properties above SSLs protective of groundwater.

The presence of TCE indicates that there is some transformation of PCE occurring. However, further transformation of parent compounds to cis-1,2-DCE and VC is limited, and natural attenuation data does not present evidence that reductive dechlorination processes are significant. The presence of cis-1,2-DCE and VC in three of the municipal bedrock wells indicate that conditions in the bedrock aquifer, or upgradient of the bedrock aquifer in the deep interval, support degradation.

Due to the volatility of the CVOCs, migration and subsequent intrusion of vapors into buildings, VI has been identified as a primary exposure pathway for human health concerns. During the RI, VIMS were still operating on the western end of the groundwater and vapor plumes.

2.4 VIMS Locations and Structure Types

Figure 1 shows the locations of the eight (8) commercial structures, including 18 business addressed, at which VIMS will be installed. The VIMS are expected to perform as preemptive mitigation until a ground water remedy, which is in the RD phase, has greatly reduced ground water concentrations and effectively removed the mechanism for vapor intrusion into structures. The commercial structures at which VIMS will be installed primarily consist of slab on grade foundations, except for CP-017-02 which contains a partial basement. Full building details are included in **Appendix B** of the Conceptual Remedial Design.

3.0 Scope of Work

CH2M requires Subcontractor assistance to construct VIMS and perform diagnostic testing at eight (8) structures at the Keystone Site. The proposal submitted in response to this solicitation shall include the following information:

- Completed bid form.
- A comprehensive technical and management approach, including site specific concerns, to accomplish the work. The Subcontractor's technical approach will be incorporated into the Remedial Action Work Plan (RAWP) and Site Specific Health and Safety Plan (SSHASP).
- A proposed schedule for completing the work.
- The anticipated personnel and equipment required to complete the work; include Subcontractors if used.
- A statement of any exceptions or assumptions that have been taken to this SOW.
- Other information as required by this SOW.

The Bidder shall carefully examine the site-specific information provided herein in order to determine the full extent of the work required to make the completed work conform to the bid requirements.
The Bidder shall satisfy himself as to the nature and location of the work, site conditions, the type and condition of the structures to be mitigated, and the character of equipment and facilities needed to complete the work as described by in this SOW.

4.0 Technical Specifications

This section provides the technical approach for the onsite activities included in this SOW.
The Subcontractor shall furnish all labor, equipment, travel, materials, supplies, and all else necessary to completely perform the scope of work identified herein. All work shall be completed in compliance with current federal, state, and local regulations and in accordance with standard industry practice. Work will require Occupational Safety and Health Administration (OSHA) 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training.

The construction of VIMS at eight (8) structures will include the following work tasks.

- Mobilization and site preparation
- Preparation of submittals during and after construction
- VIMS installation at eight (8) commercial structures
- System activation including balancing of the negative pressure field

- System commissioning including one round of baseline measurements and sampling

Additional information regarding each of these tasks is provided below.

4.1 Mobilization/Demobilization and Site Preparation

This task will consist of the mobilization of personnel and equipment to the work site and the establishment of temporary facilities, consisting primarily of equipment laydown and storage areas/trailers and possibly portable sanitary facilities. Prior to beginning site work activities, the Subcontractor shall attend a pre-mobilization meeting at the site.

Each of the locations where VIMS are proposed are within commercial buildings. No extra site security procedures will be put in-place. In cases where the occupants are not present during VIMS construction, Remedial Action Contractor (RAC) and subcontractor personnel will secure the property when leaving the site for supplies, lunch breaks, and at the end of each workday. This will be discussed with the owners and occupants during the site access and coordination phase of the project.

4.2 Preparation of Submittals

The following submittals are required during construction:

- A daily report of all activities at each site, equipment used, personnel who were onsite and the hours worked, a description of the work performed, and any inspection results.
- All material and equipment not specified in this SOW or on the accompanying drawings. Cut sheets shall be submitted for acceptance before it will be allowed to be used on Site.

The Subcontractor shall also obtain the appropriate building, mechanical, and/or electrical permits in compliance with federal, state, and local regulations.

The following submittals are required after construction is complete:

- Manufacturer equipment and specification sheets on materials used in construction
- Equipment user manuals

4.3 VIMS Construction

The tasks required for the installation of the VIMS at each specific structure are described in this section. Site photographs and design detail sheets are included in Appendix B. The following requirements apply to each of the eight (8) structures where VIMS will be installed at the Keystone site.

- The VIMS installation shall be done so as to coordinate with other building components especially those that require maintenance or clearance of any type. All system components shall be installed to facilitate servicing, maintenance and repair or replacement of other equipment components in or outside the building. Where mounting heights are not detailed or dimensions given, system materials and equipment shall be installed to provide the maximum headroom or side clearance as is possible. All systems, materials and equipment shall be installed level, plumb, parallel or perpendicular to other building systems and components unless otherwise specified.
- Every possible precaution shall be taken to avoid any damage to existing utilities located anywhere in the building or those located in or below the slab floor.

- The RAC will be responsible for covering or finishing any piping or electrical conduit that is exposed. All penetrations through foundation walls or floors shall be sealed. There will be no piping or conduit placed that would inhibit maintenance activities in any areas.
- Foreign materials shall not be left or drawn into the system piping or fan which might at a later period interfere with or in any way impair the VIMS performance.
- Entire system shall have Underwriters Laboratory (UL) or equivalent ratings for both individual components and the entire system as applicable.
- For each slab suction node, the Subcontractor shall cut a 5-inch core through the concrete and remove a minimum of five gallons of subslab material. Four-inch diameter polyvinyl chloride (PVC) schedule 40 coupling shall be secured in the top of each suction hole.
- All horizontal pipe runs between the fan and the first suction hole shall be installed with at least 1/8-inch slope back towards the suction hole for each foot of horizontal pipe run. All vertical pipe runs shall be installed plumb. All horizontal pipe runs shall be run with a 1/8-inch slope back towards the fan and ultimately the suction hole. In no case shall the piping be installed so as to create a possible water trap in the piping.
- A flow control ball valve shall be placed on the vertical PVC riser at each SSD node to allow for balancing of the negative pressure field during system commissioning.
- All horizontal pipe runs shall have a support with an appropriate device within 2 feet of each fitting and a maximum distance between supports of 8 feet as per BOCA National Plumbing Code. Galvanized conduit channel with pipe clamps shall be used outdoors to support PVC.
- The pipe shall be supported at least every 6 feet of horizontal run and at least every 8 feet of vertical run.
- Any visible expansion joints or cracks in the slab areas being mitigated that have 1/16-inch or greater opening shall be sealed. Any cracks to be sealed shall be vacuumed to prepare them for installation of gun-grade urethane caulk sealant. Cracks or open expansion joints in the concrete floor shall be sealed by applying a bead of urethane caulk on top of the joint. The gun grade caulk shall then be mechanically pressed down into the crack in order to maximize its seal. Sealants that spill over or drip onto the existing carpet or floor shall be scraped off immediately and then wiped thoroughly using manufacturers requirements for cleanup. Any openings into the slab such as may occur around conduit pipe penetrations through the slab shall be cleaned and sealed with gun-grade urethane caulk.
- The Subcontractor shall install a disconnect switch within 3 feet of each fan and a second switch accessible from the ground. The switch accessible from the ground will also have an indicator light to determine if the fan is operating. All wiring will comply with current National Electrical Code (NEC) requirements
- The Subcontractor shall use outdoor rated flexible conduit from each switch box to the fan. Wiring from the power source to the fan shall be a gauge wire no smaller than allowed for the circuit the power is wired from. A dedicated breaker is not required.
- All mitigation systems that have exposed piping inside the building shall have a magnehelic gauge installed for each system in the vertical section of the pipe inside the building that is the closest vertical pipe to the fan location. A magnehelic gauge with a suitable range for the applied vacuum in inches of water column pressure shall be connected to the final leg of a manifold that is connected to each fan. The purpose is to measure the actual vacuum being applied by the fan. The gauge shall

be mounted indoors with pressure tubing routed to the nearest location of the combined vacuum being applied by the fan.

- All pressure gauge locations shall contain a label with the RAC name, telephone number, installation date and final installation pressure readings. All labels must be readable from 3 feet away. A label shall be installed at each fan disconnect location that says “Soil Gas Fan” or equivalent. A label shall be installed at the main panel electrical disconnect switch that says “Soil Gas Fan” or equivalent.
- The Subcontractor shall measure the pressure difference between the subslab and the space above at the vapor pin locations indicated on the mitigation system drawings. The Subcontractor shall record the system magnehelic gauge readings and the final pressure readings between the subslab and the space above on a copy of each mitigation system drawing. The measurements shall be made with a digital micromanometer capable of reading in units of 0.001-inches or 0.1 pascal (Pa). A copy of these final measurements, including the magnehelic gauge measurements, will be maintained by the RAC and the Owner.
- A general materials list, including fan performance curves, for material and equipment specified for the individual designs is provided in Appendix D of the Conceptual Performance-Based Vapor Intrusion Mitigation System Remedial Design (CH2M, 2019).
- Following VIMS installation, the owners will be responsible for protecting and repairing any system component from rodent damage, or from any other activities that could damage the VIMS components.

The tasks required for the installation of the VIMS at each specific structure are provided below.

4.3.1 PVC Piping Installation

As shown in the design drawings in Appendix B of the Conceptual Performance-Based Vapor Intrusion Mitigation System Remedial Design (CH2M, 2019). A 4-inch PVC coupling shall be secured to the slab and then sealed with urethane caulking. Then, 4-inch schedule 40 PVC piping shall be routed through the drywall ceiling into the attic for the one peaked roof or on the roof for flat roofs. Exhaust will be vented in accordance to state and local guidance. Penetrations shall be sealed with off-white urethane caulking. PVC piping secured against wood framing shall have a piece of backer rod placed between the pipe and the framing to minimize fan vibration transfer to the wood framing. A rubber boot shall be used to connect the PVC piping to the fan. Common roof pipe flashing and screened cap will be installed in accordance with state and local guidance.

4.3.2 System Performance Indicator Installation

A magnehelic gauge in the range of the applied vacuum (i.e., capable of at least 0.020-in. water column) shall be installed in the PVC riser in a location accessible from the ground in each SSD node. Flexible tubing shall be routed from the magnehelic gauge to the fittings in the PVC piping.

4.3.3 Fan Installation

In the attic for each building with a peaked roof, a RadonAway HS2000 fan or equivalent shall be in a vertical position on the PVC piping using rubber plumbing connection boots. For buildings with flat roofs, a RadonAway HS2000 fan or equivalent shall be installed in a vertical position on the PVC piping using rubber plumbing connection boots on the roof. A single electrical gang box with a single pole switch (labeled “Soil Gas Fan”) shall then be installed within eyesight of the fan. The electrical power source shall be obtained from each building where that particular fan is located.

4.3.4 Post-Implementation Pressure Field Testing

After the fan is activated and all slab sealing has been completed, the pressure differential shall be measured between the subslab and the building interior using a digital micromanometer. The pressure readings on the PVC nodes shall be recorded. If the pressure difference under the slab is less than negative 0.020-inches of water column, the measurements will be recollected after a minimum of 72 hours. This will ensure that system performance is not temporarily disrupted by an irregular condition, such as an unusually high water table. If the pressure difference under the slab is less than negative 0.020-inch of water column during the second event, the depressurization fan shall be switched to the next larger size, and pressure field testing shall repeated. The final differential pressure shall be reported in the construction completion report.

4.3.5 Subslab Depressurization System Installation

VIMS will be installed based on the recommendations in Section 5 and on system layouts presented in Figures 8-32 of the Conceptual Performance-Based Vapor Intrusion Mitigation System Remedial Design (CH2M, 2019). If operating parameters are not met, contingency plan 1 and 2 may be implemented as needed.

4.4 System Activation

Once the systems have been constructed, the fans shall be turned on and the VIMS shall begin to draw soil gas from the subslab area of the structures. This is the only step that is required to activate the VIMS.

4.5 System Commissioning

Following construction, the systems shall be turned on and allowed to operate for an initial operating period of 72 hours. Following this initial operating period, baseline pressure measurements and flow measurements shall be collected to evaluate the system effectiveness. These measurements will include subslab to indoor air differential pressure measurements, applied vacuum measurements at each SSD node and fan/blower, and air flow measurements at each node and fan. The negative pressure field shall be balanced to obtain the 0.020-in. water column differential pressure at all subslab measurement ports.

Should this diagnostic testing identify that any of the VIMS are not achieving the designed pressure difference, additional system components such as additional SSD nodes or more or larger mitigation fans shall be required to meet depressurization requirements for each structure.

5.0 Project Schedule

Subcontractor shall provide whatever resources necessary to complete the scope of work within the timeframe presented in the final project schedule developed for the project. Work is limited to daylight hours with work on the weekends acceptable as needed. The Subcontractor is requested to state in the proposal the estimated duration of performing the various major tasks required to complete Subcontractor’s work, including all submittals, and the total estimated duration of performing the total project. This information shall be provided in the form of a project schedule indicating all tasks to complete the work, long lead time items, and indicating the sequence of work.

5.1 Period of Performance

The period of performance is anticipated to be 90 days from award of subcontract.

6.0 References

CH2M HILL, Inc. (CH2M). 2019*. Draft Conceptual Vapor Intrusion Mitigation System Remedial Design For Keystone Corridor Groundwater Contamination Site, Marion County, Indiana*. September.

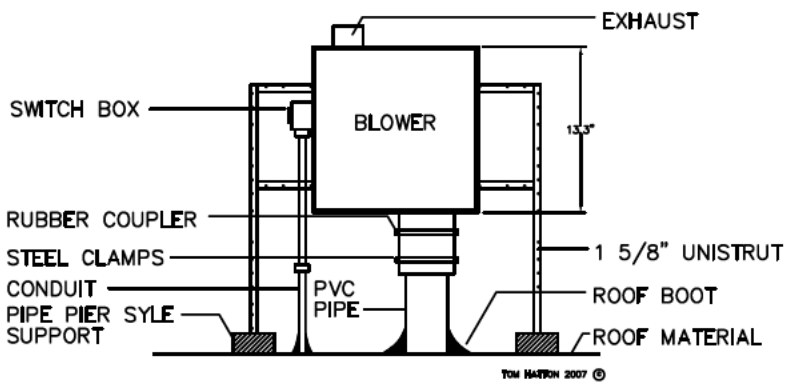
U.S. Environmental Protection Agency (EPA). 2018. *Proposed Plan, Keystone Corridor Groundwater Contamination Site, Operable Unit 3, Indianapolis, Indiana*. March.

U.S. Environmental Protection Agency (EPA). 2018b. *EPA Superfund Program, Record of Decision, Keystone Corridor Groundwater Contamination Site, Indianapolis, Marion County, Indiana*. September.

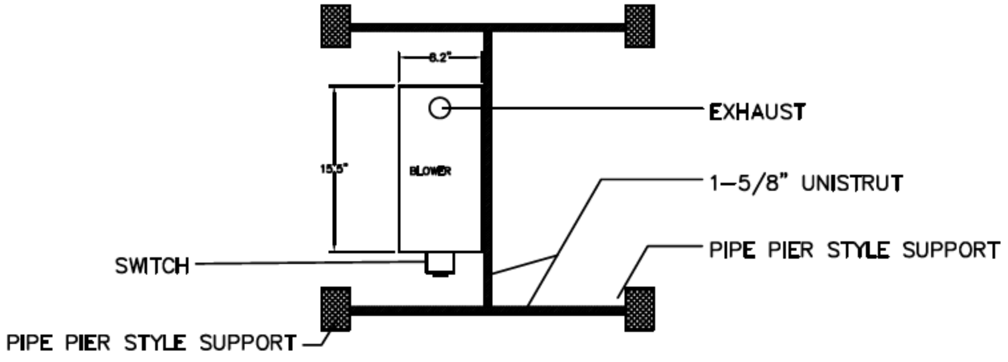
Appendix B

Design Details, Cutsheets, and Fan Performance Curves

RADONAWAY SERIES FANS

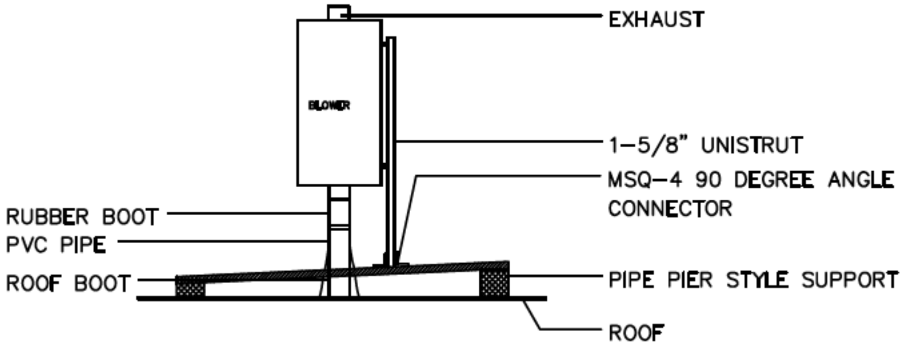


FRONT VIEW



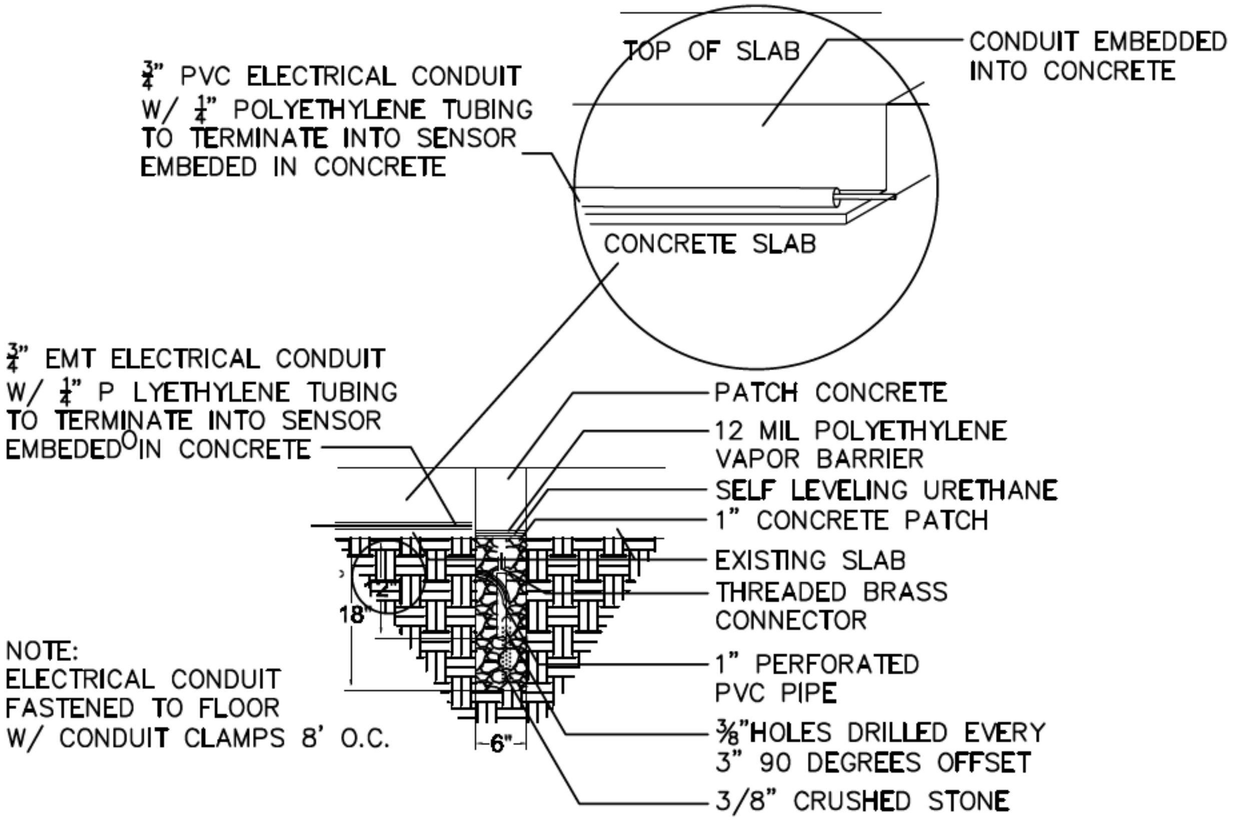
TOP VIEW

NTS



SIDE VIEW

[redacted]



NOTE:
ELECTRICAL CONDUIT FASTENED TO FLOOR W/ CONDUIT CLAMPS 8' O.C.

SUB SLAB PRESSURE PROBE DETAIL

EQUIPMENT SCHEDULE

- I. Vapor Vent Piping
  - a. Schedule 80 PVC ASTM D-2467
  - b. PVC Schedule 40 pipe and fittings ASTM D-2665
    - i. Hollow Core PVC is not permissible
  - c. PVC cement clear primer will comply with ASTM F-656
  - d. PVC cement adhesive will comply with ASTM D-2564
  - e. 3 inch inline PVC slide valves (Valterra Bladex)
- II. Piping Support and Hardware
  - a. 3" Hanging Pipe Supports
  - b. Adjustable swivel ring or standard bolt type clevis hangers
  - c. Adjustable band hangers
  - d. 3/8" threaded rod
  - e. 1/2" threaded rod
  - f. Conduit clamps
  - g. Assorted bolts, nuts, & washers
  - h. 1 5/8" C-Profile Galvanized Unistrut
  - i. 1 3/16" C-Profile galvanized Unistrut
- III. Vapor Blower
  - a. RadonAway HS2000 Series Fans
- IV. Blower Support Frames
  - a. 1 5/8" C-Profile Galvanized Unistrut
  - b. Dura Block BlockTM Unistrut supports
- V. Visual Pressure Indicator and Protective Enclosure
  - a. Dwyer Magnetic (range to be determined)
  - b. Hoffman Enclosures
- VI. Sealing Materials
  - a. Gun Grade Urethane Caulk (Vulkem 116)
  - b. Flowable Urethane Caulk (Vulkem 45SSL)

Note: Hilti is the suggested manufacturer of fastening products and fire collars

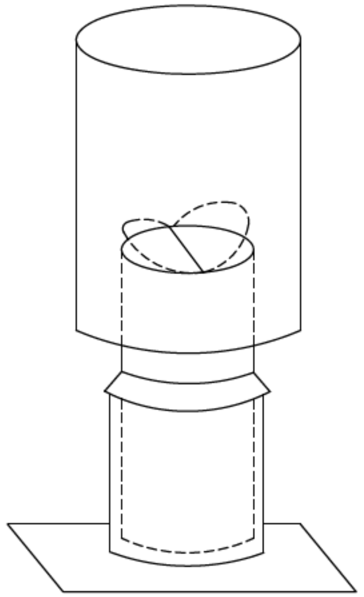
*Original drawing – Clean Vapor LLC

CONCEPTUAL PERFORMANCE-BASED
VAPOR INTRUSION MITIGATION SYSTEM REMEDIAL DESIGN
KEYSTONE CORRIDOR GROUNDWATER CONTAMINATION SITE
MARION COUNTY INDIANA

REVISION AS-BUILTS	DATE
DRAWN BY	
APPROVED	
SCALE	
CHECKED BY	

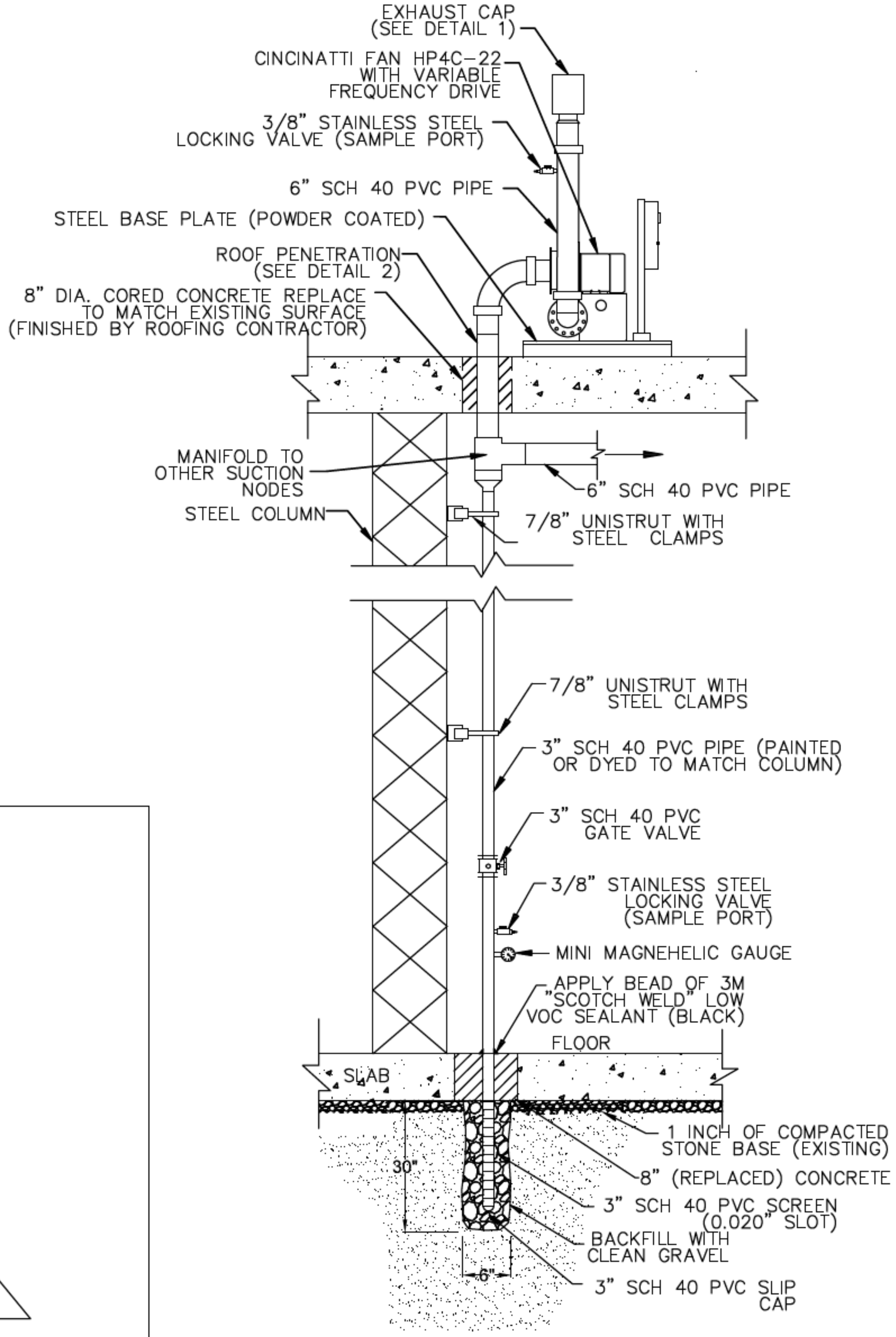
SHEET TITLE
MECHANICAL DETAILS

SHEET NO.


STACK CAP (GALVANIZED STEEL) TO INCLUDE BUTTERFLY DAMPER AND CONCENTRIC GUTTER TO PREVENT RAIN INTRUSION WITH UNOBSTRUCTED VERTICAL FLOW.

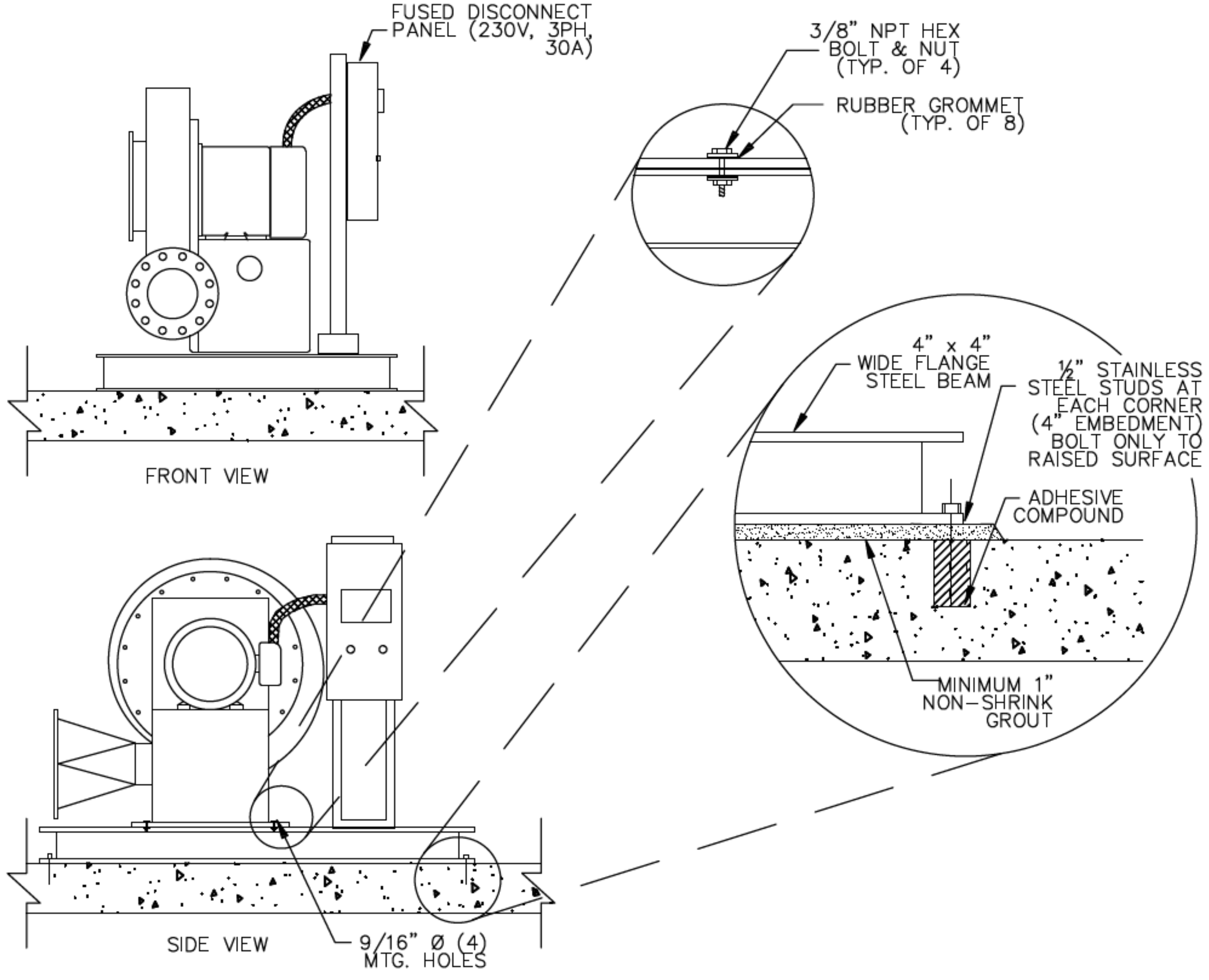
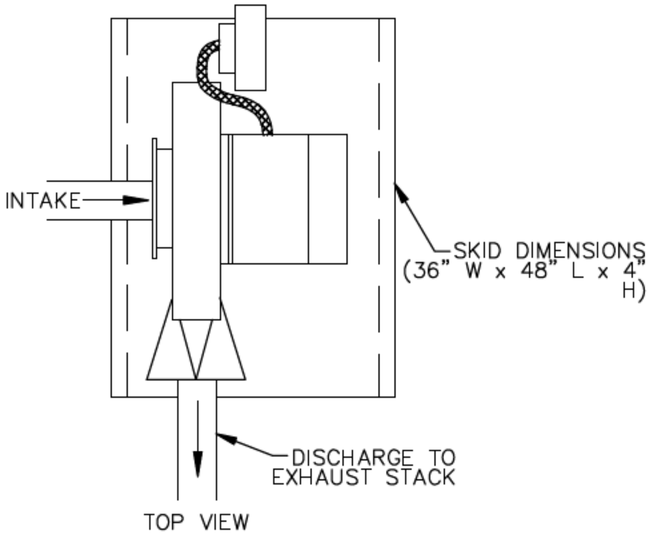
DETAIL 1: EXHAUST CAP

NOT TO SCALE



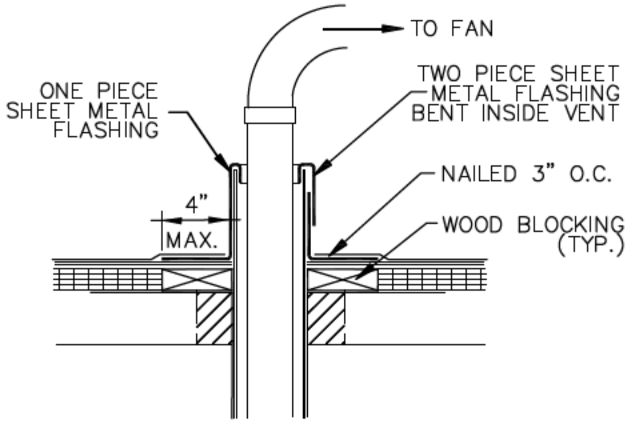
ROOF MOUNT FAN AND SUCTION NODE PROFILE VIEW (TYPICAL)

NOT TO SCALE

FAN ROOF MOUNTING

NOT TO SCALE



DETAIL 2: ROOF PENETRATION

NOT TO SCALE

CONCEPTUAL PERFORMANCE-BASED
VAPOR INTRUSION MITIGATION SYSTEM REMEDIAL DESIGN
KEYSTONE CORRIDOR GROUNDWATER CONTAMINATION SITE
MARION COUNTY INDIANA

MECHANICAL DETAILS

RadonAway®

The world's leading radon fan manufacturer

HS Series

Radon Mitigation Fan

HS fans offer a proven solution for tough radon mitigation jobs, providing up to 25 times the suction of inline tube fans to deal with sand, tight soil or clay sub-slab material.

Features

- Internal condensate bypass
- Brackets for vertical mounting indoors and outdoors
- Inlet: 3.0" PVC / Outlet: 2.0" PVC
- Weight: 18 lbs.
- Size: 15.5"W x 13.3"H x 8.2"D
- Warranty: 1 year (3-year option available)

MODEL	WATTS	SOUND RATING (dBA)			RECOM. MAX. OP. PRESSURE "WC	TYPICAL CFM* vs. STATIC PRESSURE WC					
		OPEN	1/2	CLOSED		0"	10"	15"	20"	25"	35"
HS2000 with cord	174-307	56.5	56.2	51.9	14	63	37	12	-	-	-
HS3000 with cord	120-250	47.9	48.0	46.2	21	39	30	25	19	-	-
HS5000 with cord	223-385	56.0	55.3	53.1	35	44	37	33	29	25	16
HS2000E with switch box	174-307	56.5	56.2	51.9	14	63	37	12	-	-	-
HS3000E with switch box	120-250	47.9	48.0	46.2	21	39	30	25	19	-	-
HS5000E with switch box	223-385	56.0	55.3	53.1	35	44	37	33	29	25	16

*Made in the USA with U.S. and imported parts.

* CFM measured through suction.

For Further Information, Contact Your Radon Professional:

cincinnati fan

HP

SERIES II

HIGH PRESSURE BLOWERS

7697 Snider Road, Mason, OH 45040-9135

Telephone: 513-573-0600

Visit us at www.cincinnatifan.com for more information.

Cat. No. HP-II-908

Supersedes HP-II-1104

cincinnati fan

A Company That Stands Behind Its Product

Since the founding of **Cincinnati Fan** in 1956, the company's mission has been to provide quality products at competitive prices, backed by dependable service.

This mission is carried out by specializing in the market for industrial air handling products up to 125 HP. But specialization does not mean the product line is small. **Cincinnati Fan** offers a wide variety of standard and customized products, production flexibility, and customer responsiveness.

Cincinnati Fan has over 170 experienced sales engineers across the U.S. and Canada ready to serve your air handling needs.

Cincinnati Fan can provide:

- Technical evaluation for correct performance conditions.
- Review of air stream and ambient conditions that require special attention.
- Selection of proper components to meet required design specifications.
- Selection of proper accessories.

Cincinnati Fan operates in a modern facility specifically designed for world class manufacturing enabling us to build standard products to order, including accessories, and ship within 10-15 working days.

With support like this, you can be sure your **Cincinnati Fan** product will be well-built and will provide maximum dependability and longevity.

Visit us at www.cincinnatifan.com for more information.

SPECIFICATIONS FOR HP SERIES II BLOWERS

Radial bladed pressure blowers shall be Cincinnati Fan HP, Series II, Model ______, Arrangement __________ Capacity: __________ CFM, __________ Static Pressure at standard conditions. Operating conditions: __________°F, __________Ft. Altitude.

Wheels shall be dynamically balanced to assure smooth operation. Fan motor and bearing vibration levels shall not exceed 1.5 mils displacement at 3500 RPM. Shafts shall be turned, ground and polished steel (or stainless steel). All fan shafts shall receive a rust preventive coating prior to shipment. All fans shall be test run at factory before shipping.

All construction gauges shall be as shown in Cincinnati Fan's HP, Series II catalog, page 16. The blower housing shall be continuously welded and supported to minimize pulsation at all conditions. Fan bearings shall be grease-lubricated, heavy-duty, self-aligning ball bearings mounted in cast iron pillow blocks. V-belt drives shall be selected for a minimum of 1.3 times nominal horsepower.

All parts in contact with airstream shall be standard steel, aluminum or stainless steel as specified.

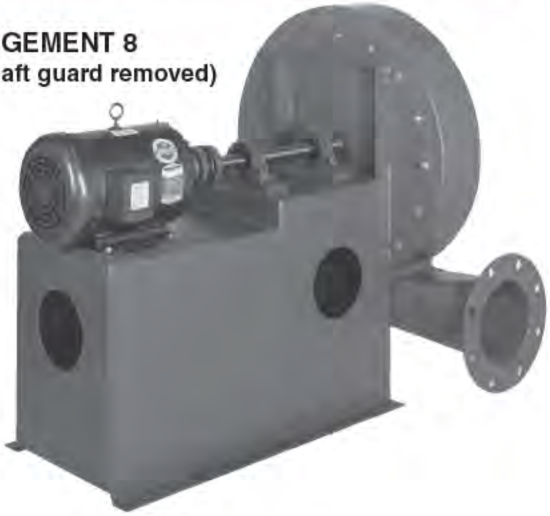
Before painting, steel parts shall be cleaned by detergent wash, phosphatized and painted with oven cured gray enamel.

The following accessories shall be included: (See page 5 for optional accessories).

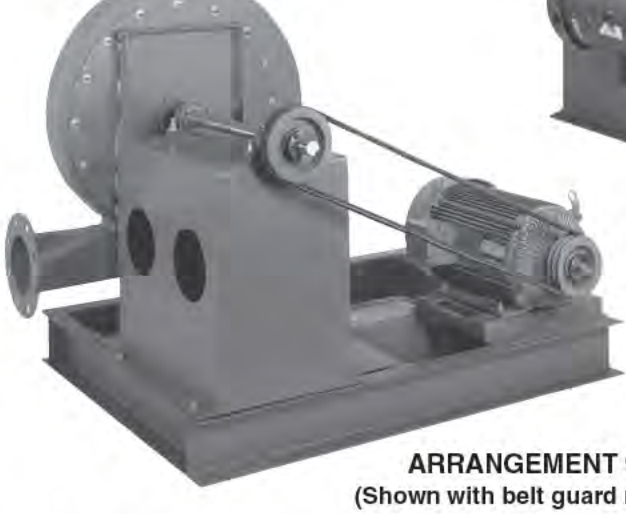
SIX STANDARD ARRANGEMENTS

ARRANGEMENT 1

ARRANGEMENT 8
(Shown with shaft guard removed)



ARRANGEMENT 9
(Shown with optional shaft guard)



ARRANGEMENT 9CB
(Shown with belt guard removed)

ARRANGEMENT 4
(Arrangement 4HM not shown)

ARRANGEMENT 1 (V-BELT DRIVE)

- Motor not mounted on bearing base.
- Wheel mounted on fan shaft with two pillow block bearings.
- Maximum temperature of standard design: 300°F; high temperature design: 750°F.

ARRANGEMENT 8 (DIRECT DRIVE)

- Motor mounted on motor base extending beyond the bearing base.
- Wheel mounted on fan shaft with two pillow block bearings.
- Maximum temperature of standard design: 300°F; high temperature design: 750°F.
- For dimensions, contact your local Cincinnati Fan sales office.

ARRANGEMENT 9 (V-BELT DRIVE)

- Motor mounted on an adjustable slide base on the side of the bearing base.
- Wheel mounted on fan shaft with two pillow block bearings.
- Maximum temperature of standard design: 300°F; high temperature design: 750°F.

ARRANGEMENT 9CB (V-BELT DRIVE)

- Same as Arrangement 9 except motor and fan are mounted on a common channel base.
- Maximum temperature of standard design: 300°F; high temperature design: 750°F.

ARRANGEMENT 4 & 4HM (DIRECT DRIVE)

- Motor mounted on motor base.
- Wheel mounted on motor shaft.
- Maximum temperature of standard design: 200°F; high temperature design: 400°F.
- For arrangement 4HM, see page 16.

HP SERIES II FEATURES

A) Wheels are fabricated of heavy-gauge, high-strength steel to assure long lasting, efficient operation. (Not shown.)

B) Turned, ground and polished shafting assures smooth operation. A rust preventative coating is applied prior to shipment.

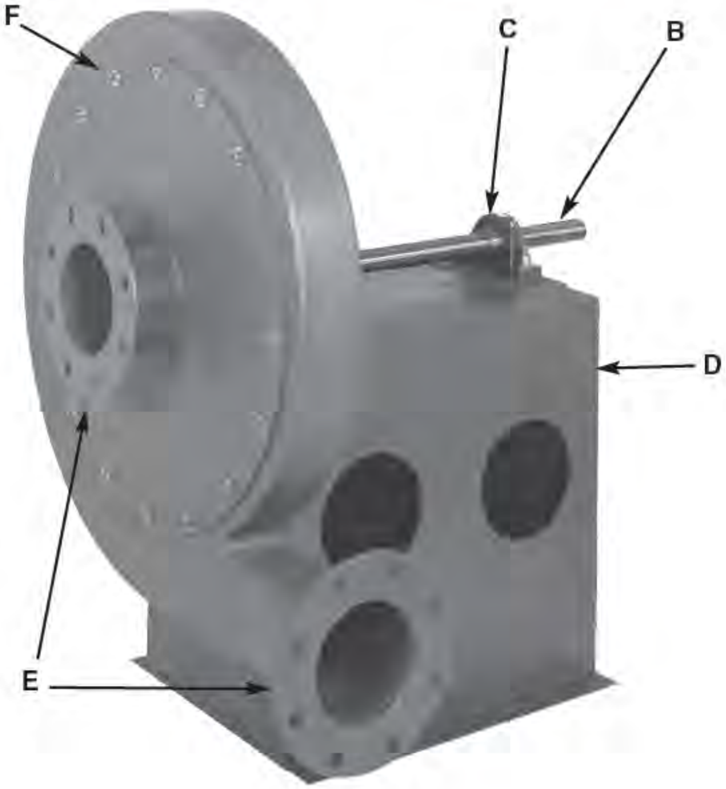
C) Heavy-duty, self-aligning ball bearings in relubricatable cast-iron pillow blocks. Bearings are selected for optimal performance depending on fan size.

D) Bearing base is heavy steel construction with internal supports to maximize rigidity and assure long equipment life. Arrangement #1 fans can be converted to Arrangement #9 with the addition of the motor slide base.

E) Flanged inlet and outlet standard. Drilled per ANSI 125 pound and ASA 150 pound specifications with holes straddling centers. See ★ note on page 18.

F) Reversible housing provides increased configuration flexibility. Removable side plates allow the wheel to be removed from the motor or inlet side of the housing. Housings are rotatable in 45 degree increments.

G) Teflon shaft seal is standard. Ceramic seal is used for applications above 400°F. (Not shown.)



SPARK-RESISTANT CONSTRUCTION

Type A: All parts in contact with airstream are of nonferrous material. **Maximum temperature 200°F.** Consult factory.

Type B: Aluminum wheel and aluminum rubbing ring for motor shaft or fan shaft. **Maximum temperature 200°F.**

Type C: Consists of an aluminum plate on drive side of the fan and aluminum inlet plate assembly. **Maximum temperature 750°F.**

⚠ WARNING

The use of aluminum or aluminum alloys in the presence of steel which has been allowed to rust requires special consideration. Research by the U.S. Bureau of Mines and others has shown that aluminum impellers rubbing on rusty steel may cause high intensity sparking.

The use of the above construction in no way implies a guarantee of safety for any level of spark resistance. Spark resistant construction also does not protect against ignition of explosive gases caused by catastrophic failure or from any airstream material that may be present in a system.

OPTIONAL ACCESSORIES

Belt Guard

Belt guard standard on Arrangement 9 and 9CB only. **Painted safety yellow.**

Drain Connection

3/4" pipe coupling welded to lowest point of housing. Not required on BH discharge position.

Inspection Door

Inspection door available on all sizes except 4A, 4C and 6C. Rubber gasket standard to 250°F. Silicone gasket standard at temperatures of 250°F. to 750°F.

Inlet Bell

With OSHA type guard.

Outlet Guard

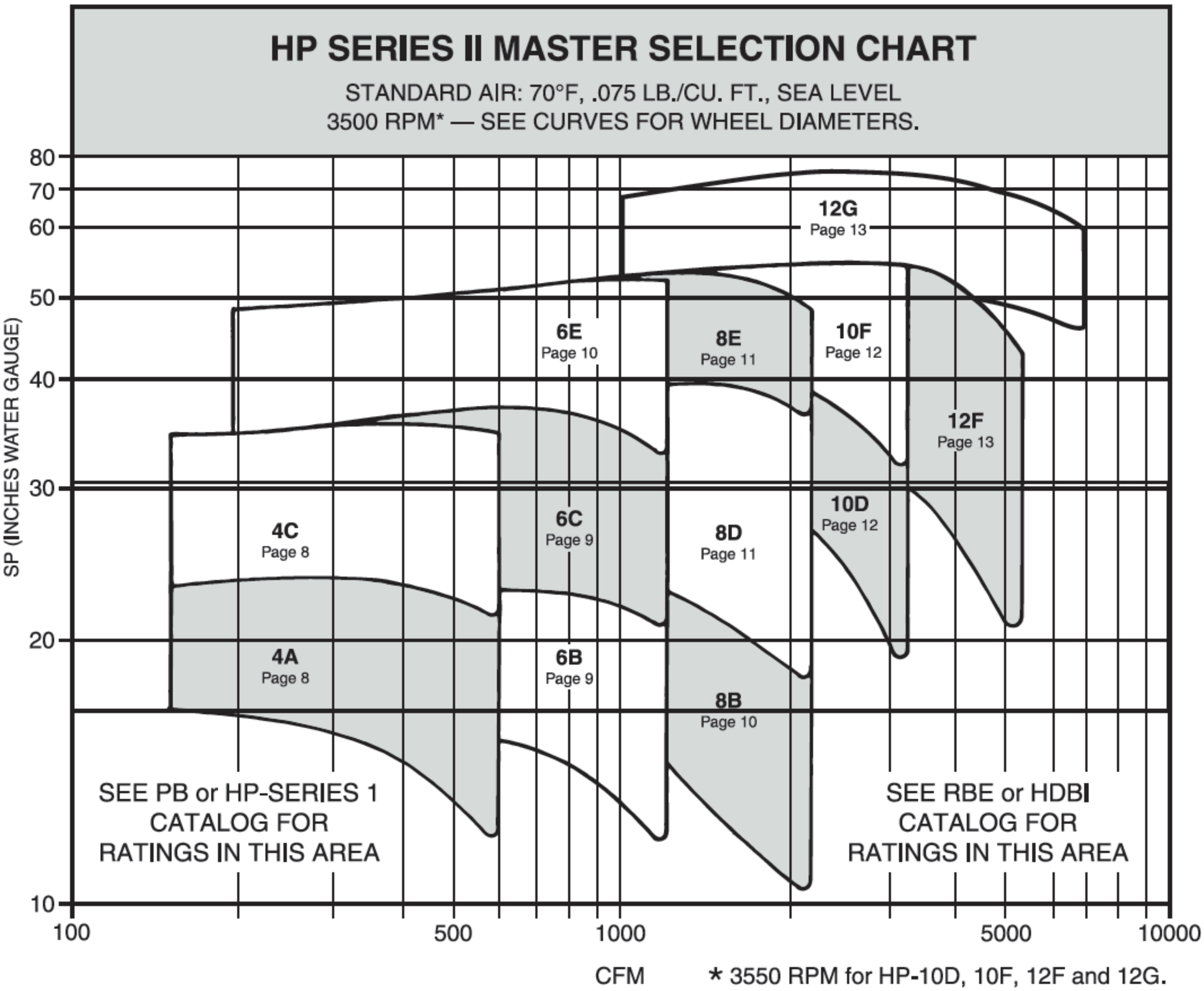
OSHA type.

Shaft and/or Heat Slinger Guard

Guard available on Arrangement 1, 9 and 9CB. Standard on Arrangement 8. Covers bearings and shaft between fan housing and belt guard. Bearings relubricatable through guard. **Painted safety yellow.**

⚠ DANGER

All fans & blowers shown have rotating parts and pinch points. Severe personal injury can result if operated without guards. Stay away from rotating equipment unless it is disconnected or locked out from its power source. Read operating instructions.



HOW TO USE THE MASTER SELECTION CHART

The above chart is intended to guide you to the correct fan for a desired performance rating. This chart was prepared for standard air (70° F., 29.92" Hg barometric pressure and .075 lbs. per cubic foot density.)

All fans were tested with an inlet bell. All performance curves in this catalog are for standard air, at the fan inlet, entering the inlet (whether belled or ducted) with static pressure measured at the discharge.

Corrections are required for temperature and/or altitude and rarefication. See page 7 for correction factors.

Rarefication: When air is pulled into a blower inlet (negative pressure) the air molecules are “stretched out”, or rarefied, and become less dense than at the blower discharge where the air is compressed.

Catalog ratings may be used directly, without correction, for static pressures defined at the fan discharge. For static pressures defined at the fan inlet (i.e., negative pressures), a correction is typically only made for inlet suction pressures greater than 15" W.G. See page 7 for details.

HIGH TEMPERATURE CONSTRUCTION

Arrangements 4 and 4 HM

Up to 200°F. **Standard fan construction.**

201°- 400°F. Standard fan with shaft seal, heat slinger, slinger guard and external hub on wheel.

Arrangements 1, 8, 9 and 9CB

Up to 300°F. **Standard fan construction.**

301°- 400°F. Standard fan with heat slinger and shaft/slinger guard.

401°- 600°F. Standard fan with heat slinger, shaft/slinger guard and high temperature shaft seal, gasketing and paint.

601°- 750°F. Standard fan with heat slinger, shaft/slinger guard, 316SS fan shaft and high temperature shaft seal, gasketing and paint.

TEMPERATURE RANGE	MAXIMUM RPM REDUCTION FACTOR†
Up to 175°F.	0%
176°-200°	2%
201°-300°	4%
301°-400°	7%
401°-500°	11%
501°-600°	15%
601°-700°	20%
701°-750°	30%

† Steel wheels only.

TEMPERATURE - ALTITUDE CONVERSIONS

AIR TEMP. F°	ALTITUDE IN FEET ABOVE SEA LEVEL										
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
0°	.87	.91	.94	.98	1.01	1.05	1.09	1.13	1.17	1.22	1.26
40°	.94	.98	1.02	1.06	1.10	1.14	1.19	1 23	1.28	1.32	1.36
70°	1.00	1.04	1.08	1.12	1.16	1.20	1.25	1.30	1.35	1.40	1.45
80°	1.02	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.48
100°	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.48	1.54
120°	1.09	1.14	1.18	1.23	1.28	1.32	1.38	1.43	1.48	1.53	1.58
140°	1.13	1.18	1.22	1.27	1.32	1.37	1.42	1.48	1.54	1.58	1.65
160°	1.17	1.22	1.26	1.31	1.36	1.42	1.47	1.53	1.59	1.64	1.70
180°	1.21	1.26	1.30	1.36	1.41	1.46	1.52	1.58	1.64	1.70	1.75
200°	1.25	1.29	1.34	1.40	1.45	1.51	1.57	1.63	1.69	1.75	1.81
250°	1.34	1.39	1.45	1.50	1.56	1.62	1.68	1.74	1.82	1.88	1.94
300°	1.43	1.49	1.55	1.61	1.67	1.74	1.80	1.87	1.94	2.00	2.08
350°	1.53	1.59	1.65	1.72	1.78	1.85	1.92	2.00	2.07	2.14	2.22
400°	1.62	1.69	1.75	1.82	1.89	1.96	2.04	2.12	2.20	2.27	2.35
450°	1.72	1.79	1.86	1.93	2.00	2.08	2.16	2.24	2.33	2.41	2.50
500°	1.81	1.88	1.96	2.03	2.11	2.19	2.28	2.36	2.46	2.54	2.62
550°	1.91	1.98	2.06	2.14	2.22	2.30	2.40	2.49	2.58	2.68	2.77
600°	2.00	2.08	2.16	2.24	2.33	2.42	2.50	2.61	2.71	2.80	2.90
650°	2.10	2.18	2.26	2.35	2.44	2.54	2.63	2.74	2.84	2.94	3.04
700°	2.19	2.27	2.36	2.46	2.55	2.65	2.75	2.86	2.97	3.06	3.18
750°	2.28	2.37	2.47	2.56	2.66	2.76	2.87	2.98	3.10	3.19	3.31

Fan performance tables are developed using standard air which is 70°F., 29.92" barometric pressure and .075 lbs. per cubic foot. Density changes resulting from temperature or barometric pressure variations (such as high altitudes) must be corrected to standard conditions before selecting a fan based on standard performance data.

Temperature and/or altitude conversion factors are used in making corrections to standard conditions.

EXAMPLE:

Select an HP Series II fan to deliver 4800 CFM at 30" SP at 160°F., and 7000' altitude.

STEP 1. From the table, conversion factor is 1.53.

STEP 2. Correct static pressure is:
1.53 x 30" SP = 45.9" SP at standard conditions.

STEP 3. Check HP, Series II catalog for 4800 CFM at 45.9" SP. We select a HP12F with a 26" diameter wheel at 3500 RPM and 56 BHP.

STEP 4. Correct the BHP for the lighter air:
56 ÷ 1.53 = 36.6 BHP. A 40 HP motor will suffice at 160° F., and 7000' but not at standard conditions. Special motor insulation may be required above 3500 feet altitude. Consult factory.

SUCTION PRESSURE CORRECTIONS

The two tables at the right give corrected static pressures for suction pressure (rarefication). These corrected static pressures are for standard air (70°F., 29.92" Hg barometric pressure and .075 lbs. per cubic foot density) at the blower inlet.

If the inlet air temperature and/or altitude are different, make those corrections as shown above and then correct for rarefication.

Suction Pressure in Inches W.G.	Corrected Static Pressure
16	16.7
18	18.8
20	21.0
22	23.3
24	25.5
26	27.8
28	30.1
30	32.4
32	34.7
34	37.1
36	39.5
38	41.9
40	44.4
42	46.8

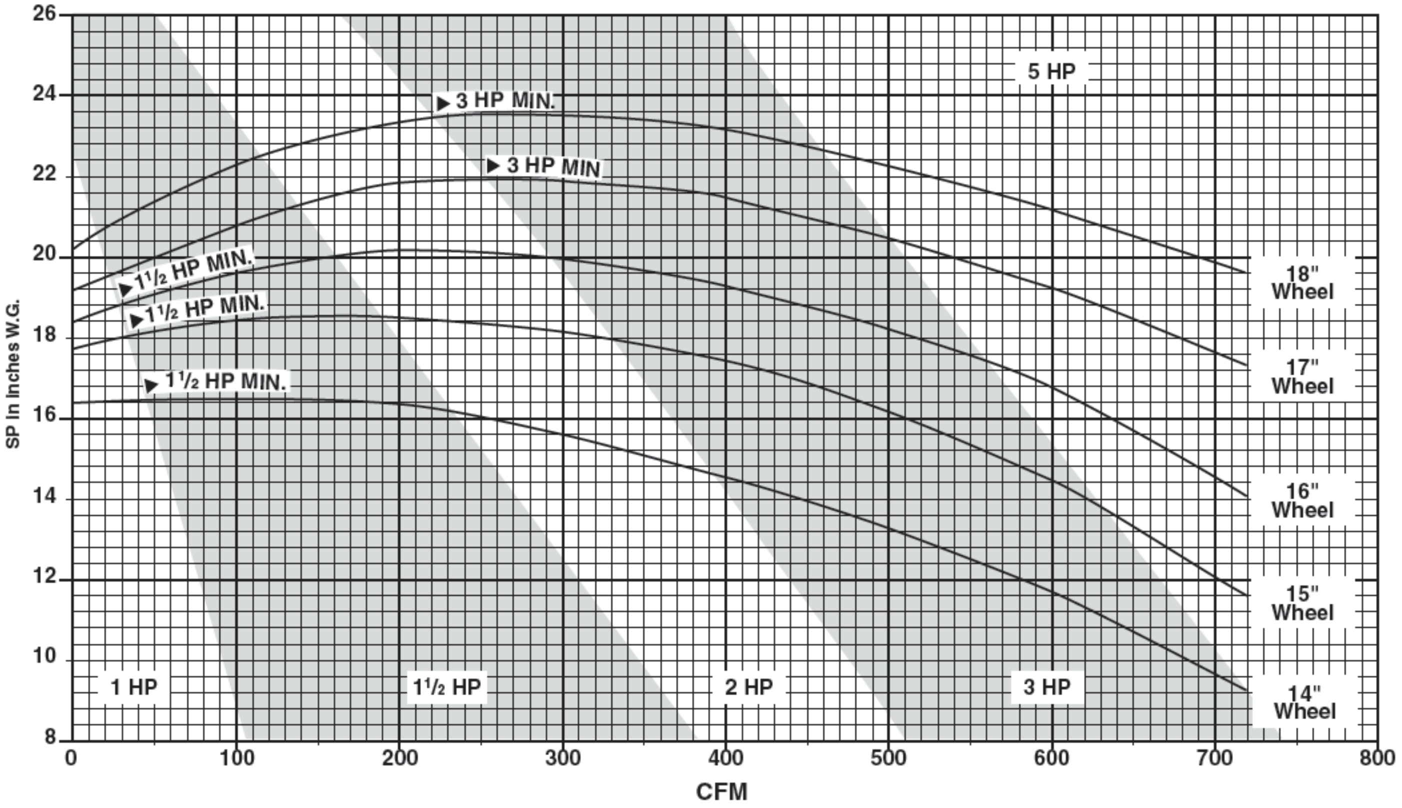
Suction Pressure in Inches W.G.	Corrected Static Pressure
44	49.3
46	51.9
48	54.4
50	57.0
52	59.6
54	62.2
56	64.9
58	67.6
60	70.4
62	73.2
64	75.9
66	78.8
68	81.6
70	84.5

DIRECT DRIVE RATINGS @ 3500 RPM

CFM and BHP at Static Pressure Shown • Ratings at 70°F., .075 Density, Sea Level

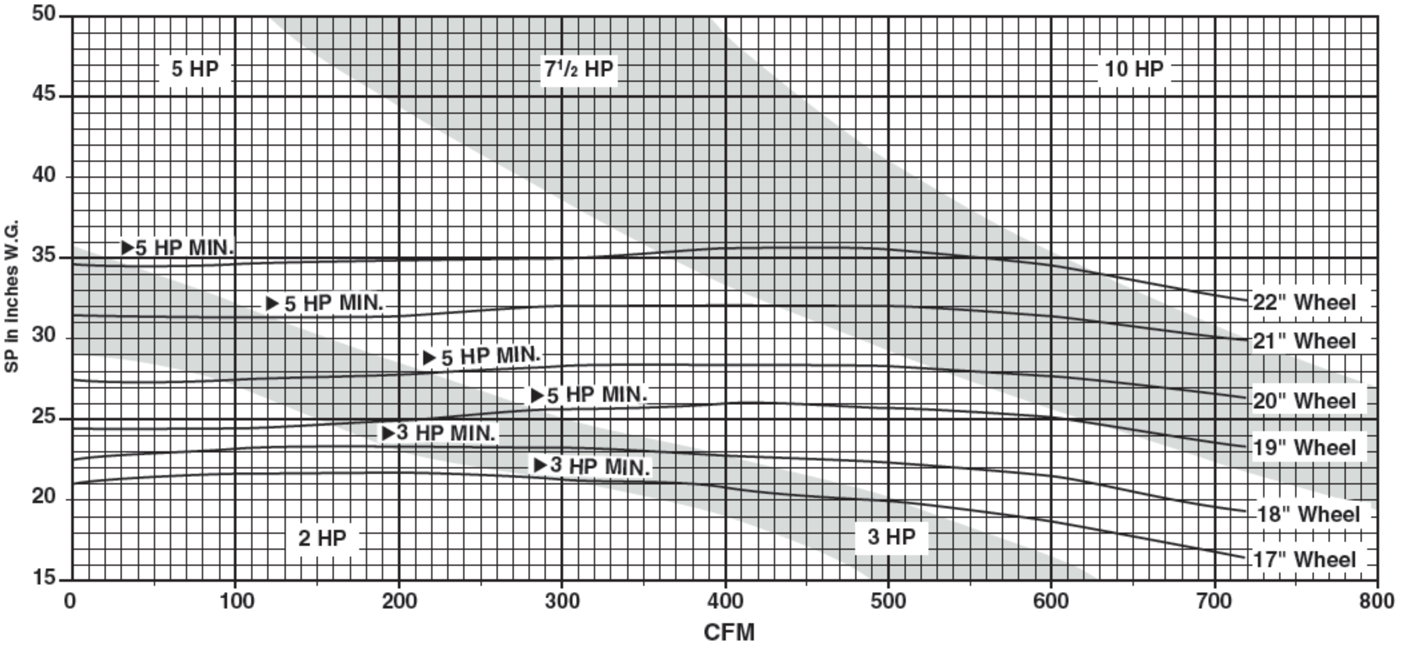
BHP values are shown. Note "▶" is minimum HP motor needed for required starting torque (WR²) for steel wheels. See page 14.

Model HP-4A



BHP values are shown. Note "▶" is minimum HP motor needed for required starting torque (WR²) for steel wheels. See page 14.

Model HP-4C



DESIGN SPECIFICATIONS

HP STEEL WHEEL WR^2 VALUES AND MINIMUM MOTOR HORSEPOWER

Model	WR^2(lb.-FT.^{2})	Min. HP*
HP-4A14	3.4	1 1/2
HP-4A15	4.4	1 1/2
HP-4A16	5.7	1 1/2
HP-4A17	7.2	3
HP-4A18	9.0	3
HP-4C17	7.2	3
HP-4C18	9.0	3
HP-4C19	11.0	5
HP-4C20	13.5	5
HP-4C21	16.2	5
HP-4C22	19.4	5
HP-6B14	3.5	2
HP-6B15	4.6	3
HP-6B16	6.0	3
HP-6B17	7.6	3
HP-6B18	9.6	3
HP-6C19	11.0	5
HP-6C20	13.5	5
HP-6C21	16.2	5
HP-6C22	19.4	5
HP-6E21	19.1	5
HP-6E22	22.2	7 1/2
HP-6E23	23.8	7 1/2
HP-6E24	28.1	10
HP-6E25	32.9	10
HP-6E26	38.3	10
HP-8B15	4.6	3
HP-8B16	6.0	3
HP-8B17	7.6	5
HP-8B18	9.6	5
HP-8D17	7.6	5
HP-8D18	9.6	5
HP-8D19	11.9	5
HP-8D20	14.5	5
HP-8D21	17.6	5
HP-8D22	21.0	7 1/2
HP-8E23	23.8	7 1/2
HP-8E24	28.0	10
HP-8E25	32.9	10
HP-8E26	38.3	10
HP-10D19	11.9	5
HP-10D20	14.5	5
HP-10D21	17.6	5
HP-10D22	21.1	7 1/2
HP-10F23	26.7	7 1/2
HP-10F24	31.5	10
HP-10F25	36.8	10
HP-10F26	42.7	15
HP-12F21	19.0	5
HP-12F22	23.0	7 1/2
HP-12F23	26.7	7 1/2
HP-12F24	31.5	10
HP-12F25	36.8	10
HP-12F26	42.7	15
HP-12G26	72.0	20
HP-12G27	83.0	20
HP-12G28	95.0	20
HP-12G29	108.0	25
HP-12G30	123.0	50
HP-12G31	138.0	50

***Min. HP:** This is the suggested minimum motor horsepower for Arrangement 4 fans with a nominal 3500 RPM motor speed. In a few situations motors suitable for the fan *operating point* BHP may not have sufficient torque to start the fan as *quickly* as desired. Therefore, use a motor horsepower at least as large as those listed in the tables to the left. The suggested motor horsepower values are based on typical Baldor three phase motors. Motor starting torques from other vendors will vary. These tables do not apply to Arrangement 4 fans with 1750 RPM and 2850 RPM motors, and any belt driven fans. A smaller horsepower motor may be acceptable for some of these applications.

DIMENSIONS and SPECIFICATIONS

NOTE: The table below contains blower housing dimensions common to all arrangements on pages 15, 17 and 18.

DIMENSIONS IN INCHES ± 1/8"

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

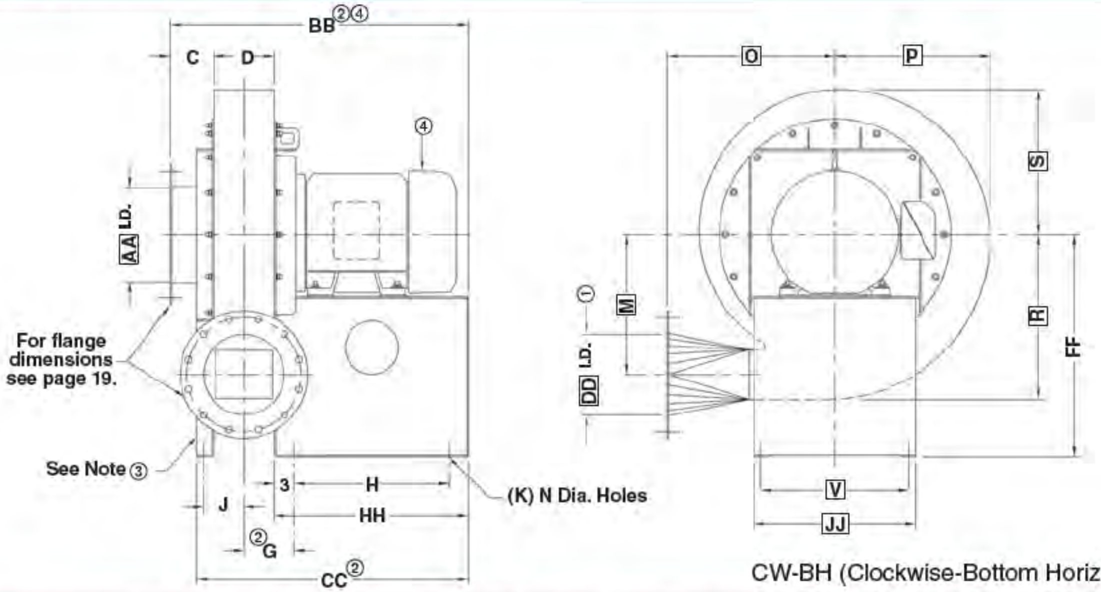
MODEL*	D	M	O	P	R	S	AA	DD①
HP-4A	4	11 3/4	18	13 9/16	14 3/8	12 3/4	6	4
HP-4C	4	14 13/16	17 7/8	16 7/16	17 7/16	15 7/16	6	4
HP-6B	6 3/8	11 3/4	18	13 9/16	14 3/8	12 3/4	8	6
HP-6C	4	14 13/16	17 7/8	16 7/16	17 7/16	15 7/16	6	6
HP-6E	5 3/8	17 7/16	19 1/8	19 3/8	20 9/16	18 3/16	8	6
HP-8B	6 3/8	11 3/4	19 13/16	13 9/16	14 3/8	12 3/4	8	8
HP-8D	6 3/8	14 13/16	19 3/4	16 7/16	17 7/16	15 7/16	8	8
HP-8E	5 3/8	17 7/16	21	19 3/8	20 9/16	18 3/16	8	8
HP-10D	6 3/8	14 13/16	21 3/4	16 7/16	17 7/16	15 7/16	8	10
HP-10F	7 3/8	17 7/16	23	19 3/8	20 9/16	18 3/16	10	10
HP-12F	7 3/8	17 7/16	23	19 3/8	20 9/16	18 3/16	10	12
HP-12G	9	20 3/4	24 15/16	23 1/16	24 7/16	21 5/8	14	12

*COMPLETE MODEL NUMBER INCLUDES WHEEL DIAMETER.

① Discharge flange not available with downblast discharge on models HP-8B, HP-10D, HP-12F and HP-12G.

DIMENSIONS and SPECIFICATIONS

Arrangement #4, Direct Drive



CW-BH (Clockwise-Bottom Horizontal Shown)

Note: For common boxed blower housing dimensions, see bottom of Page 14.

DIMENSIONS IN INCHES ± 1/8" DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL*	MOTOR FRAME	C	② G	H	③ J	K	N	V	②④ BB	②④ CC	FF	HH	JJ
HP-4A	143T-184T	4 1/2	5	6 3/4	—	9/16	4	14 3/4	21 1/4	—	21	12 3/4	16 3/4
HP-4C	143T-215T	4 1/2	5	9	—	9/16	4	17	23 1/2	—	25	15	19
	254T-256T			14					28 1/2			20	
HP-6B	143T-184T	4 1/2	6 3/16	6 3/4	—	9/16	4	14 3/4	23 5/8	—	21	12 3/4	16 3/4
	213T-215T			12 1/2					29 5/8			18 1/2	
HP-6C	143T-215T	4 1/2	5	9	—	9/16	4	17	23 1/2	—	25	15	19
	254T-256T			14					28 1/2			20	
HP-6E	184T-256T	4 1/2	5 11/16	13	—	9/16	4	19	28 7/8	—	29	19	21
HP-8B	143T- 184T	4 1/2	6 3/16	6 3/4	—	9/16	4	14 3/4	23 5/8	—	21	12 3/4	16 3/4
	213T-256T			12 1/2					29 3/8			18 1/2	
HP-8D	182T-215T	4 1/2	6 3/16	9	—	9/16	4	17	25 7/8	—	25	15	19
	254T-286TS			14					30 7/8			20	
HP-8E	184T-256T	4 1/2	5 11/16	13	—	9/16	4	19	28 7/8	—	29	19	21
	284TS-286TS			15 1/2					31 3/8			21 1/2	
HP-10D	184T-215T	4 1/2	6 3/16	9	—	9/16	4	17	25 7/8	—	25	15	19
	254T-286TS			14					30 7/8			20	
HP-10F	215T-256T	4 1/2	6 11/16	13	—	9/16	4	19	30 7/8	—	29	19	21
	284TS-326TS			15 1/2					33 3/8			21 1/2	
	364TS-365TS			22					39 7/8			28	
HP-12F	184T-256T	4 1/2	6 11/16	13	—	9/16	4	19	30 7/8	—	29	19	21
	284TS-326TS			15 1/2					33 3/8			21 1/2	
	364TS-365TS			22					39 7/8			28	
HP-12G	254T-256T	6 1/2	7 1/2	13	6	3/4	6	22	34 1/2	30 1/2	33	19	24
	284T-326T			21					42 1/2	38 1/2		27	
	364T-365T			23					44 1/2	40 1/2		29	
	404T-405T			26					47 1/2	43 1/2		32	
	444TS			30					51 1/2	47 1/2		36	

* COMPLETE MODEL NUMBER INCLUDES WHEEL DIAMETER. Fan housings are reversible and rotatable in 45° increments.

① Discharge flange not available with Downblast (DB) discharge position on models HP-8B, HP-10D, HP-12F and HP-12G.

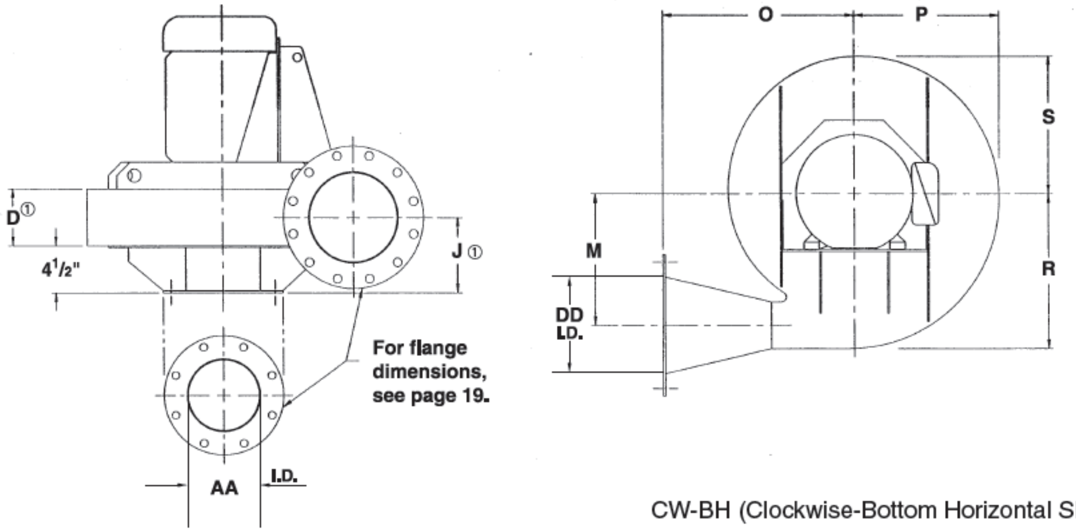
② For AMCA Type "C" spark resistant construction, add 1/8 inch to dimensions "G", "BB" and "CC".

③ Inlet side support plate is only included on model HP-12G.

④ On some models, motor may extend past end of motor base.

DIMENSIONS and SPECIFICATIONS

Arrangement #4HM, Direct Connected



For flange dimensions, see page 19.

CW-BH (Clockwise-Bottom Horizontal Shown)

DIMENSIONS IN INCHES ± 1/8"

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL*	MOTOR FRAME	① D	① J	M	O	P	R	S	AA	DD
HP-4A	143T-184T	4	6 1/2	11 3/4	18	13 9/16	14 3/8	12 3/4	6	4
HP-4C	143T-256T	4	6 1/2	14 13/16	17 15/16	16 7/16	17 7/16	15 7/16	6	4
HP-6B	143T-215T	6 3/8	7 11/16	11 3/4	18	13 9/16	14 3/8	12 3/4	8	6
HP-6C	143-256T	4	6 1/2	14 13/16	17 15/16	16 7/16	17 7/16	15 7/16	6	6
HP-6E	184T-256T	5 3/8	7 3/16	17 7/16	19 3/16	19 3/8	20 9/16	18 3/16	8	6
HP-8B	143T-254T	6 3/8	7 11/16	11 3/4	19 13/16	13 9/16	14 3/8	12 3/4	8	8
HP-8D	182T-286TS	6 3/8	7 11/16	14 13/16	19 3/4	16 7/16	17 7/16	15 7/16	8	8
HP-8E	213T-286TS	5 3/8	7 3/16	17 7/16	21	19 3/8	20 9/16	18 3/16	8	8
HP-10D	184T-286TS	6 3/8	7 11/16	14 13/16	21 3/4	16 7/16	17 7/16	15 7/16	8	10
HP-10F	215T-326TS	7 3/8	8 3/16	17 7/16	23	19 3/8	20 9/16	18 3/16	10	10
HP-12F	184T-326TS	7 3/8	8 3/16	17 7/16	23	19 3/8	20 9/16	18 3/16	10	12

*COMPLETE MODEL NUMBER INCLUDES WHEEL DIAMETER.

① For AMCA "C", add: 1/8 inch to dimension "J" and 1/4 inch to dimension "D".

FAN HOUSINGS ARE REVERSIBLE AND ROTATABLE IN 45° INCREMENTS.

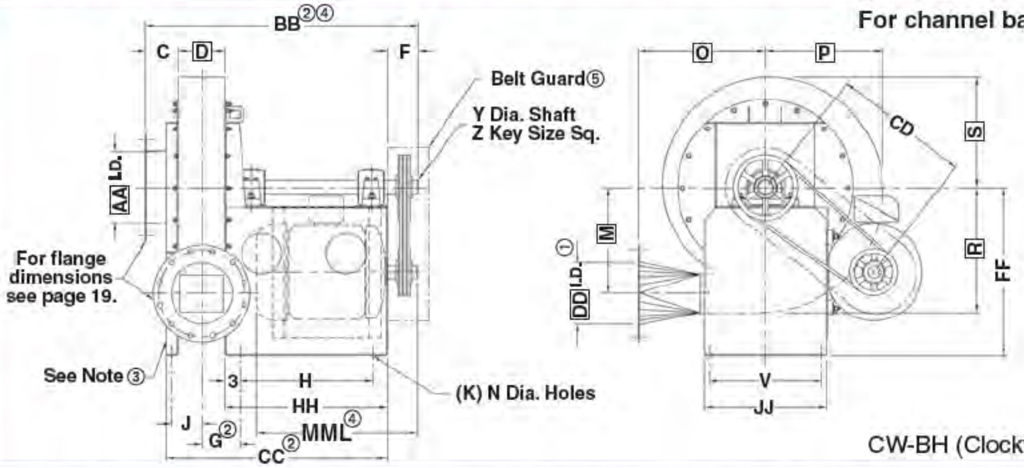
CONSTRUCTION GAUGES

	Inlet				Housing			Wheel			
MODEL	Side Plate	Inlet Collar	Inlet Flange	Outlet Flange	Side Plates	Scroll	Transition	Back Plate	Shroud	Blades	All Bases
HP-4A & HP-4C	7	10	10	10	7	10	14	7	7	10	7
HP-6B & HP-6E	7	10	7	10	7	10	14	7	7	10	7
HP-6C	7	10	10	10	7	10	14	7	7	10	7
HP-6E	7	10	7	10	7	10	14	7	7	10	7
HP-8B through HP-12F	7	10	7	10	7	10	14	7	7	10	7
HP-12G	1/4"	10	7	7	1/4"	10	14	1/4"	1/4"	10	7

DIMENSIONS and SPECIFICATIONS

Arrangement #1 and #9, Belt Drive (specify 9R or 9L)

For channel base dimensions, see page 18.



Unit shown is Arrangement 9R (motor on right side.) For motor on left side, specify Arrangement 9L.

CW-BH (Clockwise-Bottom Horizontal Shown)

Note: For common boxed blower housing dimensions, see bottom of Page 14.

DIMENSIONS IN INCHES ± 1/8" — DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL*	MOTOR FRAME	C	F	② G	H	②③ J	K	N	V	Y	Z	② BB	② CC	FF	HH	JJ	④ MML
HP-4A	143T-215T	4 1/2	4	5	12 13/16	—	4	9/16	14 3/4	1 7/16	3/8	31 5/16	—	21	18 13/16	16 3/4	21 1/2
HP-4C	143T-256T	4 1/2	5	5	17 1/16	—	4	9/16	17	1 7/16	3/8	36 9/16	—	25	23 1/16	19	26 1/4
HP-6B	143T-215T	4 1/2	4	6 3/16	12 13/16	—	4	9/16	14 3/4	1 7/16	3/8	33 11/16	—	21	18 13/16	16 3/4	21 1/2
HP-6C	143T-256T	4 1/2	5	5	17 1/16	—	4	9/16	17	1 11/16	3/8	36 9/16	—	25	23 1/16	19	26 1/4
HP-6E	184T-286T	4 1/2	5	5 11/16	21	—	4	9/16	19	1 15/16	1/2	41 7/8	—	29	27	21	30 1/4
HP-8B	143T-215T	4 1/2	4	6 3/16	12 13/16	—	4	9/16	14 3/4	1 7/16	3/8	33 11/16	—	21	18 13/16	16 3/4	21 1/2
	254T-256T		5		17 1/16					1 11/16	3/8	38 15/16			23 1/16		26 1/4
HP-8D	184T-256T	4 1/2	5	6 3/16	17 1/16	—	4	9/16	17	1 11/16	3/8	38 15/16	—	25	23 1/16	19	26 1/4
HP-8E	182T- 286T	4 1/2	5	5 11/16	21	—	4	9/16	19	1 15/16	1/2	41 7/8	—	29	27	21	30 1/4
HP-10D	184T-256T	4 1/2	5	6 3/16	17 1/16	—	4	9/16	17	1 11/16	3/8	38 15/16	—	25	23 1/16	19	26 1/4
HP-10F	215T-324T	4 1/2	6	6 11/16	21	—	4	9/16	19	2 3/16	1/2	44 7/8	—	29	27	21	30 1/4
HP-12F	215T-324T	4 1/2	6	6 11/16	21	—	4	9/16	19	2 3/16	1/2	44 7/8	—	29	27	21	30 1/4
HP-12G	213T-365T	6 1/2	6	7 1/2	26	6	6	3/4	22	2 11/16	5/8	53 1/2	43 1/2	33	32	24	32 1/8

*COMPLETE MODEL NUMBER INCLUDES WHEEL DIAMETER.

FAN HOUSINGS ARE REVERSIBLE AND ROTATABLE IN 45° INCREMENTS.

① Discharge flange not available with Downblast (DB) discharge position on models HP-8B, HP-10D, HP-12F and HP-12G.

② For "AMCA Type "C" spark resistant construction, add 1/8 inch to dimensions "G", "BB" and "CC".

③ Inlet side support plate is only included on model HP-12G.

④ "MML" is the Maximum Motor Length (for maximum motor frame size listed) on customer supplied motor. Motor manufacturers "C" dimension cannot exceed "MML" without a special base.

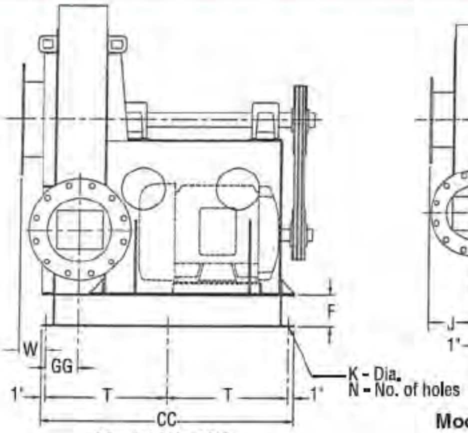
⑤ Belt guard is standard on Arrangement 9 blowers. Arrangement 1 blowers do not include motor, motor slide base, belt guard, sheaves or belts.

C.D. BELT CENTER DISTANCE — DIMENSIONS IN INCHES

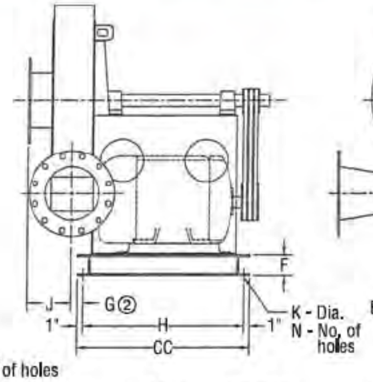
	MOTOR FRAME SIZE													
	143T-145T		182T-184T		213T-215T		254T-256T		284T-286T		324T-326T		364T-365T	
MODEL	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
HP-4A & HP-6B	12 5/8	14 1/16	14 3/8	15 7/8	15 11/16	17 3/8	—	—	—	—	—	—	—	—
HP-4C & HP-6C	13 11/16	15	15 7/16	16 7/8	16 3/4	18 7/16	18 7/8	20 3/4	—	—	—	—	—	—
HP-6E & HP-8E	—	—	15	16 1/2	16 3/8	18 3/8	18	20 7/16	18 15/16	21 15/16	—	—	—	—
HP-8B	12 5/8	14 1/16	14 3/8	15 7/8	15 11/16	17 1/2	17 3/8	19 1/4	—	—	—	—	—	—
HP-8D & HP-10D	—	—	15 7/16	16 7/8	16 3/4	18 7/16	18 7/8	20 3/4	—	—	—	—	—	—
HP-10F & HP-12F	—	—	—	—	16 3/8	18 3/8	18	20 7/16	18 15/16	21 15/16	19 5/8	23 1/4	—	—
HP-12G	—	—	—	—	19 3/4	21	21 1/2	23	22 1/2	24 3/8	24 3/8	26 3/4	25 3/4	27 1/2

DIMENSIONS and SPECIFICATIONS

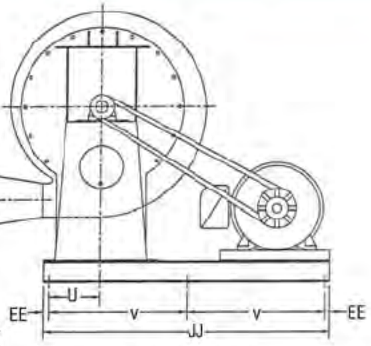
Arrangement #9RCB or #9LCB Channel Base, Belt Drive



Model HP-12G



Models HP-4A thru HP-12F



All Models
Clockwise Bottom Horizontal Discharge
and arrangement 9RCB shown.

Note: For common boxed blower housing dimensions, see bottom of Page 14.

DIMENSIONS IN INCHES ± 1/8"

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL*	MOTOR FRAME	F	② G	H	J	K	N	T	U	V	W	CC	EE	GG	JJ
HP-4A	182T - 215T	4	3	16 13/16	6 1/2	9/16	6	--	7 3/8	21 1/2	—	18 13/16	1	—	45
HP-4C	182T - 256T	4	3	21 1/16	6 1/2	9/16	6	—	8 1/2	22 1/2	—	23 1/16	1	—	47
HP-6B	182T - 215T	4	4 3/16	16 13/16	7 11/16	9/16	6	—	7 3/8	21 1/2	—	18 13/16	1	—	45
HP-6C	213T - 256T	4	3	21 1/16	6 1/2	9/16	6	—	8 1/2	22 1/2	—	23 1/16	1	—	47
HP-6E	213T - 286T	4	1 3/16	30	7 3/16	9/16	6	—	9 1/2	25 1/2	—	32	1	—	53
HP-8B	213T - 256T	4	4 3/16	21 1/16	7 11/16	9/16	6	—	7 3/8	21 1/2	—	23 1/16	1	—	45
HP-8D	213T - 286T	4	4 3/16	21 1/16	7 11/16	9/16	6	—	8 1/2	22 1/2	—	23 1/16	1	—	47
HP-8E	213T - 326T	4	1 3/16	30	7 3/16	9/16	6	—	9 1/2	25 1/2	—	32	1	—	53
HP-10D	213T - 326T	4	4 3/16	21 1/16	7 11/16	9/16	6	—	8 1/2	22 1/2	—	23 1/16	1	—	47
HP-10F	213T - 364T	4	2 3/16	30	8 3/16	9/16	6	—	9 1/2	25 1/2	—	32	1	—	53
HP-12F	213T - 364T	4	2 3/16	30	8 3/16	9/16	6	—	9 1/2	25 1/2	—	32	1	—	53
HP-12G	284T- 444T	6	—	—	—	3/4	8	22 1/2	7	28 3/16	5	47	5	6	66 3/8

② For AMCA "C", add: 1/8 inch to dimensions "G".

*COMPLETE MODEL NUMBER INCLUDES WHEEL DIAMETER.

16 DISCHARGE POSITIONS AVAILABLE. 45° DISCHARGE POSITIONS NOT SHOWN.
Discharges shown are determined by viewing fan from motor or drive side.

CW-TH

Clockwise Top Horizontal Discharge ★

CW-DB

Clockwise Down-Blast Discharge

CW-BH

Clockwise Bottom Horizontal Discharge

CW-UB

Clockwise Up-Blast Discharge

CCW-TH

Counter-Clockwise Top Horizontal Discharge

CCW-DB

Counter-Clockwise Down-Blast Discharge ★

CCW-BH

Counter-Clockwise Bottom Horizontal Discharge

CCW-UB

Counter-Clock-wise Up-Blast Discharge

★ Discharge flange not available with downblast discharge on models HP-8B, HP-10D, HP-12F and HP-12G.

⚠ DANGER

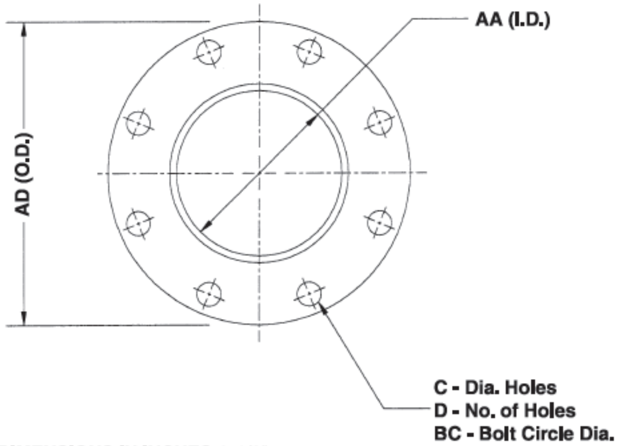
All fans & blowers shown have rotating parts and pinch points. Severe personal injury can result if operated without guards. Stay away from rotating equipment unless it is disconnected or locked out from its power source.

Read operating instructions.

DIMENSIONS and SPECIFICATIONS

INLET AND DISCHARGE FLANGES

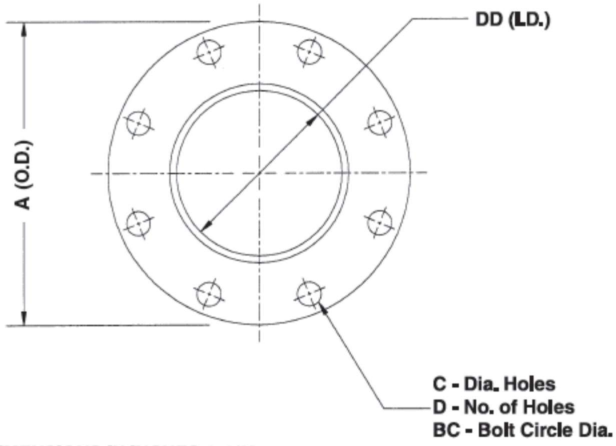
INLET FLANGE



DIMENSIONS IN INCHES ± 1/8"

MODEL	AA I.D.	AD O.D.	BC B.C.	C Dia.	D
HP-4A, 4C and 6C	6	11	$9\frac{1}{2}$	$\frac{7}{8}$	8
HP-6B, 6E, 8B, 8D, 8E and 10D	8	$13\frac{1}{2}$	$11\frac{3}{4}$	$\frac{7}{8}$	8
HP-10F and 12F	10	16	$14\frac{1}{4}$	1	12
HP-12G	14	21	$18\frac{3}{4}$	$1\frac{1}{8}$	12

DISCHARGE FLANGE ★



DIMENSIONS IN INCHES ± 1/8"

MODEL	DD I.D.	A O.D.	BD B.C.	C Dia.	D
HP-4A and 4C	4	9	$7\frac{1}{2}$	$\frac{3}{4}$	8
HP-6B, 6C and 6E	6	11	$9\frac{1}{2}$	$\frac{7}{8}$	8
HP-8B, 8D and 8E★	8	$13\frac{1}{2}$	$11\frac{3}{4}$	$\frac{7}{8}$	8
HP-10D and 10F★	10	16	$14\frac{1}{4}$	1	12
HP-12F and 12G★	12	19	17	1	12

★See note under discharge positions available on page 18

All dimensions except flange thickness meet ANSI-125 lb. and ASA-150 lb. specifications. Standard orientation is holes straddling major center lines. Holes may be specified to be on center lines at no additional cost.

APPROXIMATE SHIPPING WEIGHTS LESS MOTOR

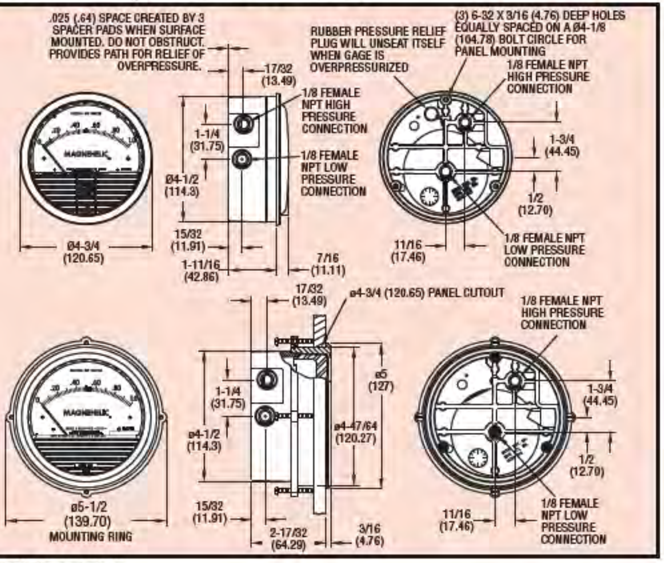
MODEL	MOTOR FRAME	Fan Arrangement			
		4	8	1 & 9	9CB
HP-4A	143T - 184T	190	265	—	—
	143T - 215T	—	—	220	—
	182T - 213T	—	—	—	315
HP-4C	143T - 215T	250	335	—	—
	254T	260	350	—	—
	143T - 256T	—	—	280	—
	182T - 254T	—	—	—	380
HP-6B	143T - 184T	210	285	—	—
	213T - 215T	240	315	—	—
	143T - 215T	—	—	270	—
	182T - 215T	—	—	—	365
HP-6C	143T - 215T	270	355	—	—
	254T	300	385	—	—
	143T - 256T	—	—	310	—
	213T - 256T	—	—	—	410
HP-6E	184T - 256T	350	445	—	—
	184T - 286T	—	—	400	—
	213T - 286T	—	—	—	510
HP-8B	143T - 184T	215	—	—	—
	213T - 254T	245	—	—	—
	143T - 215T	—	290	275	—
	254T - 256T	—	320	300	—
	213T - 256T	—	—	—	395
HP-8D	182T - 215T	280	365	—	—
	254T - 286TS	300	—	—	—
	254T - 256T	—	385	—	—
	184T - 256T	—	—	340	—
	213T - 286T	—	—	—	440

MODEL	MOTOR FRAME	Fan Arrangement			
		4	8	1 & 9	9CB
HP-8E	213T - 256T	360	455	—	—
	284T - 324T	380	—	—	—
	284TS - 326TS	—	475	—	—
	182T - 286T	—	—	430	—
	213T - 326T	—	—	—	540
HP-10D	184T - 215T	290	375	—	—
	184T - 256T	—	—	350	—
	254T - 286TS	310	395	370	—
	213T - 326T	—	—	—	470
HP-10F	215T - 256T	380	475	—	—
	284TS - 326TS	395	490	—	—
	215T - 324T	—	—	445	—
	213T - 364T	—	—	—	565
HP-12F	184T - 256T	380	—	—	—
	215T - 256T	—	475	—	—
	284TS - 364TS	400	495	—	—
	215T - 324T	—	—	465	—
	213T - 364T	—	—	—	595
HP-12G	254T - 256T	712	—	—	—
	284T - 326T	766	—	—	—
	364T - 365T	787	—	—	—
	404T - 405T	802	—	—	—
	444TS	856	—	—	—
	213T - 365T	—	—	1080	—
	284T - 444T	—	—	—	1400

Series 2000

Magnehelic® Differential Pressure Gages

Indicate Positive, Negative or Differential, Accurate within 2%



Select the Dwyer® Magnehelic® gage for high accuracy – guaranteed within 2% of full-scale – and for the wide choice of 81 models available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® gage movement, it quickly indicates low air or non-corrosive gas pressures – either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

The Magnehelic® gage is the industry standard to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.

Mounting

A single case size is used for most models of Magnehelic® gages. They can be flush or surface mounted with standard hardware supplied. Although calibrated for vertical position, many ranges above 1˝ may be used at any angle by simply re-zeroing. However, for maximum accuracy, they must be calibrated in the same position in which they are used. These characteristics make Magnehelic® gages ideal for both stationary and portable applications. A 4-9/16˝ hole is required for flush panel mounting. Complete mounting and connection fittings, plus instructions, are furnished with each instrument. See page 7 for more information on mounting accessories.

Flush, Surface or Pipe Mounted

Enclosure Mounted

SPECIFICATIONS

Service: Air and non-combustible, compatible gases (natural gas option available).
Note: May be used with hydrogen. Order a Buna-N diaphragm. Pressures must be less than 35 psi.
Wetted Materials: Consult factory.
Housing: Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.
Accuracy: ±2% of FS (±3% on - 0, -100 Pa, -125 Pa, 10MM and ±4% on - 00, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).
Pressure Limits: -20 in Hg to 15 psig† (-0.677 to 1 034 bar); MP option: 35 psig (2.41 bar); HP option: 80 psig (5.52 bar).
Overpressure: Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. See Overpressure Protection Note on next page.
Temperature Limits: 20 to 140°F* (-6.67 to 60°C). -20°F (-28°C) with low temperature option.
Size: 4˝ (101.6 mm) diameter dial face.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Process Connections: 1/8˝ female NPT duplicate high and low pressure taps - one pair side and one pair back.
Weight: 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).
Standard Accessories: Two 1/8˝ NPT plugs for duplicate pressure taps, two 1/8˝ pipe thread to rubber tubing adapter, and three flush mounting adapters with screws. (Mounting and snap ring retainer substituted for three adapters in MP & HP gage accessories.)
Agency Approval: RoHS. **Note:** -SP models not RoHS approved.
†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options at lower left.

ACCESSORIES

Model A-432 Portable Kit
Combine carrying case with any Magnehelic® gage of standard range, except high pressure connection. Includes 9 ft (2.7 m) of 3/16˝ ID rubber tubing, standhang bracket and terminal tube with holder.

Model A-605 Air Filter Gage Accessory Kit
Adapts any standard Magnehelic® gage for use as an air filter gage. Includes aluminum surface mounting bracket with screws, two 5 ft (1.5 m) lengths of 1/4˝ aluminum tubing two static pressure tips and two molded plastic vent valves, integral compression fittings on both tips and valves.

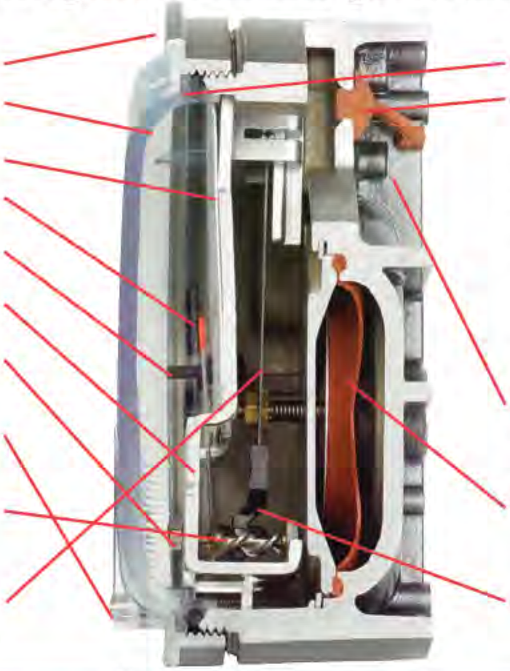
A-605B Air Filter Gage Accessory Kit, Air filter kit with two plastic open/close valves, two 4˝ steel static tips, plastic tubing and mounting flange

A-605C Air Filter Gage Accessory Kit, Air filter kit with two plastic open/close valves, two plastic static tips, plastic tubing and mounting flange

Dwyer®

Series 2000

Magnehelic® Gage Models & Ranges



Bezel provides flange for flush mounting in panel

Clear plastic face is highly resistant to breakage Provides undistorted viewing of pointer and scale

Precision litho-printed scale is accurate and easy to read

Red tipped pointer of heat treated aluminum tubing is easy to see It is rigidly mounted on the helix shaft

Pointer stops of molded rubber prevent pointer over-travel without damage

"Wishbone" assembly provides mounting for helix helix bearings and pointer shaft

Jeweled bearings are shock-resistant mounted provide virtually friction-free motion for helix Motion damped with high viscosity silicone fluid

Zero adjustment screw is conveniently located in the plastic cover and is accessible without removing cover O-ring seal provides pressure tightness

Helix is precision made from an alloy of high magnetic permeability Mounted in jeweled bearings it turns freely following the magnetic field to move the pointer across the scale

Calibrated range spring is flat spring steel Small amplitude of motion assures consistency and long life It reacts to pressure on diaphragm Live length adjustable for calibration

O-ring seal for cover assures pressure integrity of case

OVERPRESSURE PROTECTION

Blowout plug is comprised of a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when over pressure reaches approximately 25 psig (1 7 bar) To provide a free path for pressure relief there are four spacer pads which maintain 0 023˝ clearance when gage is surface mounted Do not obstruct the gap created by these pads The blowout plug is not used on models above 180˝ of water pressure medium or high pressure models or on gages which require an elastomer other than silicone for the diaphragm The blowout plug should not be used as a system overpressure control High supply pressures may still cause the gage to fail due to over pressurization resulting in property damage or serious injury Good engineering practices should be utilized to prevent your system from exceeding the ratings or any component

Die cast aluminum case is precision made and iridite-dipped to withstand 168 hour salt spray corrosion test Exterior finished in baked dark gray hammerloid One case size is used for all standard pressure options and for both surface and flush mounting

Silicone rubber diaphragm with integrally molded O-ring is supported by front and rear plates It is locked and sealed in position with a sealing plate and retaining ring Diaphragm motion is restricted to prevent damage due to overpressures

Samarium Cobalt magnet mounted at one end of range spring rotates helix without mechanical linkages

Model	Range Inches of Water
2000-00N†••	05-0- 2
2000-00†••	0- 25
2000-0†•	0- 50
2001	0-1 0
2002	0-2 0
2003	0-3 0
2004	0-4 0
2005	0-5 0
2006	0-6 0
2008	0-8 0
2010	0-10
2012	0-12
2015	0-15
2020	0-20
2025	0-25
2030	0-30
2040	0-40
2050	0-50
2060	0-60
2080	0-80
2100	0-100
2120	0-120
2150	0-150
2160	0-160
2180*	0-180
2250*	0-250
Zero Center Ranges	
2300-00†••	0 125-0-0 125
2300-0†•	25-0- 25
2301	5-0- 5
2302	1-0-1
2304	2-0-2
2310	5-0-5
2320	10-0-10
2330	15-0-15

Model	Range PSI
2201	0-1
2202	0-2
2203	0-3
2204	0-4
2205	0-5
2210*	0-10
2215*	0-15
2220*	0-20
2230**	0-30

Model	Range, CM of Water
2000-15CM	0-15
2000-20CM	0-20
2000-25CM	0-25
2000-50CM	0-50
2000-80CM	0-80
2000-100CM	0-100
2000-150CM	0-150
2000-200CM	0-200
2000-250CM	0-250
2000-300CM	0-300
Zero Center Ranges	
2300-4CM	2-0-2
2300-10CM	5-0-5
2300-30CM	15-0-15

†These ranges calibrated for vertical scale position
• Accuracy +/-3%
• • Accuracy +/-4%
*MP option standard
**HP option standard

Model	Range MM of Water
2000-6MM†••	0-6
2000-10MM†•	0-10
2000-15MM	0-15
2000-25MM	0-25
2000-30MM	0-30
2000-50MM	0-50
2000-80MM	0-80
2000-100MM	0-100
2000-125MM	0-125
2000-150MM	0-150
2000-200MM	0-200
2000-250MM	0-250
2000-300MM	0-300
Zero Center Ranges	
2300-6MM†••	3-0-3
2300-10MM†•	5-0-5
2300-20MM†•	10-0-10

Model	Range, Pa
2000-60NPA†••	10-0-50
2000-60PA†••	0-60
2000-100PA†•	0-100
2000-125PA†•	0-125
2000-250PA	0-250
2000-300PA	0-300
2000-500PA	0-500
2000-750PA	0-750
2000-1000PA	0-1000
Zero Center Ranges	
Model	**Range, Pa**
2300-60PA†••	30-0-30
2300-100PA†•	50-0-50
2300-120PA	60-0-60
2300-200PA	100-0-100
2300-250PA	125-0-125
2300-300PA	150-0-150
2300-500PA	250-0-250
2300-1000PA	500-0-500

Model	Range, kPa
2000-0.5KPA	0-0 5
2000-1KPA	0-1
2000-1.5KPA	0-1 5
2000-2KPA	0-2
2000-2.5KPA	0-2 5
2000-3KPA	0-3
2000-4KPA	0-4
2000-5KPA	0-5
2000-8KPA	0-8
2000-10KPA	0-10
2000-15KPA	0-15
2000-20KPA	0-20
2000-25KPA	0-25
2000-30KPA	0-30
Zero Center Ranges	
2300-1KPA	5-0- 5
2300-2KPA	1-0-1
2300-2.5KPA	1 25-0-1 25
2300-3KPA	1 5-0-1 5

Dual Scale Air Velocity Units
For use with pitot tube

Model	Range in W.C./ Velocity F.P.M.
2000-00AV†••	0- 25/300-2000
2000-0AV†•	0- 50/500-2800
2001AV	0-1 0/500-4000
2002AV	0-2 0/1000-5600
2005AV	0-5 0/2000-8800
2010AV	0-10/2000-12500

Dual Scale English/Metric Models

Model	Range, in w.c.	Range, Pa or kPa
2000-00D†••	0- 25	0-62 Pa
2000-0D†•	0-0 5	0-125 Pa
2001D	0-1 0	0-250 Pa
2002D	0-2 0	0-500 Pa
2003D	0-3 0	0-750 Pa
2004D	0-4 0	0-1 0 kPa
2005D	0-5 0	0-1 25 kPa
2006D	0-6 0	0-1 5 kPa
2008D	0-8 0	0-2 0 kPa
2010D	0-10	0-2 5 kPa
2015D	0-15	0-3 7 kPa
2020D	0-20	0-5 kPa
2025D	0-25	0-6 2 kPa
2050D	0-50	0-12 4 kPa
2060D	0-60	0-15 kPa

VELOCITY AND VOLUMETRIC FLOW UNITS

Scales are available on the Magnehelic® that read in velocity units (FPM m/s) or volumetric flow units (SCFM m³/s m³/h) Stocked velocity units with dual range scales in inches w c and feet per minute are shown above For other ranges contact the factory
When ordering volumetric flow scales please specify the maximum flow rate and its corresponding pressure Example 0 5 in w c = 16 000 CFM

ACCESSORIES

A-321, Safety Relief Valve
A-448, 3-piece magnet kit for mounting Magnehelic® gage directly to magnetic surface
A-135, Rubber gasket for panel mounting
A-401, Plastic Carry Case

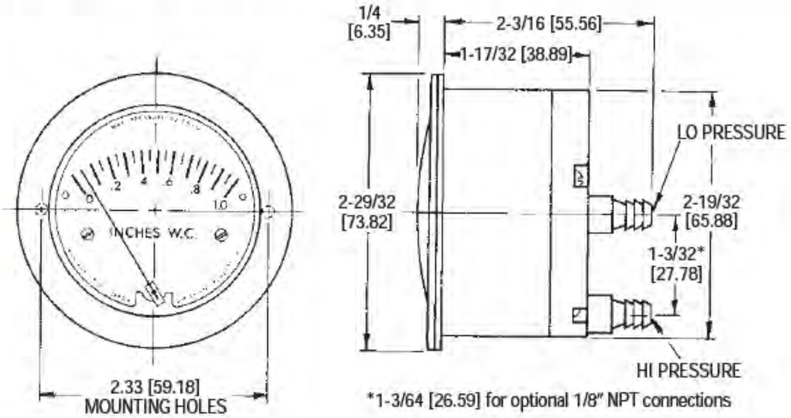
A-310A 3-Way Vent Valves

In applications where pressure is continuous and the Magnehelic® gage is connected by metal or plastic tubing which cannot be easily removed we suggest using Dwyer A-310A vent valves to connect gage Pressure can then be removed to check or re-zero the gage

Bulletin A-36

Series 2-5000 Minihelic® II Differential Pressure Gage

Specifications: Installation & Operating Instructions



Dimensions, Series 2-5000 Minihelic®II Gage.

Series 2-5000 Minihelic® II Differential Pressure Gages have clean design, small size, low cost and sufficient accuracy for all but the most demanding applications. With housing molded from mineral- and glass-filled nylon and a lens molded from polycarbonate, this gage will withstand rough use and exposure, as well as high total pressure up to 30 psig [2.067 bar].Over-pressure is accommodated by a blow-out membrane molded in conjunction with the diaphragm.

INSTALLATION

1. Select a location free from excessive vibration and where ambient temperature will be between 20°F to 120°F (-6.7°C to 49°C). Sensing lines may be any length necessary without affecting accuracy. However, long runs of tubing will dampen readings slightly and cause a minor increase in response time. If pulsing pressure or vibration cause excessive pointer oscillation, please contact factory for ways to provide additional damping.

2. This gage is calibrated and zeroed in the vertical position at the factory. If the gage is used in any other position, it must be re-zeroed each time the position is changed. Gages with ranges under 5 inches w.c.(1.24 kPa), or the equivalent, should be used only in the vertical position unless special calibration was specified when ordering.

SPECIFICATIONS

Dimensions: 2-29/32″ (73.82 mm) x 2- 7/16″ (61.93 mm).
Weight: 6 oz. [170 gr].
Rated Total Pressure: 50 psig (3.445 bar) surge; 30 psig (2.067 bar) continuous to either pressure connection.
Ambient Temperature Range: 20°F to 120°F (- 6.7°C to 49°C).
Accuracy: ± 5% of full scale at 70°F (21.1°C).
Connections: standard, barbed for 3/16″ I.D. tubing; optional,1/8″ NPT(M).
Housing: glass-filled nylon, polycarbonate lens.
Finish: black
Standard Accessories: (2) 4-40 x 1-5/8″ mounting studs, (2) 4-40 hex nuts, (1) .050″ hex allen wrench, (1) panel mounting bracket.

CAUTION:

Use only with air or compatible non-corrosive gases.

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e-mail: info@dwyer-inst.com

PANEL MOUNTED INSTALLATION

3. To surface-mount the gage, drill two 5/32″ [3.97 mm] holes on a horizontal line, 2-1/3″ [59.26 mm] apart for mounting screws. Next, drill two 7/16″ [11.11 mm] holes 1-1/32″ [26.19 mm] apart on a vertical line for pressure connections. Install mounting studs in back of the gage, insert through holes in the panel, and secure with hex nuts provided. Be careful not to block the slotted hole near the right-hand mounting hole. This provides a path for pressure relief in the event of over-pressurization.

4. To panel-mount gage, cut a 2-5/8″ diameter hole. Install the mounting studs in the back of gage, position gage in the panel, and place bracket over the studs. Thread hex nuts over studs and tighten.

5. After installation, the gage may need to be zeroed before placing in operation. If re-zeroing is required, firmly hold the case of gage with one hand and unscrew the front cover with the palm of the other hand in a counterclockwise direction. If difficult to loosen, place a small sheet of rubber between the cover and the palm of the hand. Zero-adjust screw is located behind the scale at the pair marked "zero." Use the hex allen wrench supplied and adjust until pointer is on zero. This must be done with both pressure connections vented to atmosphere and the gage oriented in the final mounting position. Replace cover.

6. To measure positive pressure, connect tubing to port marked "HI" and vent "LO" port to atmosphere. For negative pressure (vacuum), connect to port marked "LO" and vent "HI" port to atmosphere. For differential pressure, connect higher pressure to port marked "HI" and lower to "LO" port. If gage is supplied with 1/8″ NPT connections, be careful not to over-tighten fittings to avoid damage to the gage.

CALIBRATION CHECK

Select a second gage or manometer of known accuracy and in an appropriate range. Use short lengths of rubber or vinyl tubing to connect the high-pressure side of the Minihelic® II gage and the test gage to two legs of a tee. Very slowly, apply pressure through the third leg. Allow enough time for pressure to equalize throughout the system and for fluid to drain. if a manometer is being used. Compare readings. If the gage being tested exceeds rated accuracy, it should be returned to the factory for recalibration.

MAINTENANCE

No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally, disconnect pressure lines to vent both sides of the gage to atmosphere and re-zero per paragraph 5.

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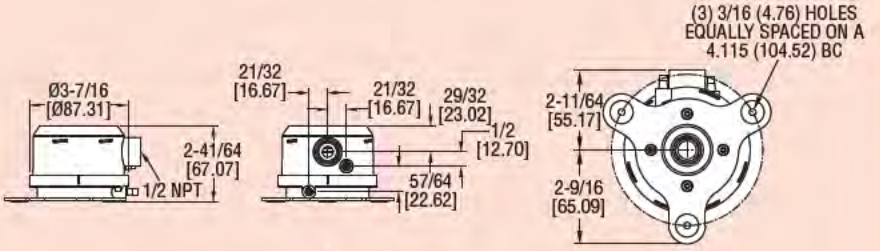
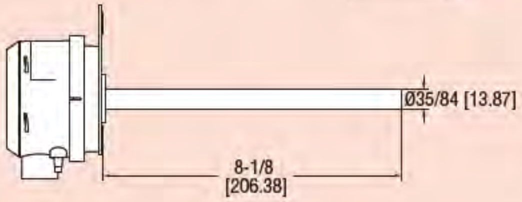
Series MS Magnesense® Differential Pressure Transmitter

Monitors Pressure & Air Velocity

Standard MS with optional LCD

MS with optional LCD and static probe





The Series MS Magnesense® Differential Pressure Transmitter is an extremely versatile transmitter for monitoring pressure and air velocity. This compact package is loaded with features such as:

- Field selectable English or Metric ranges
- Field upgradeable LCD display
- Adjustable damping of output signal (with optional display)
- Ability to select a square root output for use with pitot tubes and other similar flow sensors

Along with these features, the patented magnetic sensing technology provides exceptional long term performance and enables the Magnesense® Differential Pressure Transmitter to be the single solution for your pressure and flow applications.

Model	Output	Selectable Ranges
MS-121*	4-20 mA	0 1″ 0 25″ 0 5″ w c (25 50 100 Pa)
MS-321*	0-10 V	0 1″ 0 25″ 0 5″ w c (25 50 100 Pa)
MS-721*	0-5 V	0 1″ 0 25″ 0 5″ w c (25 50 100 Pa)
MS-111*	4-20 mA	1″ 2″ 5″ w c (250 500 1250 Pa)
MS-311*	0-10 V	1″ 2″ 5″ w c (250 500 1250 Pa)
MS-711*	0-5 V	1″ 2″ 5″ w c (250 500 1250 Pa)
MS-131	4-20 mA	10″ w c (2 kPa)
MS-141	4-20 mA	15″ w c (3 kPa)
MS-151	4-20 mA	25″ w c (5 kPa)
MS-331	0-10 V	10″ w c (2 kPa)
MS-341	0-10 V	15″ w c (3 kPa)
MS-351	0-10 V	25″ w c (5 kPa)
MS-021	4-20 mA	±0 1″ 0 25″ 0 5″ w c (±25 50 100 Pa)
MS-221	0-10 V	±0 1″ 0 25″ 0 5″ w c (±25 50 100 Pa)
MS-621	0-5 V	±0 1″ 0 25″ 0 5″ w c (±25 50 100 Pa)

OPTIONS

Note: Add -LCD to end of model for units with display
*Models available with duct mount static pressure probe Change last digit from 1 to 2 Ex MS-122

Add suffix -N ST to end of model numbers for N ST traceable calibration certificate Example MS-021-N ST

Add suffix -FC to end of model numbers for factory calibration certificate Example MS-021-FC

SPECIFICATIONS

Service: Air and non-combustible compatible gases
Wetted Materials: Consult factory
Accuracy: ±1% for 0 25″ (50 Pa) 0 5″ (100 Pa) 2″ (500 Pa) 5″ (1250 Pa) 10″ (2 kPa) 15″ (3 kPa) 25″ (5 kPa) ±2% for 0 1″ (25 Pa) 1″ (250 Pa) and all bi-directional ranges
Stability: ±1% / year FSO
Temperature Limits: 0 to 150°F (-18 to 66°C)
Pressure Limits: 1 psi maximum operation 10 psi burst
Power Requirements: 10 to 35 VDC (2-wire) 17 to 36 VDC or isolated 21 6 to 33 VAC (3-wire)
Output Signals: 4 to 20 mA (2-wire) 0 to 5 V 0 to 10 V (3-wire)
Response Time: Adjustable 0 5 to 15 sec time constant Provides a 95% response time of 1 5 to 45 seconds
Zero & Span Adjustments: Digital push button
Loop Resistance: Current output 0-1250 Ω max Voltage output min load resistance 1 kΩ
Current Consumption: 40 mA max
Display (optional): 4 digit LCD
Electrical Connections:
4-20 mA 2-Wire European style terminal block for 16 to 26 AWG
0-10 V 3-Wire European style terminal block for 16 to 22 AWG
Electrical Entry: 1/2″ NPS thread
Accessory (A-151) Cable gland for 5 to 10 mm diameter cable
Process Connections: 3/16″ D tubing (5 mm D) Maximum OD 9 mm
Enclosure Rating: NEMA 4X (P66)
Mounting Orientation: Diaphragm in vertical position
Weight: 8 0 oz (230 g)
Agency Approvals: CE

ACCESSORIES

A-435, Field Upgradeable LCD
A-480, Plastic Static Pressure Tip
A-481, Installer kit Includes 2 plastic static pressure tips and 7 ft (2 1 m) of PVC tubing
A-489, 4″ Straight Static Pressure Tip with Flange
A-302F-A, 303 SS Static Pressure Tip with mounting flange For 3/16″ D rubber or plastic tubing 4″ insertion depth Includes mounting screws
SCD-PS, 100 to 240 VAC/VDC to 24 VDC Power Supply

See page 567 for process tubing options