SUPPLEMENTAL
INVESTIGATION WORK PLAN

Interim Approval: Groundwater and Direct-Push Tasks
Interim Approval: In-Home Sampling Tasks

PerkinElmer Missouri Metals Site
Overland, Missouri

Prepared for

PerkinElmer, Inc.

April 2012

Burns & McDonnell Project No. 26682

prepared by

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1.0 INTRODUCTION

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) has prepared this Supplemental Investigation Work Plan (SIWP) for PerkinElmer, Inc.'s (PerkinElmer) Missouri Metals Site located in Overland, Missouri (Site). The Site location is illustrated on Figure 1-1. The SIWP was submitted to the Missouri Department of Natural Resources (MDNR) on January 19, 2010. On May 14, 2010 the MDNR and the Missouri Department of Health and Senior Services (MDHSS) provided comments on the SIWP and MDHSS comments on the Quality Assurance Project Plan (QAPP). The first revision to the SIWP and the corresponding QAPP was submitted to the MDNR in August 2010. On February 24, 2011 the MDNR provided additional comments on the first revision to the SIWP and corresponding QAPP. In a letter dated July 15, 2011, MDNR granted conditional approval of the second revision of the SIWP and corresponding QAPP for the scope of work that includes the collection of groundwater samples at temporary and existing monitoring well locations. This work was conducted in August and September 2011.

On September 21, 2011 MDNR provided comments on the second revision of the SIWP mostly related to the next phase of work; soil gas sampling. A third revision of the SIWP incorporating the responses to these comments, identified in track changes, was submitted on October 5, 2011 via email.

In a letter dated November 8, 2011, MDNR redirected the next phase of work based on the results of the groundwater sampling. Based on MDNR's direction, the next phase of work will consist of in-home sampling at selected residences. On January 5, February 24, and March 27, 2012, MDNR provided additional comments related to in-home sampling activities. We have updated the third revision of the SIWP, and corresponding QAPP, incorporating the responses to MDNR comments from these three dates. In an email dated April 13, 2012, MDNR granted conditional approval of this third revision of the SIWP and corresponding QAPP for the scope of work that includes the collection of in-home samples (sub-slab and indoor air).

This SIWP provides a summary of planned field activities, sampling rationale, sampling procedures and protocols, and analytical methods used during supplemental investigation activities. In addition, this SIWP includes the necessary information to satisfy the requirements of a sampling and analysis plan (SAP) when used in combination with the QAPP (Burns & McDonnell, 2012).

1.1 PURPOSE

The primary purpose of the supplemental investigation activities is to assess the potential vapor intrusion pathway in the off-Site areas. Analytical data used for the previous off-Site evaluation was collected approximately ten years ago and at that time an evaluation was made by MDHSS of the in-home sampling conducted in the off-site area. MDHSS concluded that the contaminants detected were not at levels expected to cause adverse health effects based on existing screening levels at that time (MDHSS, 2001). MDHSS also recommended that the sources of the detected contaminants in basement air be determined and that further sampling should be conducted. Since the MDHSS report in 2001, screening levels for the COCs have become significantly more conservative. Based on this and on recommendations by MDHSS, there is a need to collect more recent data and re-evaluate the risk based on the current United States Environmental Protection Agency (USEPA) standards.

As an ancillary benefit, some of the data collected as part of this supplemental investigation will be useful in further assessing the effectiveness of the on-site remediation activities conducted to date. In addition, the new data will eventually be a part of the data set used to develop a Focused Risk Assessment to determine the path forward for the Site.

1.2 SITE LOCATION AND HISTORY

The Site is located at 9970 Page Avenue in Overland, Missouri (Figure 1-1), near the center of Section 31, Township 46 North, Range 6 East in St. Louis County, Missouri. The property area is approximately 3.5 acres located in an area that is primarily commercial and/or light industrial. An area of residential development is located southeast of the Site, across Meeks Boulevard. Structures on the property consist of two manufacturing buildings and two metal storage buildings. The Site layout is shown in Figure 1-2.

The Site is located in an area of rolling hills, with the northwest corner of the property approximately 15 feet higher than the southeast corner. The majority of the ground surface, approximately 90 percent, is paved with asphalt or concrete (Figure 1-2) with small areas of grass, gravel and bare soil present in portions of the property. A public water supply system is available at the Site and the surrounding area. The City of Overland is served by the St. Louis County Water Company which draws water from surface water sources, namely the Meramec and the Missouri Rivers.

Data obtained from past soil and groundwater investigations suggests that historical releases of solvents, primarily PCE and TCE, into the soil and groundwater have occurred at the Site. These solvents were previously used at the Site, but their use has since been eliminated in an effort to prevent additional releases. Written records on plant chemical usage and waste disposal practices for this facility are available only for recent years. No facility spill reports are available concerning historical release information, such as location or date of releases (Burns & McDonnell, 1992).

1.2.1 Chemicals of Concern

The primary chemicals of concern (COCs) at the Site are solvents previously used at the Site [tetrachloroethylene (PCE) and trichloroethylene (TCE)] and their daughter products [1,1-dichloroethylene (DCE), cis-1,2-DCE, trans-1,2-DCE and vinyl chloride (VC)].

The 1994 Consent Agreement between MDNR and PerkinElmer (MDNR, 1994) includes the aforementioned COCs, as well as additional compounds that have at one time been identified in soil and/or groundwater at the Site. These additional compounds include benzene, chlorobenzene, chloroform, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethane, methylene chloride, toluene, and 1,1,1-trichloroethane. During the five-year groundwater monitoring period following the signing of the 1994 Consent Agreement, benzene, chlorobenzene, 1,2-dichloroethane, 1,1-dichloroethane, toluene, and 1,1,1-trichloroethane were not detected. As a result, those compounds were removed from the list of Site-specific COCs.

Methylene chloride has been detected during several groundwater and soil sampling events at the Site, but each time it has also been detected in the sample trip and/or method blank and was thus considered a laboratory contaminant. As a result, methylene chloride was removed from the list of Site-specific COCs. During the 1999 off-Site groundwater investigation activities, chloroform was detected in two groundwater samples at concentrations significantly below the MCL of 100 µg/L for chloroform. Chloroform was not detected during monitoring wells sampling from 1995 through 1999 and was not detected during the off-Site soil investigation activities. As a result, chloroform was removed from the list of Site-specific COCs. During the 1999 off-Site soil investigation activities, 1,4-dichlorobenzene was detected in only one soil sample (SB-8) with a concentration substantially below the Any-Use Soil Levels identified in the 1994 Consent Agreement and current USEPA Regional Screening Levels for Residential Soil (USEPA, 2010). 1,4-dichlorobenzene was not detected in any groundwater samples during the five year monitoring period. As a result, 1,4-dichlorobenzene was removed from the list of Site-specific COCs.

Based on the sampling history at the Site, the remaining COCs are PCE, TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE and VC. These have been the COCs at the Site since 2000, and have been the focus of all investigation and remediation efforts at the Site since that time.

1.2.2 Site Timeline

As mentioned in the previous section, PerkinElmer entered into a Consent Agreement with MDNR in 1994 to facilitate the development and implementation of a Remedial Action Plan (RAP) for the Site. As dictated by the Consent Agreement, a five-year monitoring period was conducted from 1994 to 1998 (Burns & McDonnell, 1998). This monitoring period was followed by the completion of a revised Remedial Alternatives Evaluation (RAE) (completed in January 2001) for the Site. Three remedial alternatives were evaluated in the RAE, and chemical oxidation was selected as the recommended remedial alternative.

Due to the innovative nature of the technology at that time, a treatability study and pilot test were required to confirm that chemical oxidation could cost-effectively meet the remedial objectives at the Site. Burns & McDonnell performed a chemical oxidation pilot test at the Site during December 2001 by delivering potassium permanganate to the subsurface by gravity well injection and hydraulic fracturing methods. The results of the pilot test indicated that the chemical oxidation with $KMnO_4$ could successfully treat the contaminated groundwater at the Site (Burns & McDonnell, 2002a)

In 2002, a RAP was prepared by Burns & McDonnell for full-scale design and implementation at the Site. Burns & McDonnell implemented the RAP during 2003 and 2004. During implementation of the RAP, potassium permanganate was injected via injections wells, fractures, and an injection trench near the former degreasing pit. The results of the RAP implementation were summarized in the Remedial Action Summary Report (RASR) submitted to MDNR in March 2005 (Burns & McDonnell, 2005).

Following completion of RA activities, a Human Health Baseline Risk Assessment (Burns & McDonnell, 2006) was prepared for PerkinElmer in January 2006 to conduct a baseline evaluation of potential human health risks that might be experienced by human exposures to contaminated media associated with the Site, and to determine clean-up levels for on-Site soil and groundwater. MDNR submitted their response to comments on the RASR and the Baseline Risk Assessment in a letter dated October 1, 2009. Burns & McDonnell submitted a response to comments in a letter dated November 2, 2009. A meeting was held between representatives of Burns & McDonnell, PerkinElmer, MDNR, and MDHSS on December 3, 2009 to discuss the path forward and scope of this work plan.

1.3 SUMMARY OF PREVIOUS OFF-SITE INVESTIGATION ACTIVITIES

The focus of the off-Site investigation within the Chicago Heights Boulevard Neighborhood in an unincorporated segment of St. Louis County, located immediately southwest of the Site (off-Site) (see Figure 1-3). The Chicago Heights Boulevard Neighborhood consists of a residential neighborhood of both single family and multi-family dwellings. Many of the residences have basements with sump pumps. The ground surface is relatively flat on the south and east, but gently slopes upward toward the Site to the northwest.

The off-Site area is generally bounded on the north by Meeks Boulevard, on the east by Werremeyer Place, on the south by Chicago Heights Boulevard, and on the west by a chain-link fence separating the neighborhood from an adjacent business. The neighborhood lies within a heavily urbanized area, surrounded by various industrial and commercial businesses. A group of rental storage units also lies northwest of the Site. The south side is adjacent to railroad tracks and commercial buildings facing Dielman Rock Island Drive, north of the River Des Peres.

Various off-Site investigations were conducted from 1998 through 2001 by MDNR and Burns & McDonnell to determine the off-Site extent (vertical and horizontal) of groundwater contamination from the Site, and any impacts to nearby residents via indoor air or sump water. The off-Site results indicated that significant impacts in the shallow overburden (the unit with potential impact on nearby residents) were limited to areas in close proximity to the Site. Historical off-Site sampling locations are illustrated on Figure 1-3. Historical off-Site investigation activities are detailed in the following sections.

1.3.1 Soil Sampling

Previous off-Site soil investigation activities were conducted by Burns & McDonnell in August 1998 and July 1999. Historical soil analytical results are presented in Table 1-1. August 1998 off-Site investigation activities conducted by Burns & McDonnell included soil sampling (soil borings SB-1 through SB-14) in the northwestern portion of the residential area (located immediately south of the Site) as illustrated on Figure 1-3. The 1998 analytical results indicated contaminant concentrations are all below the Any-Use Soil Levels identified in the 1994 Consent Agreement and current USEPA Regional Screening Levels for Residential Soil (USEPA, 2010). PCE was detected at one location, SB-2, with a concentration of 54 µg/kg. TCE was detected in three soil samples with concentrations ranging from 16 µg/kg at SB-12 to 1,900 µg/kg at SB-8. 1,1-DCE was detected at one location, SB-12, with a concentration of 29 µg/kg. A total of six samples with concentrations ranging from 6 µg/kg in SB-13 and SB-3 to 290 µg/kg in SB-8. Cis-1,1-DCE was detected in a total of six samples with concentrations ranging from 6 µg/kg in SB-13 to 290 µg/kg in SB-8. Trans-1,2-DCE was detected at one location, SB-12, with a concentration of 29 µg/kg and there were no detections of vinyl chloride.

July 1999 off-Site investigation activities by Burns & McDonnell included subsurface soil sampling at 14 locations across the off-Site residential area (see Figure 1-3). Direct-push borings (B-1 through B-14) were generally completed to depth of refusal or 20 feet bgs, whichever was encountered first. One soil boring was collected from each boring just above the groundwater interface. There were no detections of COCs in the 14 subsurface soil samples. Results of the Burns & McDonnell off-Site soil investigation is discussed in the Additional Off-Site Investigation Report (Burns & McDonnell, 1999)

1.3.2 Groundwater Sampling

Previous shallow off-Site groundwater investigation activities were conducted by Burns & McDonnell in July 1999 and by MDNR in November and December 1999. Deeper groundwater investigations were conducted by Burns & McDonnell from 2000 through 2004. Historical groundwater analytical results are presented in Table 1-2. Historical groundwater monitoring well analytical results are presented in Table 1-3.

1.3.2.1 Shallow Groundwater (Loess Unit)

July 1999 investigation activities included installation of temporary piezometers and groundwater sampling following soil sampling at 13 direct-push locations (Burns & McDonnell, 1999). Direct-push locations B-1 and B-3 through B-14 are illustrated on Figure 1-3. Temporary piezometers were installed with 12, 15, or 18 feet (depending on the total depth of borehole) of 0.010-inch slot PVC screen from the bottom of the boring to approximately one to three-feet above grade. A piezometer was not installed at boring location B-2, due to the presence of perched groundwater at shallow depths (approximately 4 feet).

Groundwater analytical results were compared to the Maximum Contaminant Levels (MCLs) identified in the 1994 Consent Agreement. The previously used MCLs are identical to the current USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (May 2010) (USEPA, 2010). Analytical results indicated that the PCE concentrations exceeded the MCL in two sample locations with concentrations of 80 micrograms per liter (µg/L) at B-4 and 10 µg/L at B-11. TCE concentrations exceeded the MCL at three sample locations ranging from 9 µg/L at B-10 to 130 µg/L at B-4. 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE and vinyl chloride were not detected at any sample location. Historical Groundwater Analytical Results are presented in Table 1-2.

In 1999, the MDNR installed temporary wells in 26 locations (Gw-01 through Gw-26) throughout the Chicago Heights Neighborhood as part of the *Combined Preliminary Assessment/Site Investigation* (PA/SI) (MDNR, 2000). MDNR groundwater sampling locations are illustrated on Figure 1-3. Each temporary well was constructed with three-feet of pre-packed screen beginning at total depth of the borehole. The total depths of the temporary piezometers ranged from 17.0 feet bgs at Gw-12 to 29.2 feet bgs at Gw-02 (see Table 1-2). Temporary Wells Gw-04, Gw-17, Gw-18, and Gw-20 were found to be dry due to an insufficient volume of groundwater and were abandoned.

Analytical results indicate that PCE exceeded the MCL at Gw-01 with a concentration of 716 µg/L. TCE exceeded the MCL at six temporary piezometers with concentrations ranging from 10.3 µg/L at Gw-08 to 1,140 µg/L at Gw-09. Cis-1,2-DCE exceeded the MCL at Gw-01 and Gw-09 with concentrations of 369 µg/L and 149 µg/L, respectively. Vinyl chloride exceeded the MCL at three temporary piezometer locations ranging from 3.4 µg/L at Gw-19 to 10.6 µg/L at Gw-01. 1,1-DCE and trans-1,2-DCE analytical results were below the MCL at all locations. The results of MDNR's groundwater investigation activities are presented in the PA/SI Report (MDNR, 2000) and are summarized on Table 1-2. In general, the locations with exceedances are in close proximity to the Site.

1.3.2.2 Deeper Groundwater (Siltstone Unit)

In August 2000, Burns & McDonnell installed off-Site Monitoring Wells GMW-19 and GMW-20 located immediately southwest of the Site (see Figure 1-3). Monitoring Wells GMW-19 and GMW-20 were installed to a total depth of 35.7 feet bgs and 33.3 feet bgs, respectively. An additional four off-Site monitoring wells were installed within the siltstone unit in the Chicago Heights Neighborhood in February and March 2001. The newly installed monitoring wells (GMW-21 through GMW-24) were completed to a depth ranging from 33.8 feet bgs at GMW-21 to 38.1 feet bgs at GMW-22. Monitoring Well locations are illustrated on Figure 1-3. Monitoring well completion details are presented in Table 1-4.

Monitoring Wells MW-19 and MW-20 were sampled on nine occasions from August 2000 through November 2004. Analytical results showed PCE concentrations ranging from non-detectable results to 670 µg/L at GMW-19 in November 2003. Analytical results showed TCE concentrations ranging from 117.0 µg/L at GMW-20 in January 2002 to 11,600 µg/L at GMW-19 in November 2003. 1,1-DCE and trans-1,2-DCE analytical results were not detected above laboratory reporting limits during any sampling event except in December 2001, with the detected concentrations in December 2001 below MCLs. Cis-1,2-DCE was detected in all but one sample (GMW-20 in August 2000) and vinyl chloride was only detected above laboratory reporting limits in one sample (GMW-19 in December 2001). Historical monitoring well groundwater analytical results are presented in Table 1-3.

Off-Site Monitoring Wells GMW-21 through GMW-24 were sampled in March 2001 and December 2004. Analytical results indicated that PCE was detected in all sample results ranging from 4.0 µg/L at GMW-24 in March 2001 to 700.0 µg/L at GMW-24 in December 2004. TCE was also detected in each sample ranging from 6.0 µg/L at GMW-22 in March 2001 to 1,900 µg/L at GMW-24 in December 2004. Cis-1,2-DCE was the only DCE compound detected above the laboratory reporting limits, and ranged from non-detectable results to 110.0J µg/L at GMW-24 in December 2004. Vinyl chloride was not detected above the laboratory reporting limit in any sample. Historical groundwater monitoring well analytical results are summarized in Table 1-3.

1.3.3 In-Home Sampling

Burns & McDonnell conducted in-home sampling in November 1998 in a total of four residential basements following the August 1998 soil sampling activities. In April 2001, following results of the PA/SI by MDNR, a Site Re-Assessment (SR) was conducted by MDNR to determine if residents in the Chicago Heights Neighborhood were being exposed to VOC vapors entering their basements (MDNR, 2001). The MDNR SR investigation sampling included indoor air sampling and sump water sampling in a total of six residential basements. During SR investigation activities, Burns & McDonnell collected split samples at selected monitoring points.

A Health Consultation was conducted by MDHSS following in-home sampling activities. MDHSS concluded that the contaminants detected were not at levels expected to cause adverse health effects based on existing screening levels at that time (MDHSS, 2001). MDHSS also recommended that the sources of the detected contaminants in basement air be determined and that further sampling should be conducted. In-home sampling activities are summarized in the following sections.

1.3.3.1 Indoor Air Sampling

In November 1998, Burns & McDonnell collected indoor air sampling in a total of four residential basements and submitted them for volatile organic compounds (VOCs) analysis (see Figure 1-3). Analytical results indicate that all were non-detect results for VOCs (see Table 1-5); however, the reporting limits generally exceed the current USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (May 2010) for Residential Air (USEPA, 2010). As a result, in Table

1-5 samples have been shaded as an exceedance if half the reporting limit exceeds the current USEPA Screening Levels.

In April 2001, MNDR collected indoor air samples within five residential basements and submitted them for VOC analysis. At that time, Burns & McDonnell collected split samples at two residences. Locations of each residence sampled are illustrated on Figure 1-3. Analytical results show a detection of 4.88 µg/m^3 of PCE at [redacted] in the Burns & McDonnell split sample, however, the MDNR sample indicated a non-detect result. TCE was detected at two residences with concentrations of 67 µg/m^3 at both [redacted] and [redacted] Cis-1,2-DCE was detected in one residence ([redacted] with a concentration of 35 µg/m^3. 1,1-DCE, trans-1,2-DCE, and vinyl chloride was not detected in any residential basement sampled.

Analytical results were compared to the current USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (May 2010) for Residential Air (USEPA, 2010) and are presented on Table 1-5. In addition, the reporting limits generally exceed the current USEPA Screening Levels for indoor air. As a result, in Table 1-5 samples have been shaded as an exceedance if half the reporting limit exceeds the current USEPA Screening Levels.

1.3.3.2 Basement Sump Water Sampling

In November 1998, Burns & McDonnell collected basement sump water samples within two residential basements and analyzed them for VOCs (see Figure 1-3). Historical residential sump water analytical results are presented on Table 1-6. Groundwater analytical results were compared to the MCLs identified in the 1994 Consent Agreement. The previously used MCLs are identical to the current USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (May 2010) (USEPA, 2010). Analytical results indicate that the only detectable result was TCE with a concentration of 4.0J µg/L collected at [redacted] The concentration was below the MCL for TCE; however, the reporting limit for VC during this sampling event exceeded the MCL. As a result, in Table 1-6 samples have been shaded as an exceedance if half the reporting limit exceeds the current USEPA Screening Levels.

In April 2001, MDNR collected basement sump water samples within five residential basements and analyzed them for VOCs. At that time, Burns & McDonnell collected split samples at two of the five MDNR locations. The results are summarized in Table 1-6. PCE was detected in three MDNR samples ranging from 3.7 µg/L at [redacted] to 1.5 µg/L at [redacted] PCE was detected in both Burns & McDonnell split samples with concentrations of 3.5 µg/L at [redacted] and 0.8J µg/L at [redacted] TCE was detected in two of the five MDNR samples with concentrations of 66.5 µg/L at [redacted] and 1,140 µg/L at [redacted] TCE was detected in both Burns & McDonnell split samples with concentrations of 0.7J µg/L at [redacted] and 76.0K µg/L at [redacted] Cis-1,2-DCE was detected in four samples collected by either MNDR or Burns & McDonnell and ranged from 0.8J µg/L to 83.7 µg/L. Trans-1,2-DCE was detected in one sample below the reporting limit at a concentration of 0.6J µg/L.

1.4 OFF-SITE ACCESS AND PERMITTING

For the Supplemental Investigation, PerkinElmer has executed a short-term access agreement with the Housing Authority of St. Louis County (HASLC) for access to rental properties to allow Burns & McDonnell access for completion of investigation activities. A copy of the short-term access agreement with the HASLC is provided in Appendix A. In addition, a special use permit for access to right-of-way locations is required and will be submitted to the St. Louis County Department of Highways and Traffic once this SIWP is approved by MDNR. Investigation activities must be completed within 30 days of special use permit approval. A copy of the special use permit application forms are also provided in Appendix A.

1.5 UTILITY CLEARANCE

Prior to any field work involving intrusive subsurface activities, utility clearance will be required. Burns & McDonnell personnel will locate utilities with the aid of Missouri One-Call (1-800-DIG-RITE). A 48-hour notification is required for Missouri One-Call prior to commencing intrusive activities. Due to presence of underground or overhead utilities, it may be necessary to offset proposed boring locations. Any modification to proposed boring locations will be done with approval of the Burns & McDonnell Project Manager and documented in the field logbook.

1.6 HEALTH AND SAFETY PLAN

A Site Health and Safety Plan (SHSP) has been prepared in accordance with all applicable OSHA regulations 1910 and 1926 and covers all work activities to be performed. It is provided in Appendix A of the QAPP. The SHSP was reviewed and approved by Burns & McDonnell's Corporate Health and Safety Manager. On-Site health and safety oversight will be provided by Burns & McDonnell. A copy of the SHSP will be kept on Site during the supplemental investigation activities. Health and safety tailgate meetings will be conducted daily by the Site Health and Safety Supervisor.

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2.0 SUPPLEMENTAL INVESTIGATION SAMPLING RATIONALE

This section details the supplemental investigation sampling rationale for conducting groundwater, soil gas, and residential in-home sampling activities for the purpose of assessing the potential vapor intrusion pathway in the off-Site areas. All data collected during field activities will be recorded in the field logbook or on designated field forms. Standard field forms are provided in Appendix B. We understand that MDNR wishes to collect spilt samples during all sampling events, and we will provide MDNR with the required notice (minimum of 2-weeks) to allow MDNR to schedule laboratory services through MDNR's Environmental Services Program.

Overall, we are proposing the following sampling events as part of this supplemental investigation:

- **Groundwater:** One direct-push sampling event and two semi-annual monitoring well sampling events.
- **Soil Gas:** A minimum of one sampling event.
- **Residential In-Home:** Three sub-slab vapor, indoor air, and sump water sampling events; one in the winter, one in the spring, and one in the summer to assess seasonal variability in the data as it relates to the potential vapor migration pathway.

The rationale for each type of sampling event is given in the following sections. An anticipated schedule is presented in Section 6.0 of this SIWP.

2.1 GROUNDWATER SAMPLING RATIONALE

This section describes the rationale used for collecting representative groundwater samples at temporary direct-push monitoring point locations located within the shallow unit (loess) off-Site, and within existing monitoring wells screened within both the shallow unit (loess) and deeper unit (siltstone) on and off-Site. In addition, this section includes the process for determining the locations for permanent off-Site shallow monitoring wells.

2.1.1 Direct-Push Groundwater Sampling

One direct-push groundwater sampling event will be conducted off-Site. Groundwater samples will be collected from within the shallow unit (loess unit) using temporary monitoring points as a screening tool to assess the groundwater plume for subsequent soil gas and residential in-home sampling, and to determine the appropriate locations for permanent shallow monitoring wells. The groundwater analytical data in combination with the soil gas analytical data will be used as a screening tool to determine residential in-home sampling locations in consultation with MDNR and MDHSS.

Proposed direct-push groundwater sampling points are in locations to confirm previous off-Site groundwater analytical results and to allow for a more complete evaluation of shallow groundwater concentrations off-Site. A total of 28 temporary monitoring points will be installed and the proposed locations are illustrated on Figure 2-1. Sampling locations may be modified during installation based on access and utility locations.

Temporary monitoring points will be installed using standard direct-push equipment to an anticipated depth of approximately 15 feet bgs based on water level data from shallow monitoring wells located on-Site. Actual depths will be determined in the field based on the depth the shallow groundwater interface is encountered. Continuous soil cores will be collected and recorded on boring logs during installation for observation and lithology. Water levels within the temporary monitoring points will be allowed to stabilize prior to the initiation of groundwater sampling. Groundwater samples will be collected for analysis of Site-specific COCs using USEPA SW-846 Method 8260. Temporary monitoring point installation procedures and direct-push groundwater sampling procedures are detailed in Sections 3.1.1 and 3.1.2, respectively.

The direct-push groundwater analytical data will be used to draw a shallow groundwater plume map of the off-Site area. The plume map will be used to determine soil gas sampling locations and the location of permanent shallow monitoring wells. At this time it is anticipated that four permanent shallow monitoring wells will be adequate, however, the actual number of permanent shallow monitoring wells to be installed will be determined based on the direct-push groundwater analytical data. Soil gas sampling locations will be determined based on exceedances of the calculated Site-specific screening levels for COCs discussed in Section 5.1 of this SIWP. In consultation with MDNR, the shallow monitoring well locations will be determined based on the plume map and access. Monitoring well installation and development procedures are detailed in Section 3.1.3 and 3.1.4, respectively.

2.1.2 Monitoring Well Groundwater Sampling

Two semi-annual groundwater sampling events will be conducted. During each event, samples will be collected from all existing off-Site and selected on-Site monitoring wells to assess the current groundwater condition in both the shallow (loess) and deeper (siltstone) units. Groundwater samples will be collected from all on-Site monitoring wells except MW-1, MW-4, and MW-18. Existing monitoring well locations are illustrated on Figure 1-2 and 1-3. Groundwater samples will be collected from newly installed off-Site shallow monitoring wells during the second semi-annual sampling event.

Groundwater samples will be collected for analysis of Site-specific COCs using USEPA SW-846 Method 8260. During purging, water quality parameters [pH, temperature, conductivity, dissolved oxygen (DO), and oxidation-reduction potential (ORP)] will be measured. Monitoring well groundwater sampling procedures are detailed in Section 3.1.5.

2.2 SOIL GAS SAMPLING RATIONALE

At a minimum one soil gas sampling event will be conducted off-Site. Soil gas samples will be collected from within the off-Site shallow unit (loess unit) using semi-permanent monitoring points to provide an indicator of the potential for vapor intrusion within the sampling area. The soil gas samples will aid in identifying potential preferential vapor migration pathways in the vadose zone, and will aid in assessing the presence and distribution of contaminants in soil and groundwater. Also, the data will be used along with the direct-push groundwater analytical data as a screening tool to determine residential in-home sampling locations in consultation with MDNR and MDHSS.

The soil gas sampling locations will be determined based on direct-push groundwater exceedances of the calculated Site-specific screening levels discussed in Section 5.1. ~~Semi-permanent s~~Soil gas sampling points will be installed at up to 28 locations adjacent to the newly installed temporary groundwater monitoring points and will be constructed using ~~an AMS® soil sampling system or~~ standard direct-push equipment. Installation depths of the sampling points will be determined once stable groundwater levels have been obtained from the temporary direct-push monitoring points. Soil gas samples will be collected above the water table, at least five feet below ground surface (bgs) to minimize the potential for short-circuiting. Soil gas sampling point installation procedures and construction details are discussed in Section 3.2.

Soil gas samples will be collected over various seasons to account for seasonal variability and in an effort to include worst case conditions. Samples will not be collected if significant precipitation (0.25 inches within a 24-hour period) or irrigation near the sampling location has occurred within the previous 48 hours. The increased soil moisture can cause the soil gas sample results to be biased low. Also, prior to sampling, a chemical leak test followed by a mechanical leak test will be performed to ensure proper seals within the sampling train assembly. Corrective actions to mitigate leaks in the soil gas point will be performed as necessary. Chemical and mechanical leak testing procedures are detailed in Section 3.2.

After the chemical leak test and mechanical leak test have been performed successfully, soil gas samples will be collected using individually-certified 1.0-liter (L) Summa™ canisters for low-level VOC analysis. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the *Sampling Instructions for Canisters with Pneumatic Flow Controllers* provided by the laboratory (Appendix C). Sample location information and meteorological conditions such as temperature, wind speed, barometric pressure, and humidity shall be recorded. Meteorological data will be obtained online from the nearest National Weather Service measuring station. Soil gas sampling procedures are detailed in Section 3.2 and the field air sampling form is provided in Appendix B.

2.3 RESIDENTIAL IN-HOME SAMPLING RATIONALE

Up to three residential in-home sampling events will be conducted off-Site; one in the winter, one in the spring, and one in the summer. The in-home sampling events are being conducted over various seasons to account for seasonal variability, and in an effort to include worst case conditions, as it relates to the potential vapor migration pathway. Residential in-home sampling will occur at locations determined in consultation with MDNR and MDHSS following review of shallow groundwater and soil gas analytical data. Shallow groundwater and soil gas analytical results will provide an indicator of potential for vapor intrusion, and will help determine locations of in-home sampling based on exceedances of the calculated Site-specific screening levels discussed in Section 5.1 of this SIWP.

Based on initial direct-push groundwater data, MDNR and MDHSS recommended initial sampling of seven residential homes and one apartment building in the Chicago Heights Boulevard Neighborhood. Appendix D includes an illustration provided by MDNR, which is an attachment of the November 8, 2011 letter, showing the locations where in-home sampling will initially be conducted.

Residential in-home sampling will include both indoor air sampling and sub-slab vapor sampling at each selected residence during each residential in-home sampling event. Residential properties include both single-family homes and a multi-family apartment building. The apartment building does not have basements and all residential units share a single slab on grade building foundation. Two sub-slab and one indoor air sample will be collected from each single family home. One sub-slab and one indoor air sample will be collected from each housing unit of the apartment building. In addition, sump air and water samples will be collected from basement sumps if present during residential in-home sampling. The procedures for indoor air sampling, sub-slab vapor, and sump air and water sampling are detailed in Sections 3.3 of this SIWP.

Prior to commencing in-home sampling activities, a preliminary screening will be conducted. In-home sampling preliminary screening activities are discussed in Section 3.3.1. Meteorological conditions such as temperature, wind speed, barometric pressure, and humidity will be recorded during in-home sampling. Meteorological data will be obtained online from the nearest National Weather Service measuring station. The groundwater level will also be measured in nearby monitoring wells. Residential in-door sampling will be conducted under closed conditions during the winter and summer seasons, plus during the spring season to account for seasonal variances. Instructions will be provided to occupants on appropriate actions that should be taken prior to and during in-home sampling events. Occupants will be instructed to refrain from using products that may contain VOCs, and to remove any household items that may be potential indoor air sources of VOCs at least 24 hours prior to the start of sampling activities.

Residential in-home sampling will not be conducted if significant precipitation (0.25 inches within a 24-hour period) or irrigation near the sampling location has occurred within the previous 48 hours. The increased soil moisture can cause the soil vapor sample results to be biased low. However, significant precipitation could result in groundwater infiltration into the building which may cause additional exposure concerns beyond vapor intrusion. This may be reevaluated at a later date based on consultation with MDNR and MDHSS.

2.3.1 Indoor Air Sampling

Indoor air samples will be collected over a 24-hour sample duration from the breathing zone height (three to six feet above the floor) using individually-certified 6.0-L Summa™ canisters for low-level VOC analysis. Prior to collection of indoor air samples, a preliminary screening will be conducted of the sample locations. Preliminary screening will be conducted using a PID capable of reading in parts per billion (ppb). In the event that PID readings showing elevated organic vapor levels are detected immediately prior to sampling, the source will be identified and removed, and the sampling will be delayed a minimum of 24 hours. Indoor air sampling procedures are detailed in Sections 3.3.2 of this SIWP.

One ambient air sample per sampling event will also be collected concurrently with the indoor air samples to provide a measure of background concentrations of VOCs in outdoor air. The ambient air samples will be collected off the ground within the breathing zone (three to six feet above the ground surface) from a representative upwind location. This location will be chosen at a place where bias is minimized.

Indoor air samples will be collected using individually-certified 6.0-L Summa™ canisters for low-level VOC analysis. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the *Sampling Instructions for Canisters with Pneumatic Flow Controllers* provided by the laboratory (Appendix C). Canisters, flow regulators/particulate filters, and vacuum gauges will be supplied by the laboratory.

2.3.2 Sub-Slab Soil Vapor Sampling

Prior to installing the sub-slab vapor probes, general building structural condition and use information will be documented. This includes a description of the general basement uses, presence/absence of wells or sumps, and documenting potential indoor VOC sources by identifying what chemicals are used or are present in the building. The point of entry of subsurface utilities will be identified. Sub-slab vapor probe installation, sampling, and analysis will be conducted in accordance with the procedures presented in Section 3.3.3 of this SIWP.

Two sub-slab sampling probes will be installed in each single family home and one sub-slab probe per housing unit of the apartment building. Each sub-slab probe will be permanent sampling probe that will remain in place after completion of the sampling event. Permanent sampling probes will be installed because they provide higher quality and more consistent data. The exact number and location of sub-slab probes will ultimately be determined in the field based upon building construction observations. A pilot hole will be drilled first to assess the thickness of the building slab. The individual probes will be removed and the holes sealed upon determining that further sub-slab soil vapor sampling will not be required at a given location. Areas of visible staining or known previous chemical spills will be avoided.

Prior to sampling, a chemical leak test followed by a mechanical leak test will be performed to ensure proper seals within the sampling train assembly. Corrective actions to mitigate leaks in the soil gas point will be performed as necessary. Chemical and mechanical leak testing procedures are detailed in Section 3.3.3 of this SIWP. Due to the small amount of volume needed to adequately purge the soil vapor probe, it will be accomplished by filling the 1.0-L Tedlar™ bag during chemical leak testing. The field air sampling form is provided in Appendix B. Samples will be collected using evacuated batch-certified 1.0-L Summa™ canisters equipped with dedicated flow regulators and integrated particulate filters. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the *Summa Canister Instructions* provided by the laboratory (Appendix C). Canisters, flow regulators/particulate filters, and vacuum gauges will be supplied by the laboratory.

2.3.3 Sump Air and Water Sampling

Residential in-home sampling will also include one 24-hour air sample collected from the basement sump opening and one sump water sample at each selected residence during each residential in-home sampling event. In the event that water is not present in the sump or the sump water is stagnant without the ability to recharge the sump to obtain a fresh groundwater sample, then sump water will not be sampled at that residence during that in-home sampling event. Sump water samples will be collected in the form of a grab sample. The procedures for sump air and water sampling are detailed in Sections 3.3.4 of this SIWP.

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3.0 FIELD SAMPLING AND ANALYSIS PLAN

This section details the supplemental groundwater investigation sampling procedures for groundwater, soil gas, sub-slab vapor, indoor air, and sump air and water sampling. Detailed information regarding sample collection procedures/methods, required equipment, decontamination of sampling equipment, and handling of investigation derived waste is included in this section. Also included in this Section are procedures for monitoring well installation and development and temporary piezometer, soil gas, and sub-slab sampling point installation and abandonment. Non-standard sampling activities are not planned. All data collected during field activities will be recorded in the field logbook or on designated field forms. Field activity documentation procedures are detailed in Section 3.6. Data management details are presented in Section 3.13 of the QAPP (Burns & McDonnell, 2012). All field activities will be performed by properly trained personnel.

3.1 GROUNDWATER INVESTIGATION ACTIVITIES

The following section presents the procedures for installation of temporary monitoring points and permanent monitoring wells, and collection of representative groundwater samples at temporary monitoring points and permanent monitoring wells. Field activity documentation details are provided in Section 3.6.

3.1.1 Temporary Groundwater Monitoring Point Installation Procedures

Off-Site groundwater samples will be collected from a total of 28 direct-push locations within the shallow unit (loess unit) using temporary monitoring points. The proposed off-Site groundwater sampling locations are illustrated on Figure 2-1. Actual sampling locations may be modified based on access and utility locations.

Temporary monitoring points will be installed using standard direct-push equipment to an anticipated depth of approximately 15 feet bgs. Actual depths will be determined in the field based on the depth the groundwater interface is encountered. Continuous soil cores will be collected and recorded on boring logs during installation for observation and lithology. A photoionization detector (PID) will be used to screen soil cores for non-specific VOCs and will be recorded on the boring logs. Soil cores will be evaluated for organic vapors with a PID at least at least every three (3) feet in uncontaminated horizons, at changes in material, and at least every 1 foot in contaminated horizons. The PID will be equipped with a 10.6 eV- lamp to account for the ionization potentials of the Site-specific COCs. Borehole logging procedures are discussed in Section 3.3.5 of the QAPP (Burns & McDonnell, 2012). Temporary monitoring points will be constructed using schedule 40, 1.25-inch diameter polyvinyl chloride (PVC), with 10 feet of 0.01-inch slot well screen. A 5-foot screen will be used if groundwater is encountered at less than 10 feet bgs.

The following procedure will be used for the installation of temporary monitoring points:

1. All rods and re-usable equipment will be decontaminated prior to each location.
2. Advance a Macro-Core® sampler [2-inch outer diameter (OD)] with acetate liner at each location.
3. Retrieve soil sample from borehole. Open the acetate liner and collect PID readings from the length of the soil core. Log the soil. Note any staining, odors, or free product present.
4. Repeat Steps 1 and 2 to until the water table is encountered.
5. Retract the rods from the borehole, install a 1.25-inch nominal diameter schedule 40 PVC well screen and riser from total depth to ground surface. PVC screen and riser pipe will be flush-threaded. The joints will be constructed so as to form a watertight seal. Screen bottoms will be sealed with a flush-threaded PVC cap or slip-on cap secured with three, stainless-steel, self-tapping screws. No glues or solvents shall be used in the construction of temporary groundwater monitoring points.
6. The temporary monitoring point will be completed with a flush mount well surface completion. A locking cap will be placed on the riser pipe

Solid and liquid IDW created during investigation activities will be containerized in Department of Transportation (DOT)-approved 55-gallon drums, labeled, and stored on-Site pending proper disposal by PerkinElmer (see Section 3.9). Non-disposable and other non-dedicated sampling and sample-contacting equipment will be decontaminated using proper decontamination techniques detailed in Section 3.5. Temporary monitoring points will be abandoned within 30 days of installation in accordance with the Missouri Well Construction Rules. Borehole abandonment procedures are detailed in Section 3.8 of this SIWP.

3.1.2 Direct-Push Groundwater Sampling Procedures

Groundwater samples will be collected for analysis of Site-specific COCs using USEPA SW-846 Method 8260. Prior to initiation of groundwater sampling, water level measurements will be taken with an electronic water level indicator to the top of the well casing to the nearest 0.01 foot. Water levels will be allowed to stabilize prior to sample collection.

Groundwater samples will be collected at temporary monitoring points in the form of grab samples using a peristaltic pump and dedicated tubing. If sufficient groundwater is present a system volume (pump and tubing) will be purged prior to sampling. Temporary monitoring points will be sampled by Burns & McDonnell personnel wearing new disposable Nitrile® gloves.

The following procedure will be used to purge and sample a temporary monitoring point using a peristaltic pump and dedicated tubing:

1. Lower the dedicated tubing with the end of the tubing terminating in the center of the screened interval of the monitoring point;
2. Connect the dedicated tubing to the flow through cell and a YSI 556 Multi-probe system (or equivalent) to measure water quality parameters;
3. If sufficient groundwater is present purge a system volume (pump and tubing) prior to measuring water quality parameters and sampling. If sufficient groundwater is not present measure water quality parameters and sample groundwater without purging;
4. Start purging groundwater;
5. Measure water quality parameters, including as pH, temperature, conductivity, DO and ORP (without regard to stabilization) and record in the field logbook;
6. Disconnect the flow-through cell prior to sampling to ensure that the sample only contacts new or dedicated sampling equipment; and
7. Sample groundwater by filling the laboratory provided container. Minimal groundwater is needed for sample collection (approximately 120 mL).

All fluids generated during temporary monitoring point purging and sampling will be containerized in DOT-approved 55-gallon drums, labeled, and stored on-Site pending proper disposal by PerkinElmer (see Section 3.9). Non-disposable and other non-dedicated sampling and sample-contacting equipment will be decontaminated using proper decontamination techniques detailed in Section 3.5.

The groundwater samples will be placed in a cooler with ice and will be submitted to a TestAmerica – Burlington (TestAmerica) of South Burlington, Vermont following proper chain-of-custody procedures (see Section 3.6.2). All groundwater samples will be sent for laboratory analysis of Site-specific COCs using USEPA SW-846 Method 8260. Field and laboratory QC sample collection and analyses details are discussed in Section 4.0.

3.1.3 Monitoring Well Installation Procedures

Permanent shallow monitoring wells will be installed based on results of the direct-push groundwater sampling activities (see Section 2.1.2). At this time it is anticipated that four permanent shallow monitoring wells will be adequate, however, the actual number of permanent shallow monitoring wells to be installed will be determined based on the direct-push groundwater analytical data. Each monitoring well installed during the supplemental investigation activities will be constructed according to the requirements set forth by the State of Missouri Well Construction Rules.

The following installation and construction requirements will be used:

1. All equipment will be decontaminated prior to drilling at each location.
2. Monitoring wells will be constructed with 2-inch nominal diameter, schedule 40 PVC riser and screen.
3. PVC monitoring well screen and riser pipe will be flush-threaded. The joints will be constructed so as to form a watertight seal. Screen bottoms will be sealed with a flush-threaded PVC cap or slip-on cap secured with three, stainless-steel, self-tapping screws. No glues or solvents shall be used in the construction of PVC monitoring wells.
4. PVC well screen shall be 0.010-inch slot size, factory slotted, and 10 feet in length unless the total depth of the monitoring well is less than 10 feet bgs.
5. A minimum annulus of 2 inches will be maintained between the outside of the well casing and the borehole wall.
6. The filter pack will consist of clean, inert, non-carbonate, uniform, 20-40 US sieve-size sand. The filter pack will be installed from the bottom of the borehole to approximately 2 feet above the top of the well screen to allow for settlement. The on-site geologist will confirm that the filter pack is uniform and continuous (has not bridged) by making frequent measurements during installation using a weighted tape measure.
7. Bentonite pellets or chips will be used as the primary well seal material above the filter pack. The bentonite will be poured from the ground surface into the annulus and continually checked with a weighted tape to verify that no bridging has occurred. When installed above the water table, the bentonite pellets or chips will be hydrated in 1-foot lifts using potable water. The bentonite seal will be 3 to 5 feet thick.
8. The bentonite pellets or chips will be allowed to hydrate a minimum of 4 hours.
9. The annulus above the bentonite seal to within 2 feet of the ground surface will be sealed with hydrated bentonite pellets or chips. The bentonite pellets or chips will be hydrated in 1-

foot lifts using potable water and allowed to hydrate for a minimum of 24 hours before well development.

10. Monitoring wells will be completed as flush-mount. A locking, protective cap (i.e., J-plug) will be placed on the riser. A square or round concrete pad will be installed around the monitoring well. The borehole will be enlarged so that the concrete pad will extend away from the well casing at the surface and taper down to the size of the borehole within 2 to 3 feet. The top of the concrete pad will slope gently away from the protective cover, but be constructed nearly flush with the surrounding surface.
11. Before groundwater sampling, each well will be developed according to specifications outlined in Section 3.1.4.

Solid and liquid IDW created during installation activities will be containerized in DOT-approved 55-gallon drums, labeled, and stored on-Site pending proper disposal by PerkinElmer (see Section 3.9). Non-disposable and other non-dedicated sampling and sample-contacting equipment will be decontaminated using proper decontamination techniques detailed in Section 3.5. Monitoring wells will be registered within 60 days of installation in accordance with the Missouri Well Construction Rules.

3.1.4 Monitoring Well Development Procedures

Newly installed shallow monitoring wells will be developed to remove fine particles and sediment from the screen and filter pack. The method will consist of swabbing with a surge block or similar apparatus, followed by pumping and/or bailing. Swabbing consists of raising and lowering a surge block within the casing and screened interval. Caution will be exercised when swabbing within the screened interval so as not to damage the screen. Sediment and volume of water removed will be monitored and recorded on monitoring well development forms until development is complete. Monitoring wells development forms are provided in Appendix B.

Development will be initiated not sooner than 48 hours, nor longer than seven days after the final grouting of the monitoring well. The initial static water level will be measured with a decontaminated water level indicator and recorded in the field logbook and on monitoring well development forms. The volume of standing water will then be calculated. The pH, conductivity, temperature, and turbidity of the water will be recorded before beginning development. After several volumes of water have been removed, these water quality parameters will be reevaluated. Development will continue until the monitoring well is properly developed based on stabilization of the pH, conductivity, and temperature.

The development sequence is as follows:

1. Collect water sample and measure pH, conductivity, temperature, and turbidity.
2. Record water level and total depth of the well.
3. Swab the well with a surge block for 10 to 15 minutes.
4. Re-measure and record the depth of the well.
5. Bail and/or pump the well to remove any sediment in the well.
6. Repeat Steps 3-5 until the water bailed or pumped until the pH, conductivity, and temperature stabilize to a point that they vary by no more than 10 percent. (At a minimum, three to five times the volume of any water introduced during drilling and installation shall be removed. Monitoring wells that purge dry during development will be purged dry three times and considered developed).

Purge water from monitoring well development activities will be containerized in DOT-approved 55-gallon drums, labeled, and stored on-Site pending proper disposal by PerkinElmer (see Section 3.9).

3.1.5 Monitoring Well Groundwater Sampling Procedures

Semi-annual groundwater samples will be collected from all existing off-Site and on-Site monitoring wells with the exception of MW-1, MW-4, and MW-18. Existing monitoring well locations are illustrated on Figures 1-2 and 1-3. Newly installed off-Site shallow monitoring wells will be sampled during the second semi-annual sampling event.

Prior to initiation of monitoring well groundwater sampling, water levels measurements will be taken with an electronic water level indicator to the top of the well casing to the nearest 0.01 foot. Monitoring wells will be purged and sampled by Burns & McDonnell personnel wearing new disposable Nitrile® gloves, polyethylene bailers and polypropylene rope. A minimum of three saturated well volumes will be purged from each well, or until dry, prior to sample collection. Prior to purging, DO will be measured using a YSI 556 Multi-probe system or equivalent and recorded in the field logbook.

The following procedure will be used to purge and sample a monitoring well using a disposable polyethylene bailer:

1. Measure water levels using an electronic water level indicator to the top of the well casing to the nearest 0.01 foot.

2. Slowly lower bailer into the monitoring well, allowing the bailer to sink and fill with minimal surface disturbance, then raise the bailer to the surface and purge the groundwater into a designated container.
3. Measure water quality parameters.
4. Continue with Step 2, purging a minimum of three saturated well volumes. Water quality parameters should be measured after each well volume is purged. Slowly purge monitoring wells to eliminate the potential for cascading water effect. In the event that the monitoring well is not recharging at a rate sufficient to prevent purging the monitoring well dry, collect the groundwater sample (using Steps 6 through 9) prior to purging the monitoring well dry.
5. Purging should continue until water quality parameters have stabilized for three consecutive readings. Collect samples once stabilization has occurred.
6. Slowly lower the bailer into the monitoring well until it contacts the water surface.
7. Allow the bailer to sink and fill with minimal surface disturbance.
8. Slowly raise the bailer to the surface.
9. Tip the bailer to allow discharge from the top into an appropriate sample container. Minimal groundwater is needed for sample collection (approximately 120 mL)

During purging, water quality parameters such as pH, temperature, conductivity, and ORP will be measured using a YSI 556 Multi-probe system or equivalent and recorded in the field logbook. All fluids generated during monitoring well purging and sampling will be containerized in DOT-approved 55-gallon drums and staged on-Site pending proper disposal by PerkinElmer as discussed in Section 3.9. Non-disposable and other non-dedicated sampling and sample-contacting equipment will be decontaminated using proper decontamination techniques as detailed in Section 3.5.

The groundwater samples will be placed in a cooler with ice and will be submitted to TestAmerica following proper chain-of-custody procedures (see Section 3.6.2). All groundwater samples will be sent for laboratory analysis of Site-specific COCs using USEPA SW-846 Method 8260. Field and laboratory QC sample collection and analyses details are discussed in Section 4.0.

3.2 SOIL GAS SAMPLING ACTIVITIES AND PROCEDURES

The soil gas sampling locations will be determined based on direct-push groundwater exceedances of the calculated Site-specific screening levels discussed in Sections 5.1 of this SIWP. ~~Semi-permanent s~~Soil gas sampling points, which will be permanent until abandonment, will be installed at up to 28 locations adjacent to the newly installed temporary groundwater monitoring points as discussed in Section 2.2. The location of each soil gas sampling point will be recorded in the field logbook. Soil gas sampling will be conducted by properly trained personnel. All procedures were developed in accordance with the MDNR *MRBCA For Petroleum Storage Tanks Soil Gas Sampling Protocol and are provided in Appendix E*. Field activity documentation details are provided in Section 3.6.

Soil Gas Sampling Point Construction and Installation

S~~emi-permanent s~~oil gas sampling points will be installed using standard direct-push equipment, with a borehole diameter of two inches~~ or an AMS® soil sampling system~~. Soil gas sampling depths will be determined following collection of stabilized water level measurement taken from adjacent temporary groundwater monitoring points. Soil gas samples will be collected above the water table, at least five feet bgs to minimize the potential for short-circuiting.

Soil gas sample points will be constructed as follows:

1. An environmental sand or glass bead filter pack (60-100 mesh) placed in the bottom of the borehole at least six inches below the desired sampling depth.
2. Sample probe tubing will consist of a ¼-inch diameter Nylaflow® nylon tube with a porous filter tip attached to the end will be placed inside a ¾-inch diameter PVC casing. The Nylaflow® nylon tube and PVC casing will be placed on the top of the environmental sand or glass bead filter pack at the desired sample depth.
3. Additional filter pack (environmental sand or glass bead) will then be placed in the annulus between the ¾-inch diameter PVC casing and the borehole wall as the ¾-inch diameter PVC casing is slowly retracted to expose the filter tip, continuing to approximately six inches above the filter tip.
4. Approximately ~~1~~2 inches of dry, granular bentonite will be placed above the sand filter pack then hydrated in 2-inch lifts for the next 10 inches to both provide a seal and also prevent saturation of the sand filter pack.
5. Then the remainder of the borehole will be sealed with bentonite grout to approximately 1-foot bgs. This surface seal should be a minimum of 2.5 feet thick
6. The ends of the Nylaflow® nylon tubing will be capped to prevent soil gas loss and/or mixing with ambient air,~~ sealed~~ and coiled within the borehole. A flush mount surface completion will be installed over the sampling point.
7. Samples will not be collected until the bentonite grout has been allowed to set for a minimum of 48 hours following installation of the sampling port.

Sample Train Assembly

Soil gas samples will be collected using individually-certified 1.0-L Summa™ canisters for low-level VOC analysis. The laboratory will provide a pre-calibrated flow regulator with integrated particulate filter, all other sampling material will be assembled by the field team. The flow regulator will be set to allow a flow rate of 100 milliliters per minute (mL/min). ~~The desired flow rate of 160 mL/min will be targeted.~~ The flow regulator/particulate filter and vacuum gauge will be attached to the canister as described in the *Sampling Instructions for Canisters with Pneumatic Flow Controllers* included in Appendix C. A new pair of Nitrile gloves will be worn while connecting the sample assembly for each soil gas point.

The sample train assembly will be constructed using the following procedures:

1. Place plastic shroud, consisting of a solid plastic container with a height of less than 6 inches and a volume less than 6.0-L, around the exposed portion of the soil gas point tubing ~~and the entire sampling train~~ to allow for helium leak testing.
2. Connect a dedicated stainless-steel fitting and Nylaflow® nylon tubing to the soil gas point while passing through the shroud to avoid cross-contamination between points.
3. Insert a second length of Nylaflow® nylon tubing into the side of the shroud and connect it to a helium cylinder on the outside of the shroud.
4. Connect the Nylaflow® nylon tubing attached to the soil vapor probe to a two-way stopcock.
5. Attach the two-way stopcock to a three-way stopcock.
6. Attach the other two outlets on the three-way stopcock to the Nylaflow® nylon tubing, the Summa™ canister and lung box, respectively.
7. The lung box will contain a 1.0-L Tedlar™ bag used for helium leak testing. Attach an air pump to the other side of the lung box in order to evacuate the air inside the lung box.

Appendix F shows a typical soil gas sample train assembly. When collecting duplicate or QA samples, two separate canister assemblies are connected using a stainless steel "T" fitting, and the "T" fitting is then connected to the Nylaflow® nylon tubing assembly described in the previous paragraph. The "T" fitting will be provided by the laboratory.

Mechanical Leak Testing

A mechanical leak test will be performed after assembling the sample train by connecting an evacuated 1L Summa™ canister to an outlet of the three-way stopcock and closing that three-way stopcock connection to the sample canister, as well as the two-way stopcock connection to the sample probe. This leak test method will confirm that all valve connections between the soil vapor probe, sample canister, and lung box are airtight. The tubing line connecting the canister to the three-way stopcock will first be purged in order to prevent that air volume from entering the sample canister. The connections between the Summa™ canister and the valve will be vacuum tested by opening the canister valve to place a test vacuum on the assembly for 10 minutes. A typical vacuum for a 1L Summa™ canister should be between -25 to -30 inches of mercury. The start time and initial vacuum, as well as the stop time and final vacuum, will be recorded on the Field Data Air Sampling Form and in the field logbook. If gauge vacuum cannot be maintained for 10 minutes, work shall be suspended and all fittings in the sample assembly will be checked and retested. If a vacuum still cannot be maintained for 10 minutes, sampling activities will be discontinued until the leak can be identified and addressed. If a gauge vacuum is maintained for 10 minutes, sample collection as described in the following paragraphs will proceed immediately.

Chemical Leak Testing

~~Prior to sampling, a~~A chemical leak test using helium will be performed immediately after conducting the mechanical leak test. This leak test method will confirm that the seal between the ground surface and soil vapor probe is airtight. The ambient air inside the shroud will be replaced with 99.9% grade helium until the atmosphere is at least 20% helium. This will be accomplished by inserting Nylaflow® nylon tubing through the side of the shroud and attaching the other end to a helium canister. The helium canister will then be opened, and the shroud atmosphere will be monitored by a Model MGD-2002 Multi-Gas Detector, which is automatically calibrated each time it is powered on~~provided pre-calibrated from the equipment vendor~~, until the desired percentage is attained. After the target atmosphere is established, the two-way and three-way stopcocks will be opened to the lung box, which contains a 1.0-L Tedlar™ bag. An air pump attached to the lung box via Nylaflow® nylon tubing will be used to evacuate the existing air inside the lung box, which will in turn cause the 1.0-L Tedlar™ bag to fill. Once filled, the 1.0-L Tedlar™ bag will be removed from the lung box and the air inside will be measured by the Model MGD-2002 Multi-Gas Detector for the presence of helium. This procedure will be conducted after each purge volume for a total of three purge volumes. In addition, a calibrated photoionization detector (PID) will be used to measure VOC concentrations in the 1.0-L Tedlar™ bag after each purge volume for a total of three purge volume. Corrective actions to mitigate leaks in the soil gas point will be performed when the sample's helium concentration exceeds 5% of the starting concentration in the helium shroud. Corrective actions may include resealing the point base and retesting or installation of a new soil gas point. Samples will not be submitted for laboratory analysis when the helium concentration in the sample exceeds 5% of the starting helium concentration in the shroud.

Sample Collection

After the chemical leak test and mechanical leak test have been performed successfully, samples will be collected. Sample location information and meteorological conditions such as temperature, wind speed, barometric pressure, and humidity shall be recorded. Meteorological data will be obtained online from the nearest National Weather Service measuring station. Digital photos will be taken of each sample location and sample assembly. Samples will not be collected following a heavy rain event (excessive precipitation). Subsurface vapor will not be sampled if significant precipitation (0.25 inches within a 24-hour period) or irrigation near the sampling location has occurred within the previous 48 hours. The increased soil moisture can cause the soil vapor sample results to be biased low.

Prior to sample collection, a minimum of 3 times the volume of air within the sand filter pack and associated sampling tubing will be slowly purged. Each purge volume will be calculated using the volume of a cylinder for the sand filter pack and associated sampling tubing (π x radius^2 x height). Purging will be accomplished using a large graduated syringe or hand-operated vacuum pump. Ensure the stopcock assembly is open from the soil gas probe to the lung box, and closed to the sample canister. Purge volumes will be recorded in the field book or designated field sampling forms.

In the event low-flow conditions are experienced, the flow will be adjusted in order to maintain a sustainable rate. If a sustainable flow rate cannot be achieved, and no leaks have been evident during the associated testing methods, a sample will be collected.

Sample collection will be collected according to the following procedures:

1. Open the two-way stopcock connecting the Summa™ canister assembly to the soil gas sampling point.
2. Open the canister valve to begin sample collection. The time and initial vacuum when sample collection starts shall be recorded on the field sampling form.
3. The laboratory-provided flow regulators will be calibrated for an approximate 10 minute sample duration or, a maximum flow rate of 100 mL/min. Close the sample canister valve when the vacuum gauge indicates approximately 5 inches Hg of vacuum remaining in the canister. Sample collection should take approximately 10 minutes for a 1.0-L Summa™

canister connected to a 100 mL/min flow regulator. The time sample collection was stopped and final vacuum shall be recorded on the field sampling form.

4. Remove the flow regulator/particulate filter and vacuum gauge assembly and replace the laboratory-supplied brass plug on the canister.
5. Disconnect the sample tubing assembly and replace the plug on the soil gas sampling point.

Label the sample canister and record on the chain-of-custody the sample name, date, and time the sample was collected, and the canister and flow controller serial numbers following the sample documentation procedures detailed in Section 3.6.1 and field sampling form is provided in Appendix B. Samples will not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be submitted to TestAmerica under proper chain-of-custody procedures for analysis of COCs using USEPA Method TO-15 Low Level Analysis (see Section 3.6.2). Field and laboratory QC sample collection and analyses details are discussed in Section 4.0.

3.3 RESIDENTIAL IN-HOME SAMPLING ACTIVITIES

The locations of residential in-home sampling activities will be determined as discussed in Sections 2.3. Residential in-home sampling will include both indoor air sampling and sub-slab vapor sampling at each selected residence during each residential in-home sampling event. Prior to commencing in-home sampling activities, a preliminary screening will be conducted. The preliminary screening is discussed in Section 3.3.1.

Residential properties include both single-family homes and a multi-family apartment building. The apartment building does not have basements and all residential units share a single slab on grade building foundation. Two sub-slab and one indoor air sample will be collected from each single family home. One sub-slab and one indoor air sample will be collected from each housing unit of the apartment building. In addition, sump air and water will be sampled if present during residential in-home sampling. Indoor air, sub-slab vapor, and sump air and water sampling procedures are detailed in the following sections. Sub-slab vapor and indoor air sampling will be conducted by properly trained personnel. Field activity documentation details are provided in Section 3.6.

3.3.1 In-Home Sampling Preliminary Screening

A preliminary screening will be conducted at each residential location prior to commencement of in-home sampling activities. A meeting between the occupants of the residences and apartments, Burns & McDonnell, MDNR, and the MDHSS will be organized to provide information to the occupants and to conduct the preliminary screening for in-home sampling.

In general, the preliminary screening will include completion of an indoor air quality questionnaire (provided in Appendix B) and an assessment of the general building condition and use information. This includes, but not limited to, the following:

- document general basement use (or main floor uses in apartments);
- assess the condition of the foundation (presence/absence of crack, etc.);
- assess the presence/absence of wells or sumps;
- document the type of HVAC system;
- document potential indoor VOC sources by identifying what chemicals are used or are present in the building (chemical inventory form provided in Appendix B);
- identify the point of entry of subsurface utilities;
- visually locate utilities in order to minimize the risk of disturbing sub-slab utilities;
- take photos; and,
- create a simple sketch of the basement layout.

Instructions will be provided to occupants on appropriate actions that should be taken prior to and during in-home sampling events. Occupants will be instructed to refrain from using products that may contain VOCs, and to remove any household items that may be potential indoor air sources of VOCs at least 24 hours prior to the start of sampling activities. Any proposed sub-slab sampling locations suspected to be near utilities will be relocated.

3.3.2 Indoor Air Sampling Procedures

A preliminary screening will be conducted of the sample locations. Preliminary screening will be conducted using a PID for non-specific VOCs which is capable of reading in ppb, and will be recorded on designated field forms. The PID will be equipped with a 10.6 eV- lamp to account for the ionization potentials of the Site-specific COCs. The PID will be calibrated using zero air and 10 parts per million by volume (ppm-v) Isobutylene following the manufacturer's instructions. The PID will be calibrated prior to and following the screening process. In the event that PID readings showing elevated organic vapor levels are detected immediately prior to sampling, the source will be identified and removed, and the sampling will be delayed a minimum of 24 hours. In addition to the PID readings, environmental conditions such as temperature, wind speed, barometric pressure, and humidity will also be recorded. Meteorological data will be obtained online from the nearest National Weather Service measuring station. The groundwater level will also be measured in nearby monitoring wells. One ambient air sample per sampling event will also be collected concurrently with the indoor air samples to provide a measure of background concentrations of VOCs in outdoor air.

Indoor air samples will be collected from the breathing zone height (three to six feet above the floor) using individually-certified 6.0-L Summa™ canisters for low-level VOC analysis. The laboratory will provide a pre-calibrated flow regulator with integrated particulate filter. The flow regulator will be set to allow a 24-hour sample duration. The flow regulator/particulate filter and vacuum gauge will be attached to the canister as described in the *Sampling Instructions for Canisters with Pneumatic Flow Controllers* included in Appendix C.

Sample collection will begin by opening the canister valve on the Summa™ canister. The start time and the initial canister pressure will be recorded on the field sampling forms or field logbook. A Summa™ canister will not be used if the initial canister vacuum is less than 25 inches of mercury (Hg). Near the end of the 24-hour sampling period, the canister vacuum pressure will be checked. The canister valve will be closed when the vacuum gauge indicates 5 inches of Hg of vacuum remains in the canister. The time and the final canister pressure will be recorded. The flow regulator/particulate filter and vacuum gauge assembly will be removed and the laboratory-supplied brass plug will be replaced on the canister.

Each sample canister will be labeled and the sample name, date, and time the sample was collected, and the canister and flow controller serial numbers will be recorded on the chain-of-custody (see Section 3.6.1). A field air sampling documentation form is provided in Appendix B. Samples will not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be submitted to a TestAmerica under proper chain-of-custody procedures for analysis of COCs using USEPA Method TO-15 Low Level Analysis (see Section 3.6.2). Field and laboratory QC sample collection and analyses details are discussed in Section 4.0.

Indoor air samples vapor will not be sampled if significant precipitation (0.25 inches within a 24 hour period) or irrigation near the sampling location has occurred within the previous 48 hours. The increased soil moisture can cause the soil vapor sample results to be biased low. All equipment that could potentially contact contaminated media will be dedicated and/or disposable. Therefore, no equipment decontamination will be required.

3.3.3 Sub-Slab Soil Vapor Sampling Procedures

General building structural condition and use information will be documented in-home sampling preliminary screening prior to sub-slab probe installation (see Section 3.3.1). Sub-slab vapor probe installation, sampling, and analysis will be conducted in accordance with the procedures presented below.

Sub-Slab Soil Vapor Probe Construction and Installation

The sub-slab soil vapor probes will be constructed using the Vapor Pin™ by Cox-Colvin & Associates, Inc. The sub-slab soil vapor probe installation procedures were derived from the Cox-Colvin & Associates, Inc. *Standard Operating Procedure – Installation and Extraction of the Vapor Pin* ™, which is provided in Appendix G. The sub-slab probes described in the following procedures are permanent sampling probes that will remain in place after completion of the sampling event. Permanent sampling probes are being installed because they provide higher quality and more consistent data. The individual probes will be removed and the holes sealed upon determining that further sub-slab soil vapor sampling will not be required at a given location.

Prior to constructing the sub-slab vapor probes, a pilot hole will be drilled using clean dedicated drill bits to assess the thickness of the building slab. Once the pilot hole is drilled, each pilot hole will be screened with a PID. If the pilot hole size is too small to accommodate a meaningful sample, a rubber stopper and a small piece of tubing will be inserted into the pilot hole. The tubing will be connected to a PID and multi-gas detector and measurements taken over a period of several minutes. Results will be recorded in the field logbook.

One pilot hole will be drilled for each sub-slab vapor probe location. The pilot hole will later be converted to the sub-slab soil vapor probe; therefore, the pilot hole will be placed in the final probe installation location. Areas of visible staining or known previous chemical spills will be avoided. The thickness of the slab will be assessed in this manner at each of the residences included in the investigation prior to proceeding with probe installation.

After determining the thickness of the slab, a rotary hammer drill and a clean drill bit will be used to create a shallow (2.5 centimeters (cm) or 1 inch) outer hole (3.75 cm or 1.5 inches in diameter) that partially penetrates the slab. This outer hole will be centered over the pilot hole. A small brush and dust pan or hand-held vacuum will be used to collect concrete dust and cuttings from the hole. Since the outer hole does not penetrate the floor slab, a dedicated drill bit is not required.

After completing the outer hole, a rotary hammer drill will be used to create a smaller diameter inner hole (1.6 cm or 5/8 inch) through the remainder of the slab and approximately 7 to 8 cm or 3 inches into sub-slab material. The pilot hole will be used as a guide for drilling the inner hole. The inner hole will be drilled using a dedicated drill bit. Drilling into sub-slab material will create an open cavity which will prevent obstruction of probe inlets during vapor sampling. Figure 2 of the Cox-Colvin & Associates, Inc. SOP illustrates the appearance of “inner” and “outer” holes (Appendix G).

The basic design of a sub-slab vapor probe is illustrated in Figure 1 of the Vapor Pin™ SOP in Appendix G. Pre-constructed sub-slab vapor probes (Vapor Pin™) will be obtained from Cox-Colvin & Associates, Inc., as well as the majority of the installation tools and materials. The probes will be closed using the protective cap provided with each Vapor Pin™.

Sub-slab vapor probes will be set in holes such that the fittings rest at the base of the outer hole and the top of the probes are completed flush with the slab. Each probe will have a protective cap so as not to interfere with day-to-day use of buildings.

Sample Train Assembly

Samples will be collected using evacuated batch-certified 1.0-L Summa™ canisters for low-level VOC analysis. The laboratory will provide a pre-calibrated flow regulator with integrated particulate filter, which will be connected into the sampling line between the sub-slab probe and the Summa™ canister, down-gradient of the flow controller. The flow regulator will be set to allow a flow rate of 100 milliliters per minute (mL/min). The desired flow rate of 100 mL/min will be targeted. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the *Sampling Instructions for Canisters with Pneumatic Flow Controllers* provided by the laboratory (Appendix C). A new pair of Nitrile gloves will be worn while connecting the sample assembly for each sub-slab point.

The sample train assembly will be constructed using the following procedures:

1. Place plastic shroud, consisting of a solid plastic container with a height of less than 6 inches and a volume less than 6.0-L, around the exposed portion of the sub-slab soil vapor probe location tubing to allow for helium leak testing.

2. Connect a dedicated stainless-steel fitting and Nylaflow® nylon tubing to the sub-slab soil vapor location while passing through the shroud to avoid cross-contamination between points.
3. Insert a second length of Nylaflow® nylon tubing into the side of the shroud and connect it to a helium cylinder on the outside of the shroud.
4. Connect the Nylaflow nylon tubing attached to the soil vapor probe to a two-way stopcock.
5. Attach the two-way stopcock to a three-way stopcock.
6. Attach the other two outlets on the three-way stopcock to the Nylaflow® nylon tubing, the Summa™ canister and lung box, respectively.
7. The lung box will contain a 1.0-L Tedlar™ bag used for helium leak testing. Attach an air pump to the other side of the lung box in order to evacuate the air inside the lung box.

Appendix F displays a typical sub-slab sample train assembly. When collecting duplicate or QA samples, two separate canister assemblies are connected using a stainless steel "T" fitting, and the "T" fitting is then connected to the Nylaflow® nylon tubing assembly described in the previous paragraph. The "T" fitting will be provided by the laboratory.

Mechanical Leak Testing

A mechanical leak test will be performed after assembling the sample train by connecting an evacuated 1L Summa™ canister to an outlet of the three-way stopcock and closing that three-way stopcock connection to the sample canister, as well as the two-way stopcock connection to the sample probe. This leak test method will confirm that all valve connections between the soil vapor probe, sample canister, and lung box are airtight. The tubing line connecting the canister to the three-way stopcock will first be purged in order to prevent that air volume from entering the sample canister. The connections between the Summa™ canister and the valve will be vacuum tested by opening the canister valve to place a test vacuum on the assembly for 10 minutes. A typical vacuum for a 1L Summa™ canister should be between -25 to -30 inches of mercury. The start time and initial vacuum, as well as the stop time and final vacuum, will be recorded on the Field Data Air Sampling Form and in the field logbook. If gauge vacuum cannot be maintained for 10 minutes, work shall be suspended and all fittings in the sample assembly will be checked and retested. If a vacuum still cannot be maintained for 10 minutes, sampling activities will be discontinued until the leak can be identified and addressed. If a gauge vacuum is maintained for 10 minutes, sample collection as described in the following paragraphs will proceed immediately.

Chemical Leak Testing

A chemical leak test using helium will be performed immediately after conducting the mechanical leak test. The ambient air inside the shroud will be replaced with 99.9% grade helium until the atmosphere is at least 20% helium. This will be accomplished by inserting Nylaflow® nylon tubing through a gas tight port side of the shroud and attaching the other end to a helium canister. The helium canister will then be opened, and the shroud atmosphere will be monitored by a Model MGD-2002 Multi-Gas Detector, which is automatically calibrated each time it is powered on, until the desired percentage is attained. After the target atmosphere is established, the two-way and three-way stopcocks will be opened to the lung box, which contains a 1.0-L Tedlar™ bag. An air pump attached to the lung box via Nylaflow® nylon tubing will be used to evacuate the existing air inside the lung box, which will in turn cause the 1.0-L Tedlar™ bag to fill. The flow rate during the filling of the 1.0-L Tedlar™ bag will be the same as during sample collection. Once filled, the 1.0-L Tedlar™ bag will be removed from the lung box and the air inside will be measured by the Model MGD-2002 Multi-Gas Detector for the presence of helium. In addition, a calibrated PID will be used to measure VOC concentrations in the 1.0-L Tedlar™ bag, as well as collecting measurements of O_2/CO_2. Corrective actions to mitigate leaks in the sub-slab soil vapor probe will be performed when the sample's helium concentration exceeds 5% of the starting concentration in the helium shroud. Corrective actions may include resealing the probe base and retesting or installation of a new sub-slab soil gas probe. Samples will not be submitted for laboratory analysis when the helium concentration in the sample exceeds 5% of the starting helium concentration in the shroud.

Due to the small amount of volume needed to adequately purge the sub-slab vapor probe, it will be accomplished by filling the 1.0-L Tedlar™ bag during chemical leak testing. Purging will be conducted using a flow rate of 100 mL/min. Given the small volume of the sample probes (approximately two to six inches in length depending on floor slab thickness and 1/4-inch in diameter), purge air can be discharged to the atmosphere. A final helium leak test will be performed after sample collection.

Sample Collection

After the chemical leak test and mechanical leak test have been performed successfully, samples will be collected. In order to assess the practicability of using 6.0-L Summa™ canisters in future sampling events, the collection of one 6.0-L canister will be attempted at a duplicate location to be determined in the field. Sample location information and meteorological conditions such as temperature, wind speed, barometric pressure, and humidity shall be recorded. Meteorological data will be obtained online from the nearest National Weather Service measuring station. Digital photos will be taken of each sample location and sample assembly.

Sample collection will be collected according to the following procedures:

1. Open the two-way stopcock connecting the Summa™ canister assembly to the sub-slab vapor probe.
2. Open the canister valve to begin sample collection. The time and initial vacuum when sample collection starts shall be recorded on the field sampling form. The initial vacuum should be at least 25 inches of mercury.
3. The laboratory-provided flow regulators will be calibrated for an approximate 10 minute sample duration or a flow rate of 100 mL/min. Close the sample canister valve when the vacuum gauge indicates approximately 5 inches Hg of vacuum remaining in the canister. Sample collection should take approximately 10 minutes for a 1.0-L Summa™ canister connected to a 100 mL/min flow regulator. The time sample collection was stopped and final vacuum shall be recorded on the field sampling form.
4. After soil gas samples are collected at each location, the sample probe lines will be connected to the PID and the multi-gas meter and measurements taken and recorded over a period of at least several minutes.
5. Remove the flow regulator/particulate filter and vacuum gauge assembly and replace the laboratory-supplied brass plug on the canister.
6. Disconnect the sample tubing assembly and replace the plug on the sub-slab vapor probe.

Label the sample canister and record on the chain-of-custody the sample name, date, and time the sample was collected, and the canister and flow controller serial numbers (see Section 3.6.1). A field air sampling documentation form is provided in Appendix B. Samples should not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be submitted to TestAmerica under proper chain-of-custody procedures for analysis of COCs using USEPA Method TO-15 Low Level Analysis (see Section 3.6.2). Field and laboratory QC sample collection and analyses details are discussed in Section 4.0.

Subsurface vapor will not be sampled if significant precipitation (0.25 inches within a 24-hour period) or irrigation near the sampling location has occurred within the previous 48 hours. The increased soil moisture can cause the soil vapor sample results to be biased low. All equipment that could potentially contact contaminated media will be dedicated and/or disposable. Therefore, no equipment decontamination will be required.

3.3.4 Sump Air and Water Sampling Procedures

Residential in-home sampling will include sump air and water sampling at each selected residence during each residential in-home sampling event. In the event that water is not present in the sump of a selected residential basement then sump air and water will not be sampled at that residence during that in-home sampling event. In order to determine whether contaminants in sump water may be contributing to volatile levels in indoor air, one 24-hour air sample and one grab water sample per residence will be collected from basement sumps if water is present during the time of indoor air sampling.

Sump Air Sampling Procedures

Each air sample will be collected immediately above the sump opening over approximately a 24-hour duration using individually-certified 6.0-L Summa™ canisters for low-level VOC analysis. In order to collect the sump air sample from the sump opening a piece of Nylaflow® nylon tubing will be attached to the flow controller with the tubing inlet placed at the sump opening. Sample collection will begin by opening the canister valve on the Summa™ Canister. The canister initial vacuum should be at least 25 inches of Hg. The start time and the initial canister pressure will be recorded on the field sampling forms or field logbook. During sampling the canister vacuum pressure will be monitored. The canister valve will be closed when the vacuum gauge indicates 5 inches of Hg of vacuum remains in the canister. The time and the final canister pressure will be recorded. The laboratory-supplied brass plug will then be replaced on the canister.

Each sample canister will be labeled and the sample name, date, and time the sample was collected, and the canister and flow controller serial numbers will be recorded on the chain-of-custody (see Section 3.6.1). A field air sampling documentation form is provided in Appendix B. Samples will not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be submitted to a TestAmerica under proper chain-of-custody procedures for analysis of COCs using USEPA Method TO-15 Low Level Analysis (see Section 3.6.2).

Sump Water Sampling Procedures

Sump water samples will be collected in the form of a grab sample. Samples will be collected to ensure that stagnant water is avoided and that fresh water entering the sump is sampled. Sump water will be sampled by Burns & McDonnell personnel wearing new disposable Nitrile® gloves using laboratory provided containers.

The following procedure will be used collect a sump water sample:

- For sumps with active water flow at the time of the sampling event the air and water sample will be collected during the same time period as the indoor air sampling.
- For sumps with stagnant water with working pumps, activate the pump and allow to it operate for a sufficient period of time to ensure that a representative sample of groundwater is available for sampling. Allow sump to recharge. Once the sump has recharged collect sump water sample by allowing the approved laboratory container to contact the water and fill with minimal surface disturbance.
- In the event that collection directly into the sampling container will result in loss of the laboratory preservative, a separate laboratory jar will be used to obtain sump water which will then be transferred into the appropriate laboratory container with minimal disturbance.
- If sump water is present in the sump but cannot be replenished a sump water sample will not be taken; however an air sample at the sump opening will be collected.

Disposable sampling and sample-contacting equipment will be used and therefore decontamination will not be required. The sump water samples will be placed in a cooler with ice and will be submitted to TestAmerica following proper chain-of-custody procedures (see Section 3.6.2). All sump water samples will be sent for laboratory analysis of Site-specific COCs using USEPA SW-846 Method 8260. Field and laboratory QC sample collection and analyses details are discussed in Section 4.0.

3.4 INSTRUMENT CALIBRATION AND FREQUENCY

Field sampling equipment will be calibrated using known standards supplied by the manufacturer or other reputable vendor. The instruments will be calibrated at the beginning of each day, and calibration checks will be performed at midday, at the end of the day, and any time readings appear abnormal. Additionally, calibration checks will be recorded on a field calibration record form provided in Appendix B. Further detail on instrument calibration and frequency is discussed in Section 3.10 in the QAPP (Burns & McDonnell, 2012).

3.5 DECONTAMINATION PROCEDURES

All sampling and investigative equipment will be decontaminated prior to beginning investigation activities, between borings, between locations, and upon completion of investigation activities. Non-disposable and other non-dedicated equipment which contact the sample will be decontaminated prior to the collection of each sample. This equipment includes, but is not limited to, sampling knives and spoons, direct-push shoes, and containers. Decontamination procedures of direct contact sampling equipment are presented in Section 3.3.6.1 of the QAPP (Burns & McDonnell, 2012).

Down-hole sampling tools such as drill string, augers, and direct-push rods, as well drill rigs and direct-push trucks/van, will be decontaminated between each borehole Decontamination procedures of non-direct contact sampling equipment is presented in Section 3.3.6.2 of the QAPP (Burns & McDonnell, 2012).

3.6 FIELD ACTIVITY DOCUMENTATION

Each sample, field measurement, and field activity will be properly documented to facilitate timely, correct, and complete analyses, and support actions concerning the supplemental investigation. The documentation system should provide a means to identify, track, and monitor individual samples from the point of collection through the final reporting of data. Details regarding field documentation are also discussed in Section 3.4 of the QAPP (Burns & McDonnell, 2012).

3.6.1 Sample Documentation

All samples will be identified with a unique sample number. Sample numbers will be used on all sample labels, chain-of-custody, field logbooks, and all other applicable documentation. As described below, the sample numbering system will be comprised of the sample point, QA/QC designator, if appropriate, and sample depth (if applicable). The general format will be "sample point QA/QC designator(s)/sample depth."

The sample point will be based on the activity being conducted as follows:

- **Soil Gas Monitoring Point Sample** – SG followed by a two digit identifying number
- **Sub-Slab Soil Vapor Samples** – SSV followed by a two digit identifying number
- **Indoor Air Samples –** IA followed by a two digit identifying number
- **Sump Indoor Air Samples –** SUA followed by a two digit identifying number
- **Sump Water Samples –** SUW followed by a two digit identifying number

- **Temporary Groundwater Monitoring Point Samples** – TGW followed by a two digit identifying number
- **Monitoring Well Groundwater Samples** – Monitoring well number

The sample designator will be followed by a QA/QC designator for all QA/QC samples including field duplicates, Matrix Spike (MS)/Matrix Spike Duplicate (MSD), and equipment rinsate blanks. The following suffixes will be used:

Abbreviation	QA/QC Sample Type
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate

For example, the groundwater sample collected from location TGW-01 would be numbered TGW-01. The MSD sample collected at the groundwater sample location TGW-04 would be labeled TGW-04/MSD. A duplicate of a groundwater sample from soil gas monitoring point SG-05 would be labeled SG-05FD.

Trip blanks will be placed in each cooler containing aqueous VOC samples. A trip blank for vapor and indoor air samples, consisting of an unopened evacuated canister, will be shipped with soil gas, sub-slab vapor, and indoor air samples at a rate of one per shipment. Trip blanks will be signified by the document control number from the COC for that cooler or shipment followed by a trip blank designator (TB-01). One temperature blank will be placed in each cooler prior to overnight shipment of VOCs to the laboratory. The temperature blank will be labeled "TEMP BLANK”.

Sample Labeling

Each sample collected for laboratory analysis will be identified with a sample label containing specific information regarding the sample. Each completed sample identification label will be securely fastened to the sample container. A standard sample label is provided in Appendix B. Complete sample labels will include the following information:

- Date;
- Time (military) of sample collection;
- Type of analyses requested;
- Sample number;

- Sample collection depth;
- Location of sample collection; and
- Type of preservative;

All samples will be identified with a unique sample number. Sample numbers will be used on all sample labels, chain-of-custody, field logbooks, and all other applicable documentation.

3.6.2 Chain-of-Custody Records

The chain-of-custody will be employed as physical evidence of sample custody. Field personnel will initiate a chain-of-custody with acquisition of the sample. Transferred possession of samples will be recorded on the chain-of-custody by both the person relinquishing and the person receiving the samples by signing, dating, and noting the time the transfer of possession takes place. Samples are considered to be a person's custody if they are within that person's line of sight, kept in a locked room or vehicle, or adequately sealed with custody seals as discussed in Section 3.6.3. A document control number consisting of the date and consecutive alphabetic suffix will be completed in the space provided on the chain-of-custody. For example, if a shipment of samples is prepared on June 5, 2010, that contains two chain-of-custody, the document control numbers will be 060510A and 060510B.

The following information is to be included on the chain-of-custody:

- Sample numbers;
- Signature(s) of field personnel;
- Date of collection;
- Time (military) of collection;
- Sample type (solid, etc.);
- Identification of sampling point (including depth);
- Number of containers;
- Preservative used;
- Parameters requested for analysis;
- Signature of person(s) involved in the chain of possession;
- Inclusive dates and times of possession;
- Notations regarding the possible compromise of sample integrity;
- Notation regarding sample temperature and;
- Document control number.

A chain-of-custody will be prepared for each cooler/box shipped or transported to the laboratory. All samples packed in each individual shipping container will be recorded on the chain-of-custody accompanying that container. After completing the chain-of-custody, the original (white copy) will be enclosed in a plastic bag. A sample chain-of-custody record is included in Appendix B.

3.6.3 Custody Seals

From the time the sample coolers/boxes are packed until they are opened in the laboratory, custody seals will be used to preserve the integrity of the samples cooler/box during shipment. Custody seals must be attached so that it is necessary to break the seals to open the sample cooler/box. The custody seals will be covered with clear tape. All samples shipped overnight to the laboratory will be shipped in coolers sealed on two opposite sides with custody seals or boxes sealed on the top and bottom. As long as the chain-of-custody is sealed inside the sample cooler/box and custody seals remain intact, commercial carriers and laboratory couriers are not required to sign the custody form. An example custody seal is provided in Appendix B.

3.7 SAMPLE PACKING AND SHIPPING

The sample packaging and shipping procedure to be used for the shipment of samples by an overnight carrier are based on USEPA specifications and United States DOT regulations (49 Code of Federal Regulations [CFR] Parts 172 and 173). Samples will be packed and shipped according to requirements for low hazard-level samples. All samples will be packaged and shipped within all applicable holding time following collection. The following procedure will be used to pack samples being shipped by overnight carrier:

<u>Groundwater Samples</u>

1. Arrange sample containers in groups by sample number. Group aqueous VOC samples so they can be placed into common shipping containers.
2. At the time of sampling, wipe the outside of each sample container with a paper towel and place a label on each container. Each label will be taped and each glass container will be wrapped with bubble wrap. Place each sample bottle in an individual, sealable plastic bag. All VOC vials for the same sample shall be placed in the same plastic bag. Trip blanks will be packed in the same manner as the VOC samples.
3. Remove as much air as possible from the plastic bag prior to sealing.
4. Tape drains shut on shipping cooler.

5. Place an absorbent pad in the bottom of the cooler, followed by a layer of bubble wrap.
6. Insert a plastic trash bag into the cooler.
7. Place the sample containers inside the trash bag inside the cooler in an upright position so they do not touch. Group all aqueous VOC samples into one common cooler. Place one trip blank set in each cooler containing aqueous VOC samples. Place one temperature blank in each cooler.
8. Add ice (double packaged in sealable plastic bags).
9. Sign the COC and indicate the time and date the cooler is sealed. Record the time in the field logbook.
10. Separate the copies of the chain-of-custody. Seal the top form (original) in a large, sealable, plastic bag and tape them to the inside of the cooler lid.
11. Complete shipping paperwork (if applicable). Include air bill number and name of carrier on the chain-of-custody, and record the information in the field logbook.
12. A FedEx air-bill will be completely filled out for the lab and attached to the top of the cooler. Use two strips of clear tape to securely fasten the shipping label to the cooler so that the label will not peel off even if the coolers are stacked during shipment. The clear tape should extend across the entire top of the cooler. All samples for chemical analysis will be shipped to TestAmerica.
13. Close the lid and latch the cooler. Tape the cooler shut on both ends, make several revolutions with the strapping tape. The strapping tape should cover the ends of the clear tape used to secure the shipping label but should not cover the label.
14. Affix signed custody seals over lid openings (opposite corners of the cooler). Cover the seals with clear, plastic tape.
15. The cooler(s) will be delivered directly to a FedEx agent or to an authorized agent for shipment. For additional questions regarding shipping, contact FedEx at 1-800-463-3339.

Soil Gas, Sub-Slab Vapor, and Indoor Air Samples

1. Arrange sample containers in groups by sample number.
2. At the time of sampling, place a label on each container. Each flow controller will be wrapped with bubble wrap. Place each flow controller with the corresponding sample canister in an individual box. For individual boxes will comprise a shipping box. Trip blanks will be packed in the same manner as the soil gas, sub-slab vapor, and indoor air samples. Include one trip blank in each canister shipment.

3. Tape shipping boxes on the top and bottoms. Check the sides and corners for damage and tape as needed.
4. Sign the chain-of-custody and indicate the time and date the boxes are sealed. Record the time in the field logbook.
5. Separate the copies of the chain-of-custody. Seal the top form (original) in a large, sealable, plastic bag and place inside of the boxes for shipment. There should be one chain-of-custody for each box shipped.
6. Complete shipping paperwork (if applicable). Include air bill number and name of carrier on the chain-of-custody, and record the information in the field logbook.
7. A FedEx air-bill will be completely filled out for the lab and attached to the top of the cooler. Use two strips of clear tape to securely fasten the shipping label to the box so that the label will not peel off even if the boxes are stacked during shipment. The clear tape should extend across the entire top of the box. All samples for chemical analysis will be shipped to TestAmerica.
8. Affix signed custody seals over lid openings (top and bottom of the box). Cover the seals with clear, plastic tape.
9. The cooler(s) will be delivered directly to a FedEx agent or to an authorized agent for shipment. For additional questions regarding shipping, contact FedEx at 1-800-463-3339.

3.8 BOREHOLE ABANDONMENT

Temporary groundwater monitoring points will be abandoned within 30 days of installation and soil gas sampling locations will be abandoned when monitoring points are no longer needed. Boreholes will be abandoned according to the Missouri Well Construction Rules. Ground surface will be restored to match the surrounding conditions. Abandonment registration records for all sampling locations that exceed 10 feet in depth will be submitted as required by the Missouri Well Construction Rules.

Sub-slab sampling points will be abandoned when sampling is no longer necessary. Abandonment will occur by sealing with cement to match the surrounding conditions.

3.9 INVESTIGATIVE DERIVED WASTE

Solid and liquid IDW created during investigation activities will be containerized, labeled, and stored on-Site pending proper disposal by PerkinElmer. Waste characterization will be conducted for proper disposal as necessary. Waste management procedures for IDW are based on the requirements specified in

Title 40 of the CFR, Part 262 (40 CFR 262) *Standards Applicable to Generators of Hazardous Waste* and good engineering judgment. IDW consisting of used personal protective equipment (PPE), disposable equipment (acetate liners, tubing, etc.), concrete dust, and other trash will be rendered non-hazardous through the removal of gross contamination and disposed of as a municipal waste in accordance with applicable regulations. Further details regarding IDW are presented in Section 3.6 of the QAPP (Burns & McDonnell, 2012).

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4.0 QUALITY ASSURANCE / QUALITY CONTROL

Quality Assurance (QA)/Quality Control (QC) information in presented in the following sections. QA/QC includes on-Site instrument calibration procedures, collection of field QC samples, and the laboratory QC samples and analyses.

4.1 ON-SITE INSTRUMENTATION

VOC monitoring will be conducted during sampling by use of a portable photoionization detector (PID) as a screening device to non-selectively monitor VOCs. The PID will be equipped with a 10.6 eV- lamp to account for the ionization potentials of the site-specific COCs. The PID will be calibrated prior to the start-up of each workday with 10 ppm-v isobutylene per the manufacturer's instructions. In addition, the PID will be calibrated before and after preliminary screening prior to in-home sampling activities. During soil gas and sub-slab vapor sampling, a Model MGD-2002 Multi-Gas Detector will be used to perform a chemical leak test using helium. The multi-gas detector will be calibrated each prior to the start-up of field activities each workday per manufacturer's instructions. Burns & McDonnell will record calibration information and any operational errors in a field logbook or on a designated field sheet (see Appendix B).

4.2 QUALITY CONTROL SAMPLES

Quality control (QC) samples will be collected to monitor the quality of field sampling techniques and potential sample transport anomalies. In addition, QC samples will assess whether quality assurance (QA) objectives have been met. These objectives include precision, accuracy, representativeness, comparability, and completeness. QC samples and their quantities for each set of media are summarized below. QC requirements are discussed in more detail in Section 3.8 of the QAPP (Burns & McDonnell, 2012).

Field Duplicates

Field duplicate sample results indicate the precision and reproducibility of sample collection and analytical results. Field duplicates will be collected at a rate of one duplicate sample per 10 samples (i.e., 10 percent) or at least one for each day for all media.

Trip Blanks

Trip Blanks will be used during shipment of groundwater samples that will be analyzed for VOCs. The laboratory prepares trip blanks and sends them to the field along with the containers for sample collection.

They are used to determine if any VOCs diffused through the sample container septum due to Site, shipping, or laboratory conditions; thereby, causing cross-contamination of samples. One trip blank will be included in each cooler that contains aqueous samples for VOC analysis.

For vapor and indoor air samples, a trip blank, consisting of an unopened evacuated canister, will be shipped with the soil gas, sub-slab vapor, and indoor air samples. Trip blanks can consist of an unopened fully evacuated canisters supplied by the laboratory. Since a fully charged canister has no vacuum with which to pull contaminants into the canister, a fully evacuated canister has a better likelihood of capturing potential transit-related contamination. The trip blank will be provided by the laboratory and will be used at a rate of one per sample shipment.

Method Blanks

USEPA methodology generally requires the analysis of a method blank sample in each analytical batch, up to 20 samples. For the method blank, a clean matrix is prepared and analyzed in the same manner as the field samples. Any detection in the method blank indicates potential laboratory contamination of the associated field samples in the analytical batch.

Matrix Spike/Matrix Spike Duplicate

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) samples will be collected for aqueous samples only. Method TO-15 for air analysis does not require a MS/MSD sample. MS/MSD analytical results will be used to assess the accuracy and precision of the laboratory analytical results in the presence of any potential sample matrix interference. Burns & McDonnell field staff will collect triplicate samples and designate the samples as field, MS, and MSD samples. MS/MSDs will be collected at a rate of one per 20 groundwater samples (i.e., 5 percent).

For vapor and indoor air samples, a laboratory duplicate will be analyzed in place of a MS/MSD in each analytical batch, up to 20 samples.

Laboratory Control Sample/Laboratory Control Sample Duplicate

For the laboratory control sample (LCS), an interference-free matrix is spiked with known concentrations of target constituents and analyzed. In addition, while not required by the methodology, some laboratories analyze laboratory control sample duplicate (LCSD). The results of these analyses are compared against the known analyte concentrations in the spike to determine the percent recovery.

LCS/LCSD will be performed for aqueous, vapor, and indoor air samples in each analytical batch, up to 20 samples. The purpose of the LCS/LCSD is to determine the performance of the laboratory with respect to analyte recovery, independent of field sample matrix interference.

Surrogates

Surrogates are added to each sample that undergoes organic analysis. Surrogates are compounds that are not normally found in environmental samples that are added (spiked) into field and QC samples and analyzed for percent recovery. Surrogates are used to give an indication of the analytical accuracy of the preparation and analysis methods on a per sample basis.

* * * * *

5.0 DATA ANALYSIS AND REPORTING

Analytical results will be validated by Burns & McDonnell personnel and compared to Site-specific screening levels during data analysis as described below. All data collection and analysis will be documented in a Supplemental Investigation Report.

5.1 SCREENING LEVELS

To evaluate the groundwater and soil gas data being collected as part of this investigation, Site-specific screening levels were calculated for the Site to be protective of indoor air for the vapor intrusion pathway. In addition, since sub-slab soil gas and indoor air sampling will be conducted, sub-slab soil gas and indoor air screening levels were also calculated for the Site. Screening levels for vapor intrusion were calculated by adjusting a risk-based allowable chemical concentration in indoor air by an appropriate soil gas-to-indoor air attenuation factor or sub-slab soil gas-to-indoor air attenuation factor.

The allowable chemical concentration in indoor air for each of the constituents being investigated at the Site was taken from the November 2011 version of USEPA's Regional Screening Level table (USEPA, 2011). The attenuation factors represent the recommended empirically-derived values from *U.S. EPA's Vapor Intrusion Database: Preliminary Evaluation of Attenuation Factors* (USEPA, 2008). The equations and variables used to calculate the screening levels are provided on Table 5-1.

To the extent that it is technically feasible using routine analytical techniques, the reporting limits for critical parameters should meet the screening levels. The analytical approach is further discussed in Section 2.4.5 of the QAPP (Burns & McDonnell, 2012). Typical reporting limits (RLs) and MDLs for the parameters of interest are indicated on Table 2-2 of the QAPP (Burns & McDonnell, 2012). The laboratory (Test America) has been instructed to report any detected concentration between the RL and MDL with a J flag (value is estimated).

5.2 DATA VALIDATION

Data validation evaluates the quality of field and laboratory activities and documents the quality of data generated. The end result of validation is a technically sound, statistically valid, legally defensible, and properly documented data set for decision-making purposes. General information pertaining to verification and validation activities is provided in the *Guidance on Environmental Data Verification and*

Data Validation, EPA QA/G-8 (USEPA, 2002). Following receipt of the analytical data packages, the Burns & McDonnell chemical validation will include a review of the following items:

- COC appropriately completed;
- Requested analyses performed;
- Analysis occurred within holding times;
- Blank results (trip blank);
- Duplicate results (laboratory duplicates, MS/MSD, LCS/LCSD, and field duplicates);
- Spike recovery results (surrogate, LCS/LCSD, and MS/MSD);
- Achievement of target reporting limits; and
- Completeness (field completeness and laboratory completeness).

The validation will include a review of method-specific criteria for the items listed. Data qualifiers, when appropriate, will be added to the data. Data validation is further discussed in Section 5.0 of the QAPP (Burns & McDonnell, 2012).

5.3 REPORTING

The primary deliverable in conjunction with this supplemental investigation will be the Supplemental Investigation Report. Anticipated content of this report includes: summary and documentation of field activities, summary and validation of analytical data, results of data screening and analysis, vapor intrusion risk evaluation, and conclusions and recommendations. In addition, interim submittals following each phase of work activity will be provided to MDNR.

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6.0 SCHEDULE

Groundwater sampling activities will be initiated immediately upon MDNR approval of the SIWP and QAPP. Below is a summary of the anticipated schedule.

- August 1, 2011 – MDNR interim approval of the SIWP and QAPP for groundwater sampling
- September 2011 – Direct-push groundwater sampling and semi-annual groundwater sampling (completed August/September 2011)
- May 2012 – Residential in-home sampling (first event)
- To be determined – Soil gas sampling
- To be determined – Second and third residential in-home sampling events
- To be determined – Semi-annual groundwater sampling and installation of shallow monitoring wells

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7.0 REFERENCES

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TABLES

Table 1-1
Historical Soil Analytical Results
Missouri Metals Site
Overland, Missouri

			PCE		TCE		1,1-DCE		cis-1,2-DCE		trans-1,2-DCE		Vinyl Chloride	
		1994 Any-Use Soil Level [1]	380,000		260,000		8,300		560,000		1,100,000		None set[2]	
		USEPA Regional Screening Levels (Residential)[3]	550		2,800		240,000		780,000		150,000		60	
		Units	µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample ID	**Sample Depth**	**Sample Date**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**
SB-1	**16'**	**08/13/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
SB-2	**10'**	**08/13/98**	**54**	5	ND	5	ND	5	**7**	5	ND	5	ND	10
SB-3	**6'**	**08/14/98**	ND	5	**67**	5	ND	5	**6**	5	ND	5	ND	10
SB-4	**12'**	**08/14/98**	ND	5	ND	5	ND	5	**12**	5	ND	5	ND	10
SB-5	**10'**	**08/14/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
SB-6	**22'**	**08/13/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
SB-7	**6'**	**08/13/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
SB-8	**16'**	**08/13/98**	ND	50	**1,900**	50	ND	50	**290**	50	ND	50	ND	100
SB-9	**12'**	**08/14/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
SB-10	**6'**	**08/13/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
SB-11	**8'**	**08/14/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
SB-12	**8'**	**08/13/98**	ND	5	**16**	5	**29**	5	**27**	5	**29**	5	ND	10
SB-13	**6'**	**08/14/98**	ND	5	ND	5	ND	5	**6**	5	ND	5	ND	10
SB-14	**6'**	**08/13/98**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-1	**11'**	**07/14/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-2	**5'**	**07/14/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-3	**3.5'**	**07/14/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-4	**3'**	**07/14/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-5	**11'**	**07/14/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-6	**3'**	**07/14/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-7	**15'**	**07/14/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-8	**7'**	**07/15/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-9	**3'**	**07/15/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-10	**11'**	**07/15/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-11	**11'**	**07/15/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-12	**15'**	**07/15/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-13	**15'**	**07/15/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10
B-14	**7'**	**07/15/99**	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10

Notes:

[1] - Any-Use Soil Level identified in the 1994 Consent Agreement.

[2] - Any-Use Soil Level for vinyl chloride was not set as of the 1994 Consent Agreement.

[3] - United States Environmental Protection Agency (USEPA) Regional Screening Levels for Chemical Contaminants at Superfund Sites for Residential Soil (May 2010).

PCE - Tetrachloroethene.
TCE - Trichloroethene.
DCE - Dichloroethene.
TCE - Trichloroethene.
µg/kg - Micrograms per kilogram

RL - Reporting Limits.
ND - Not Detected.
VOCs - Volatile Organic Compounds.

Table 1-2
Historical Groundwater Analytical Results
Missouri Metals Site
Overland, Missouri

			PCE		TCE		1,1-DCE		cis-1,2-DCE		trans-1,2-DCE		Vinyl Chloride	
		MCL Screening Levels[1]	5		5		7		70		100		2	
		Units	μg/L		μg/L		μg/L		μg/L		μg/L		μg/L	
Sample ID	**Sample Date**	**Screened Interval**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**
B-1	**07/19/99**	**2.5 - 17.5**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-2[2]	**NS**	**Not Installed**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B-3	**07/19/99**	**2.1 - 20.1**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-4	**07/16/99**	**1.5 - 19.5**	**80**	1.0	**130**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-5	**07/20/99**	**4.5 - 16.5**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-6	**07/19/99**	**2.0 - 20.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-7	**07/19/99**	**1.0 - 19.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-8	**07/19/99**	**2.0 - 20.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-9	**07/20/99**	**2.0 - 17.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-10	**07/20/99**	**3.5 - 18.5**	ND	1.0	**9**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-11	**07/20/99**	**2.0 - 17.0**	**10**	1.0	**23**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-12	**07/20/99**	**1.5 - 19.5**	**1**	1.0	**1**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-13	**07/20/99**	**3.0 - 18.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
B-14	**07/20/99**	**1.0 - 18.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
Gw-01	**11/30/99**	**24.5 - 27.5**	**716**	1.0	**367**	1.0	**1.6**	1.0	**369**	1.0	**4.3**	1.0	**10.6**	2.0
Gw-02	**11/29/99**	**26.2 - 29.2**	ND	1.0	**2.1**	1.0	ND	1.0	**24.6**	1.0	ND	1.0	**8.7**	2.0
Gw-03	**12/01/99**	**22.0 - 25.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-04[3]	**NS**	**25.0 - 27.0**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gw-05	**11/30/99**	**23.0 - 26.0**	**2.4**	1.0	**1.4**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-06	**12/01/99**	**21.0 - 24.0**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-07	**11/30/99**	**22.0 - 25.0**	**1.2**	1.0	**51.6**	1.0	ND	1.0	**9.2**	1.0	ND	1.0	ND	2.0
Gw-08	**12/07/99**	**20.1 - 23.1**	ND	1.0	**10.3**	1.0	ND	1.0	**5.5**	1.0	ND	1.0	ND	2.0
Gw-09	**12/01/99**	**16.5 - 19.5**	**2.5**	1.0	**1,140**	1.0	**1.9**	1.0	**149**	1.0	ND	1.0	ND	2.0
Gw-10	**12/07/99**	**15.1 - 18.1**	ND	1.0	**64.8**	1.0	ND	1.0	**21.3**	1.0	ND	1.0	ND	2.0
Gw-11	**12/07/99**	**20.1 - 23.1**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-12	**12/07/99**	**14.0 - 17.0**	**1.6**	1.0	**2.3**	1.0	ND	1.0	**18.4**	1.0	ND	1.0	ND	2.0
Gw-13	**12/07/99**	**17.8 - 20.8**	**1.1**	1.0	**6.7**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-14	**12/01/99**	**17.3 - 20.3**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-15	**12/07/99**	**19.2 - 22.2**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-16	**12/07/99**	**17.3 - 20.3**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0

Table 1-2
Historical Groundwater Analytical Results
Missouri Metals Site
Overland, Missouri

			PCE		TCE		1,1-DCE		cis-1,2-DCE		trans-1,2-DCE		Vinyl Chloride	
		MCL Screening Levels[1]	5		5		7		70		100		2	
		Units	µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
Sample ID	**Sample Date**	**Screened Interval**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**
Gw-17[3]	**NS**	**16.0 - 19.0**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gw-18[3]	**NS**	**15.2 - 18.2**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gw-19	**12/01/99**	**21.4 - 24.4**	ND	1.0	ND	1.0	ND	1.0	**2.2**	1.0	ND	1.0	**3.4**	2.0
Gw-20[3]	**NS**	**19.0 - 22.0**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gw-21	**12/01/99**	**17.7 - 20.7**	ND	1.0	ND	1.0	ND	1.0	**2.4**	1.0	ND	1.0	ND	2.0
Gw-22	**12/07/99**	**14.6 - 17.6**	ND	1.0	**4.5**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-23	**12/07/99**	**17.6 - 20.6**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-24	**12/01/99**	**19.7 - 22.7**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-25	**12/07/99**	**14.1 - 17.1**	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0
Gw-26	**12/01/99**	**20.0 - 23.0**	**1.5**	1.0	**1.3**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	2.0

Notes:

[1] - Maximum Continment Levels (MCLs) identified in the 1994 Consent Agreement.

[2] - Sampling Point (B-2) was not sampled due to the presence of perched groundwater at shallow depths (approximately 4 feet below ground surface).

[3] - Sampling Points and Temporary Piezometers were considered dry during sample collection and did not produce sufficient water for sampling.

NS - Not Sampled.

ND - Not Detected.

PCE - Tetrachloroethene.

TCE - Trichloroethene.

DCE - Dichloroethene.

µg/L - Micrograms per Liter.

-Exceeds MCLs identified in the 1994 Consent Agreement.

TABLE 1-3
Historical Groundwater Monitoring Well Analytical Results
PerkinElmer
Missouri Metals

Monitoring Well	Sample Date	PCE (ug/L)	TCE (ug/L)	1,1-DCE (ug/L)	cis-1,2-DCE (ug/L)	trans-1,2-DCE (ug/L)	Vinyl Chloride (ug/L)
	MCL[1 2]	5	5	7	70	100	2
GMW-1	05/05/97	ND	ND	ND	ND	ND	ND
	11/17/97	ND	ND	ND	ND	ND	ND
	06/03/98	ND	ND	ND	ND	ND	ND
	11/18/98	ND	ND	ND	ND	ND	ND
	05/27/99	ND	ND	ND	ND	ND	ND
	03/27/03	ND	ND	ND	ND	ND	ND
	11/24/03	ND	ND	ND	ND	ND	ND
	03/10/04	ND	ND	ND	ND	ND	ND
	07/21/04	ND	ND	ND	ND	ND	ND
	11/23/04	ND	ND	ND	ND	ND	ND
GMW-3	05/05/97	12.4 J	454	ND	407	ND	16.4 J
	11/17/97	ND	385	ND	369	ND	19.7
	06/03/98	ND	370	ND	280	ND	ND
	11/18/98	ND	880	ND	920	ND	40 J
	05/27/99	ND	860	ND	970	ND	34 J
pre-pilot	12/04/01	3.1 J	138	1.8 J	308	2.6 J	10.5
post-pilot	01/10/02	ND	65.1	2.3 J	476	ND	19.2
pre-full	03/28/03	17 J	26 J	ND	835	ND	22.5
	11/24/03	84 J	984	ND	888	ND	36 J
	03/11/04	34.9	40.3	ND	95.4	ND	3.3
	07/20/04	2.5 J	351	2.8 J	652	6.5	34.2
	11/23/04	ND	120	ND	1,010	ND	47.9
GMW-4	12/05/01	ND	ND	ND	ND	ND	ND
pre-full	03/28/03	2.0 U* J	ND	ND	ND	ND	ND
	11/24/03	2.6 U* J	ND	ND	ND	ND	ND
	03/11/04	ND	ND	ND	ND	ND	ND
	07/20/04	ND	ND	ND	ND	ND	ND
	11/23/04	ND	ND	ND	ND	ND	ND
GMW-5	05/06/97	10,400	4,830	ND	3,800	ND	713
	11/17/97	11,000	4,630	ND	3,360	ND	625 J
	06/03/98	7,100	5,000	ND	4,200	ND	740
	11/18/98	7,900	4,800	ND	4,700	ND	600
	05/27/99	9,100	5,900	ND	6,500	ND	1,100
pre-pilot	12/04/01	1,510	1,120	6.3	2,960	28.7	239
post-pilot	01/11/02	ND	ND	ND	ND	ND	ND
pre-full	03/27/03	839	1,060	ND	2,880	ND	254
	11/24/03	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	03/10/04	706	1,170	ND	2,860	40 J	390
	07/21/04	1,250	1,680	ND	4,670	38 J	702
	11/23/04	1,140	1,670	ND	4,820	ND	657

TABLE 1-3
Historical Groundwater Monitoring Well Analytical Results
PerkinElmer
Missouri Metals

Monitoring Well	Sample Date	PCE (ug/L)	TCE (ug/L)	1,1-DCE (ug/L)	cis-1,2-DCE (ug/L)	trans-1,2-DCE (ug/L)	Vinyl Chloride (ug/L)
	MCL[1 2]	5	5	7	70	100	2
GMW-6	05/06/97	47,400	25,200	ND	25,200	ND	ND
	11/17/97	15,800	12,400	ND	18,600	ND	ND
	06/03/98	67,000	26,000	ND	22,000	ND	ND
	11/18/98	53,000	21,000	ND	21,000	ND	ND
	05/27/99	72,000	26,000	ND	25,000	ND	ND
pre-pilot	12/04/01	64,100	19,800	48 J	19,400	69 J	797
post-pilot	01/11/02	57,000	17,100	ND	16,400	ND	ND
GMW-6R pre-full	03/27/03	46,400	19,300	ND	22,500	ND	ND
	11/24/03	36,500	13,100	ND	10,600	ND	ND
	03/10/04	54,400	23,100	ND	23,300	ND	582
	07/20/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	11/24/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	04/11/06	18,600	12,700	ND	28,500	ND	1,100 J
	06/14/06	18,400	13,600	ND	31,700	ND	1,050
GMW-7	05/05/97	ND	2,180	ND	401	ND	ND
	11/17/97	ND	2,120	ND	346	ND	ND
	06/03/98	ND	2,300	ND	410	ND	ND
	11/18/98	ND	3,200	ND	460	ND	ND
	05/27/99	ND	2,200	ND	490	ND	ND
pre-full	03/28/03	25 J	612	ND	347	ND	23.2
	11/24/03	52 J	487	ND	282	ND	ND
	03/10/04	7.6	468	1.7 J	302	1.6 J	14.1
	07/20/04	9.7	534	1.8 J	270	ND	13.1
	11/23/04	5.7 J	335	ND	220	ND	8.8 J
GMW-8	05/05/97	ND	8,120	ND	24,500	ND	2,450
	11/17/97	835 J	8,260	ND	27,600	ND	2,770
	06/03/98	ND	7,100	ND	26,000	ND	1,800
	11/18/98	ND	7,900	ND	32,000	ND	2,700
	05/27/99	ND	5,300	ND	22,000	ND	1,400
pre-pilot	12/04/01	1,140.0	7,110	ND	25,800	64 J	2,030
post-pilot	01/10/02	ND	6,880	ND	22,400	ND	1,900
pre-full	03/28/03	200 J	3,640	ND	14,100	ND	731
	11/25/03	920 J	2,400 J	ND	15,100	ND	710 J
	03/11/04	ND	1,310	ND	8,380	ND	459
	07/20/04	ND	2,190	ND	12,000	ND	380
	11/23/04	ND	3,030	ND	19,000	ND	889
GMW-9	05/05/97	ND	8,810	ND	571	ND	ND
	11/17/97	ND	9,220	ND	577	ND	ND
	06/03/98	ND	8,300	ND	500	ND	ND
	11/18/98	ND	8,800	ND	650	ND	ND
	05/27/99	ND	7,300	ND	570	ND	ND
post-pilot	01/10/02	ND	ND	ND	ND	ND	ND
pre-full	03/28/03	8.0	148	ND	97	ND	3.2
	11/25/03	83 J	980	ND	831	ND	ND
	03/11/04	ND	592	ND	1,020	ND	ND
	07/20/04	ND	591	ND	1,150	ND	ND
	11/23/04	ND	676	ND	655	ND	13 J

TABLE 1-3
Historical Groundwater Monitoring Well Analytical Results
PerkinElmer
Missouri Metals

Monitoring Well	Sample Date	PCE (ug/L)	TCE (ug/L)	1,1-DCE (ug/L)	cis-1,2-DCE (ug/L)	trans-1,2-DCE (ug/L)	Vinyl Chloride (ug/L)
	MCL[1 2]	5	5	7	70	100	2
GMW-10	05/22/96	187	543	ND	533	ND	30.1
pre-full	03/28/03	66.4	50.3	ND	45.2	ND	ND
	11/25/03	28.8	20.1	ND	36.1	ND	ND
	03/11/04	5.5	5.7	ND	38	1.1 J	4.0
	07/21/04	5.6	4.9 J	ND	40.6	ND	4.7
	11/24/04	4.7 J	6.9	ND	38.6	ND	2.6
GMW-11	05/05/97	ND	258	ND	1,290	ND	ND
	11/17/97	ND	257	ND	1,780	ND	ND
	06/03/98	ND	150	ND	1,200	ND	ND
	11/18/98	ND	460	ND	1,600	ND	ND
	05/27/99	ND	540	ND	1,800	ND	ND
pre-full	03/28/03	4.5 U* J	60.6	1.7 J	173	2.2 J	3.1
	11/25/03	4.0 U* J	44.7	1.6 J	195	1.9 J	4.6
	03/11/04	2.2 J	49.5	1.2 J	171	2.1 J	6.4
	07/21/04	ND	12.2	ND	77	ND	11.3
	11/24/04	ND	8.8	ND	76	ND	10.2
GMW-14	05/05/97	103,000	123,000	ND	ND	ND	11,700
	11/17/97	ND	43,800	ND	72,200	ND	7,040
	06/03/98	ND	50,000	ND	72,000	ND	5,100
	11/18/98	ND	57,000	ND	84,000	ND	6,900
	05/27/99	2,600 J	58,000	ND	85,000	ND	7,200
pre-pilot	12/04/01	3,580	39,600	68.4	69,700	ND	6,180
post-pilot	01/10/02	ND	ND	ND	ND	ND	ND
pre-full	03/28/03	4,640	50,700	ND	64,400	ND	2,400
	11/24/03	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	03/11/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	07/20/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	11/23/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
GMW-15	05/06/97	39,200	9,030	ND	13,500	ND	ND
	06/03/98	53,000	10,000	ND	17,000	ND	ND
	11/18/98	67,000	18,000	ND	24,000	ND	ND
	05/27/99	74,000	23,000	ND	22,000	ND	ND
pre-pilot	12/04/01	65,200	14,500	34.5	23,800	ND	940 J
post-pilot	01/11/02	66,500	27,200	ND	19,300	ND	ND
pre-full	03/27/03	68,100	17,600	ND	21,900	ND	ND
	11/24/03	64,300	67,900	ND	13,700	ND	ND
	03/10/04	73,800	25,500	ND	27,600	ND	500 J
	07/20/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	11/23/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$

TABLE 1-3
Historical Groundwater Monitoring Well Analytical Results
PerkinElmer
Missouri Metals

Monitoring Well	Sample Date	PCE (ug/L)	TCE (ug/L)	1,1-DCE (ug/L)	cis-1,2-DCE (ug/L)	trans-1,2-DCE (ug/L)	Vinyl Chloride (ug/L)
	MCL[1 2]	5	5	7	70	100	2
GMW-16	05/05/97	ND	48	ND	32.8	ND	ND
	11/17/97	3.0	56.3	ND	20.5	ND	ND
	06/03/98	ND	150	ND	90	ND	ND
	11/19/98	3.0	36	ND	20	ND	ND
	05/27/99	4.0 J	60	ND	38	ND	ND
pre-pilot	12/04/01	18.0 J	158	ND	176	2.5 J	ND
post-pilot	01/10/02	1.6 J	89.3	ND	97	ND	ND
pre-full	03/28/03	390 J	5,390	ND	14,100	ND	82 J
	04/08/03	360 J	5,750	ND	13,000	ND	ND
	11/24/03	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	03/11/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	07/20/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
	11/23/04	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$
GMW-17	05/06/97	ND	386	ND	ND	ND	ND
	11/17/97	ND	513	ND	ND	ND	ND
	06/03/98	ND	340	ND	ND	ND	ND
	11/18/98	ND	560	ND	ND	ND	ND
	05/27/99	ND	460	ND	ND	ND	ND
pre-pilot	12/05/01	50.9	664	ND	28 J	ND	ND
post-pilot	01/11/02	90.3	673	ND	34	ND	ND
pre-full	03/27/03	339	772	ND	132	ND	ND
	11/24/03	1,530	2,620	ND	450 J	ND	ND
	03/10/04	100 J	2,020	ND	64 J	ND	ND
	07/21/04	119.0	1,300	ND	67 J	ND	ND
	11/23/04	100 J	1,060	ND	60 J	ND	ND
GMW-19	08/18/00	ND	11,000	ND	2,900	ND	ND
	03/02/01	260 J	4,300	ND	1,200	ND	ND
pre-pilot	12/05/01	200 B	7,180	3.1 J	2,460	8.1	3.3
post-pilot	01/10/02	ND	622	ND	944	ND	ND
pre-full	03/28/03	362	9,060	ND	3,100	ND	ND
	11/25/03	670 J	11,600	ND	4,320	ND	ND
	03/11/04	280 J	9,690	ND	3,720	ND	ND
	07/20/04	200 J	8,070	ND	3,030	ND	ND
	11/23/04	180 J	7,870	ND	3,030	ND	ND
GMW-20	08/18/00	ND	2,000	ND	ND	ND	ND
	03/02/01	ND	1,700	ND	400	ND	ND
pre-pilot	12/05/01	44.0	2,260	1.3 J	521	1.8 J	ND
post-pilot	01/10/02	ND	117	ND	176	ND	ND
pre-full	03/28/03	62 J	1,900	ND	524	ND	ND
	11/25/03	170 J	1,860	ND	591	ND	ND
	03/11/04	95 J	2,910	ND	663	ND	ND
	07/20/04	34 J	2,400	ND	622	ND	ND
	11/23/04	28 J	2,500	ND	656	ND	ND

TABLE 1-3
Historical Groundwater Monitoring Well Analytical Results
PerkinElmer
Missouri Metals

Monitoring Well	Sample Date	PCE (ug/L)	TCE (ug/L)	1,1-DCE (ug/L)	cis-1,2-DCE (ug/L)	trans-1,2-DCE (ug/L)	Vinyl Chloride (ug/L)
	MCL[1 2]	**5**	**5**	**7**	**70**	**100**	**2**
GMW-21	03/02/01	170	360	ND	ND	ND	ND
	12/22/04	24.5	66.7	ND	3.2 J	ND	ND
GMW-22	03/02/01	2.0	6.0	ND	ND	ND	ND
	12/22/04	273	380	ND	7.6 J	ND	ND
GMW-23	03/02/01	8.0	26.0	ND	0.8 J	ND	ND
	12/22/04	640	1010	ND	ND	ND	ND
GMW-24	03/02/01	4.0	17.0	ND	2	ND	ND
	12/22/04	700	1900	ND	110 J	ND	ND

Notes:
[1] - United States Environmental Protection Agency (USEPA) Regional Screening Levels for Chemical Contaminants at Superfund Sites (May 2010).
[2] - Maximum Continment Levels identified in the 1994 Consent Agreement.
PCE - Tetrachloroethylene
TCE - Trichloroethylene
DCE - Dichloroethylene
ug/L - Micrograms per liter
MCL - Maximum contaminant level for drinking water
ND - Not detected
J - Qualified as estimated
U* - Qualified as undetected
$KMnO_4$ - Potassium permanganate

TABLE 1-4
Monitoring Well Completion Details
PerkinElmer
Missouri Metals

Monitoring Well	Well Diameter	Total Depth (feet bgs)	Screen Length (feet)	Screened Formation	Screened Interval	Ground Surface Elevation (feet, msl)	Top of Casing Elevation (feet, msl)
GMW-1	2"	16.5	5.0	loess	shallow	650.92	650.92
GMW-3	2"	16.5	5.0	loess	shallow	635.87	635.83
GMW-4	2"	16.5	5.0	loess	shallow	641.60	641.54
GMW-5	2"	17.5	15.0	loess	shallow	646.29	646.29
GMW-6R	2"	15.0	10.0	loess	shallow	642.61	642.35
GMW-7	2"	14.0	10.0	loess	shallow	638.21	638.32
GMW-8	2"	14.0	10.0	loess	shallow	636.35	635.91
GMW-10	2"	15.0	10.0	loess	shallow	643.06	643.06
GMW-11	2"	15.0	10.0	loess	shallow	643.15	643.15
GMW-9	2"	20.0	10.0	loess	shallow/inter.	637.57	637.50
GMW-15	4"	19.9	4.5	loess	intermediate	642.31	642.31
GMW-14	4"	23.0	4.5	loess/siltstone	intermediate	636.41	636.23
GMW-28	4"	22.6	19.5	loess/siltstone	intermediate	645.19	644.62
GMW-16	4"	34.5	5.0	siltstone	deep	636.49	636.00
GMW-17	4"	48.8	10.0	siltstone (deep)	deep	646.29	646.29
GMW-19	2"	35.7	5.0	siltstone	deep	633.83	633.61
GMW-20	2"	33.3	5.0	siltstone	deep	634.29	634.12
GMW-21	2"	33.8	5.0	siltstone	deep	627.60	627.29
GMW-22	2"	38.1	5.0	siltstone	deep	618.03	617.60
GMW-23	2"	34.7	5.0	siltstone	deep	610.06	609.80
GMW-24	2"	35.5	5.0	siltstone	deep	618.73	618.37

Notes:

bgs - Below ground surface

msl - Mean sea level

Table 1-5
Historical Residential Indoor Air Analytical Results
Missouri Metals Site
Overland, Missouri

			PCE		TCE		1,1-DCE		cis-1,2-DCE		trans-1,2-DCE		Vinyl Chloride	
USEPA Regional Screening Levels (Residential)[1]			0.41		1.2[4]		210		--		63		0.16	
Units			$\mu g/m^3$		$\mu g/m^3$		$\mu g/m^3$		$\mu g/m^3$		$\mu g/m^3$		$\mu g/m^3$	
House Address	**Sample ID**	**Sample Date**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**	**Result**	**RL**
[redacted]	A-2 (Split)	04/24/01	**4.88**	3.2	ND	2.57	ND	1.90	ND	1.88	ND	1.88	ND	1.23
	0119868	04/24/01	ND	7.7	ND	6.1	ND	4.5	ND	4.5	ND	18	ND	2.9
	[redacted]	11/20/98	ND	9.09	ND	7.2	ND	5.31	ND	5.31	ND	5.31	ND	3.43
	[redacted]	11/20/98	ND	9.43	ND	7.47	ND	5.51	ND	5.51	ND	5.51	ND	3.55
	0119867	04/24/01	ND	7.9	**67**	6.3	ND	4.6	**35**	4.6	ND	18	ND	3.0
	0119869	04/24/01	ND	7.9	ND	6.3	ND	4.6	ND	4.6	ND	18	ND	3.0
	[redacted]	11/20/98	ND	9.09	ND	7.2	ND	5.31	ND	5.31	ND	5.31	ND	3.43
	A-1 (split)	04/24/01	ND	2.92	ND	2.31	ND	1.71	ND	1.69	ND	1.69	ND	1.10
	0119866	04/24/01	ND	7.9	ND	6.3	ND	4.6	ND	4.6	ND	18	ND	3.0
	0119865	04/24/01	ND	10	**67**	8.1	ND	6	ND	6	ND	24	ND	3.9
	[redacted]	11/20/98	ND	9.56	ND	7.58	ND	5.59	ND	5.59	ND	5.59	ND	3.6

Notes:

[1] - United States Environmental Protection Agency (USEPA) Regional Screening Levels for Chemical Contaminants at Superfund Sites (May 2010).

VOCs - Volatile Organic Compounds.

RL - Reporting Limits.

ND - Not Detected.

PCE - Tetrachloroethene.

TCE - Trichloroethene.

DCE - Dichloroethene.

$\mu g/m^3$ - Micrograms per cubic meter.

-Exceeds USEPA Regional Screening Levels for Residential Air.

***A sample result will be also highlighted If the sample result is ND and half of the RL exceeds a screening level.**

Table 1-6
Historical Residential Sump Water Analytical Results
Missouri Metals Site
Overland, Missouri

			PCE		TCE		1,1-DCE		cis-1,2-DCE		trans-1,2-DCE		Vinyl Chloride	
		MCL Screening Levels[1]	5		5		7		70		100		2	
		Units	µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
House Address	Sample ID	Sample Date	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL
[redacted]	[redacted]	11/20/98	ND	5.0	**4.0 J**	5.0	ND	5.0	ND	5.0	ND	5.0	ND	5.0
	0119863	04/24/01	**2.3**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
	0119864 (Dup)	04/24/01	**2.1**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
	SW-2 (Split)	04/24/01	**3.5**	1.0	**0.7 J**	1.0	ND	1.0	**0.8 J**	1.0	ND	1.0	ND	1.0
	0119862	04/24/01	**3.7**	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
	[redacted]	11/20/98	ND	5.0	ND	5.0	ND	5.0	ND	5.0	ND	5.0	ND	5.0
	0119860	04/24/01	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0	ND	1.0
	SW-1 (Split)	04/24/01	**0.8 J**	1.0	**76 K**	1.0	ND	1.0	**83 K**	1.0	**0.6 J**	1.0	ND	1.0
	0119861	04/24/01	ND	1.0	**66.5**	1.0	ND	1.0	**83.7**	1.0	ND	1.0	ND	1.0
	0119859	04/24/01	**1.5**	1.0	**1,140**	1.0	ND	1.0	**73.2**	1.0	ND	1.0	ND	1.0

Notes:

[1] - Maximum Continment Levels identified in the 1994 Consent Agreement.

RL - Reporting Limits.

ND - Not Detected.

PCE - Tetrachloroethene.

TCE - Trichloroethene.

DCE - Dichloroethene.

µg/L - Micrograms per Liter.

J - estimated value, below reporting limit

K - compound above calibration range in intial analysis. Sample diluted and re-analyzed to obtain result.

-Exceeds USEPA Regional Screening Levels for Groundwater (MCLs) and the MCL identified in the 1994 Consent Agreement.

***A sample result will be also highlighted If the sample result is ND and half of the RL exceeds a screening level.**

Table 5-1
Site-Specific Screening Levels
Missouri Metals Site
Overland, Missouri

Equations:

$C_{SS} = C_{IA} / AF_{SS}$

$C_{SG} = C_{IA} / AF_{SG}$

$C_{Gw} = C_{IA} / (AF_{Gw} \times H \times 1{,}000 L/m^3)$

Where:

C_{SS} = Calculated screening level in sub-slab soil gas ($\mu g/m^3$)
C_{SG} = Calculated screening level in soil gas ($\mu g/m^3$)
C_{Gw} = Calculated screening level in groundwater (µg/L)
C_{IA} = Published screening level in indoor air ($\mu g/m^3$)
AF_{SS} = Sub-slab soil gas to indoor air attenuation factor (unitless)
AF_{SG} = Soil gas to indoor air attenuation factor (unitless)
AF_{Gw} = Groundwater to indoor air attenuation factor (unitless)
H = Henry's Law Constant (unitless)

Variable Values:

C_{SS} = Calculated
C_{SG} = Calculated
C_{GW} = Calculated
C_{IA} = Chemical-specific (USEPA, 2011)[1]
AF_{SS} = 1.00E-01 Empirically-derived value (USEPA, 2008)[2]
AF_{SG} = 1.00E-02 Empirically-derived value (USEPA, 2008)[2]
AF_{Gw} = 1.00E-03 Empirically-derived value (USEPA, 2008)[2]
H = Chemical-specific (USEPA, 2011)[1]

Chemical	**C_{IA} ($\mu g/m^3$)**	**C_{SS} ($\mu g/m^3$)**	**C_{SG} ($\mu g/m^3$)**	**H (unitless)**	**C_{GW} (µg/L)**
Volatile Organic Compound					
1,1-Dichloroethene	2.10E+02	2.10E+03	2.10E+04	1.07E+00	1.97E+02
cis-1,2-Dichloroethene[3]	7.30E+00	7.30E+01	7.30E+02	1.67E-01	4.38E+01
trans-1,2-Dichloroethene	6.30E+01	6.30E+02	6.30E+03	1.67E-01	3.78E+02
1,2-Dichloroethene, total	NA	--	--	1.67E-01	--
Tetrachloroethene[3]	9.36E+00	9.36E+01	9.36E+02	7.24E-01	1.29E+01
Trichloroethene	4.30E-01	4.30E+00	4.30E+01	4.03E-01	1.07E+00
Vinyl Chloride	1.60E-01	1.60E+00	1.60E+01	1.14E+00	1.41E-01

Notes:

$\mu g/m^3$ - micrograms per cubic meter.
µg/L - micrograms per liter.
[1] - Values represent USEPA's Regional Screening Levels for residential indoor air (USEPA, November, 2011).
[2] - Value calculated from U.S. EPA's Vapor Intrusion Database: Preliminary Evaluation of Attenuation Factors, March 4, 2008.
[3] - C_{IA} value calculated following USEPA RSL procedures using updated toxicity information.
NA - Value not available.
-- Value not calculated.
IA - indoor air.
SS - sub-slab.
SG - soil gas.
GW - groundwater.

SOURCE: MAPQUEST.COM

N

NOT TO SCALE

Burns & McDonnell SINCE 1898

Figure 1-1
SITE LOCATION MAP
MISSOURI METALS SITE
PERKINELMER, INC.
OVERLAND, MISSOURI

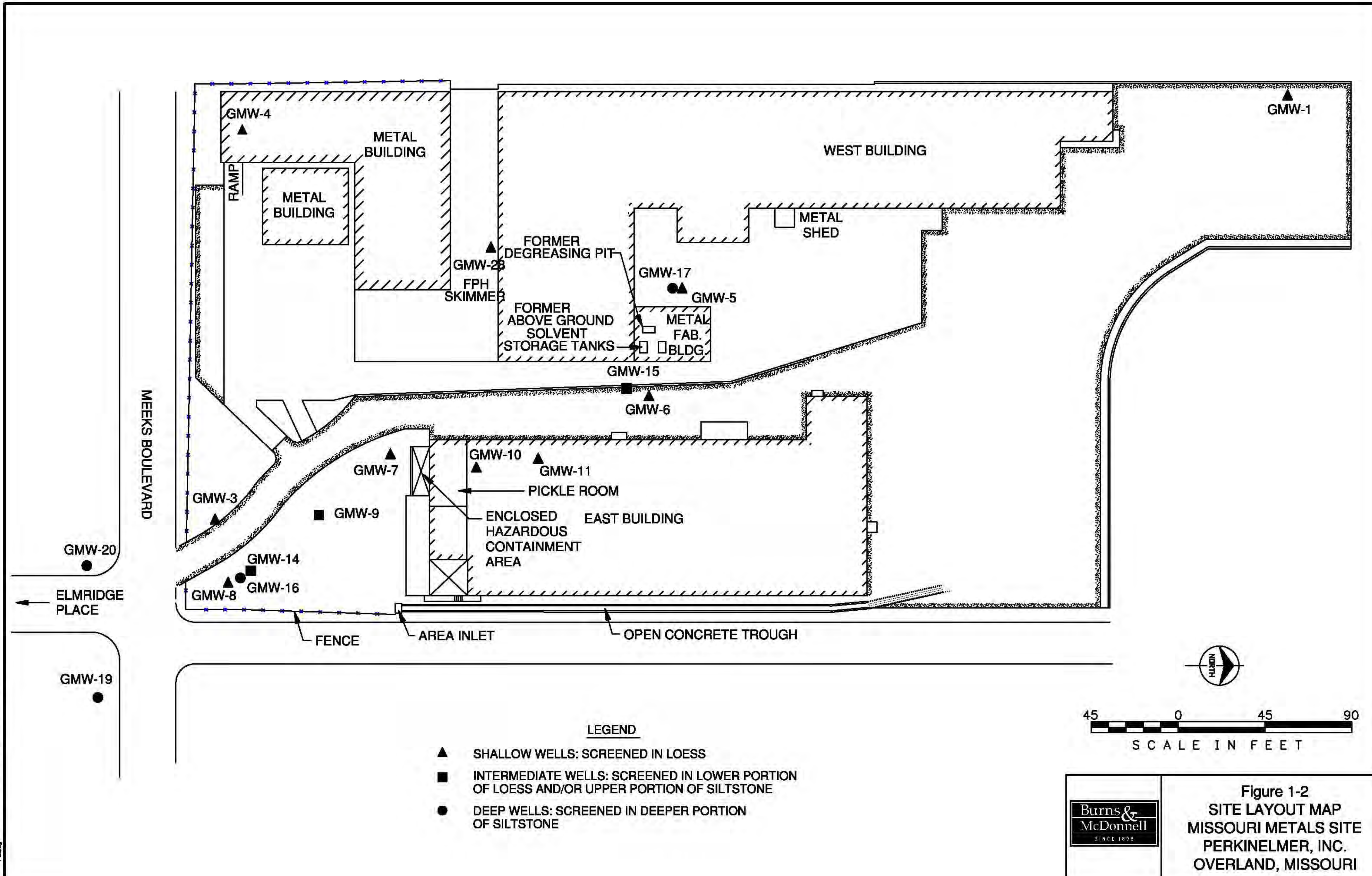


Figure 1-2
SITE LAYOUT MAP
MISSOURI METALS SITE
PERKINELMER, INC.
OVERLAND, MISSOURI

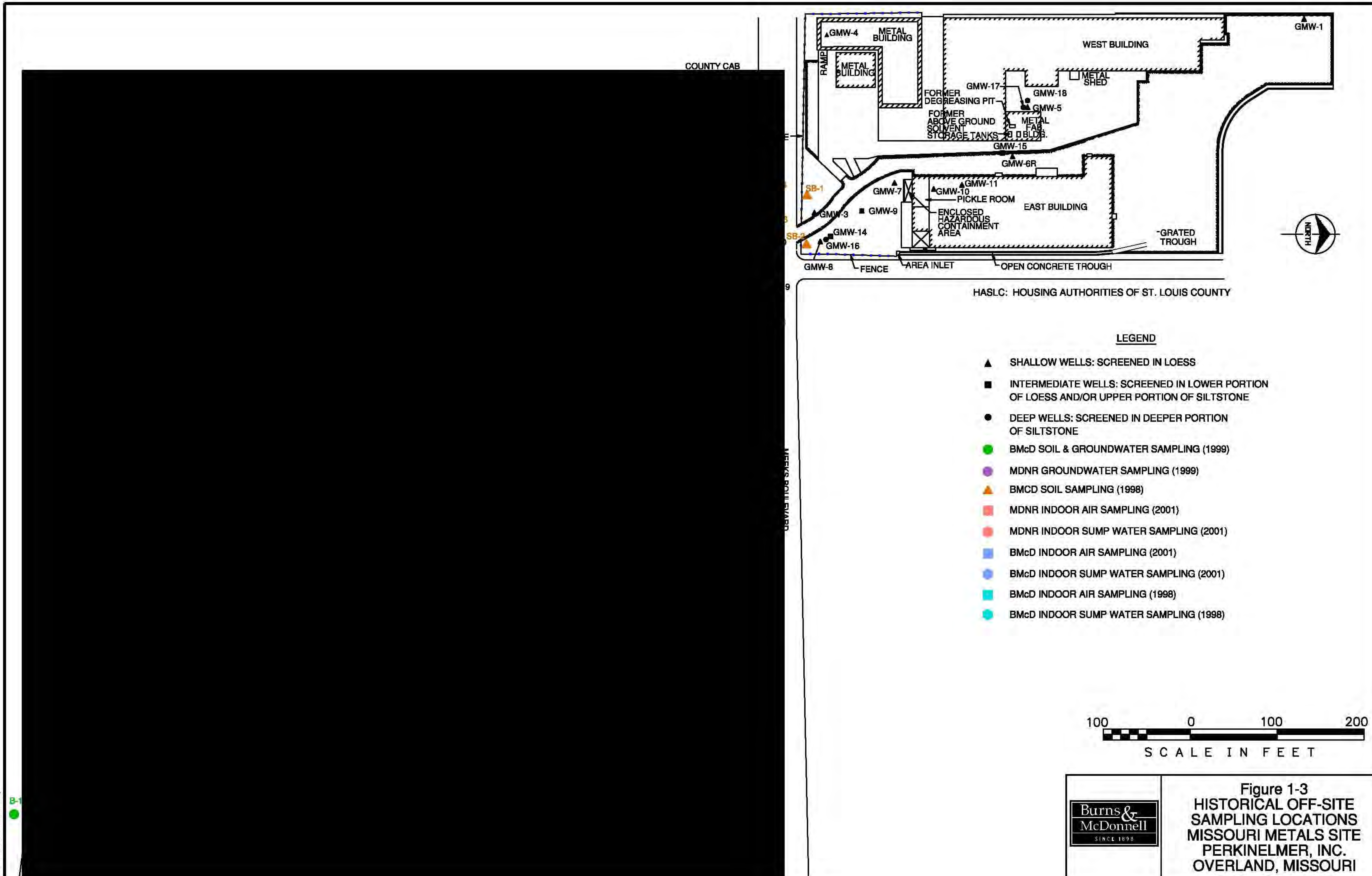
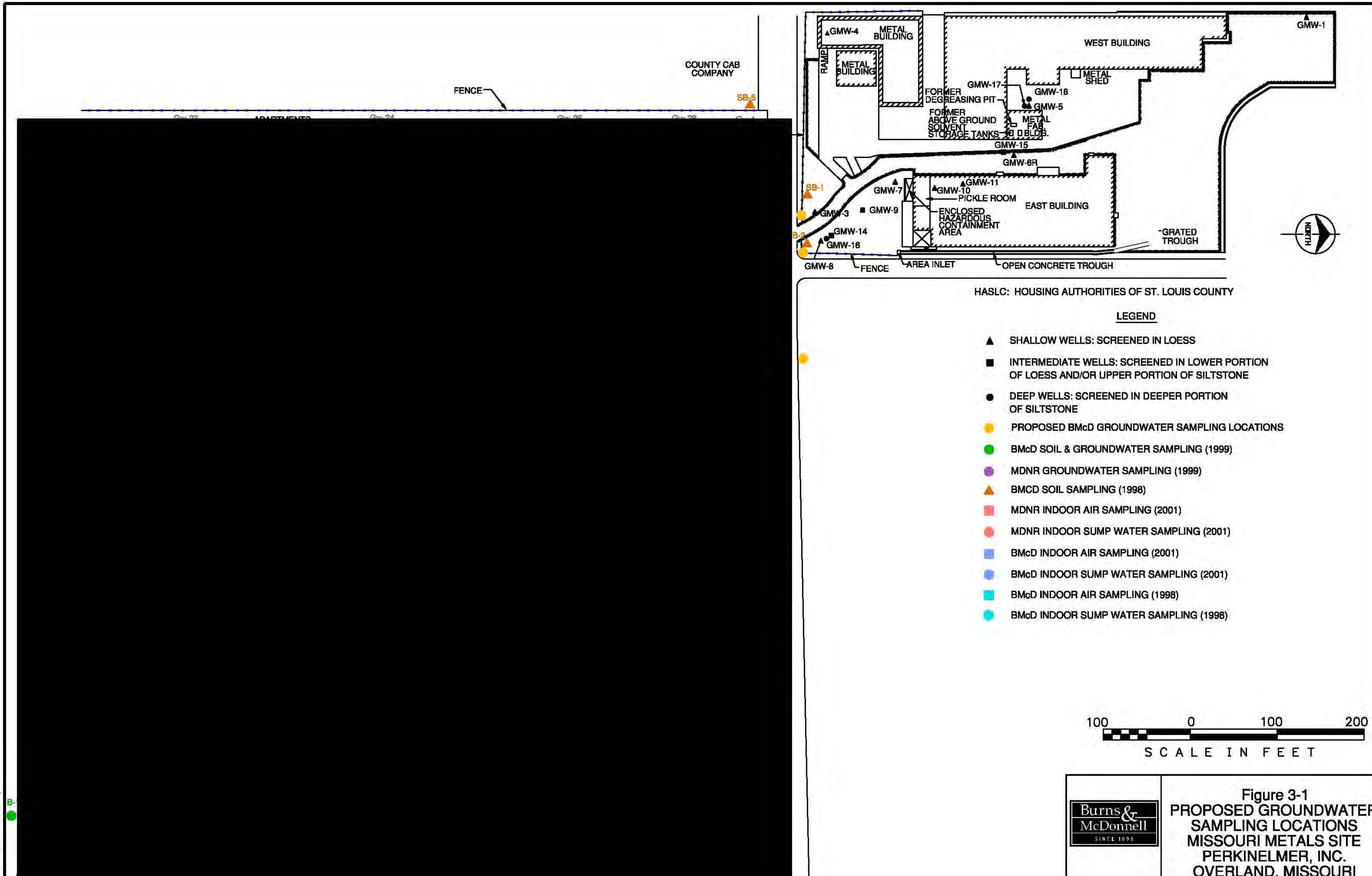


Figure 1-3
HISTORICAL OFF-SITE SAMPLING LOCATIONS
MISSOURI METALS SITE
PERKINELMER, INC.
OVERLAND, MISSOURI



HASLC: HOUSING AUTHORITIES OF ST. LOUIS COUNTY

LEGEND

- ▲ SHALLOW WELLS: SCREENED IN LOESS
- ■ INTERMEDIATE WELLS: SCREENED IN LOWER PORTION OF LOESS AND/OR UPPER PORTION OF SILTSTONE
- ● DEEP WELLS: SCREENED IN DEEPER PORTION OF SILTSTONE
- PROPOSED BMcD GROUNDWATER SAMPLING LOCATIONS
- BMcD SOIL & GROUNDWATER SAMPLING (1999)
- MDNR GROUNDWATER SAMPLING (1999)
- BMCD SOIL SAMPLING (1998)
- MDNR INDOOR AIR SAMPLING (2001)
- MDNR INDOOR SUMP WATER SAMPLING (2001)
- BMcD INDOOR AIR SAMPLING (2001)
- BMcD INDOOR SUMP WATER SAMPLING (2001)
- BMcD INDOOR AIR SAMPLING (1998)
- BMcD INDOOR SUMP WATER SAMPLING (1998)

100 0 100 200
SCALE IN FEET

Burns & McDonnell SINCE 1898

Figure 3-1
PROPOSED GROUNDWATER SAMPLING LOCATIONS
MISSOURI METALS SITE
PERKINELMER, INC.
OVERLAND, MISSOURI

APPENDIX A

Off-Site Access Agreements and Special Use Permit Application

AGREEMENT FOR SITE ACCESS

THIS AGREEMENT, made and entered into this 15 day of August 2011, by and between the [redacted] (herein referred to as Owner) and PerkinElmer, Inc., a Massachusetts corporation ("PerkinElmer"), with its corporate headquarters at 940 Winter Street, Waltham, Massachusetts, 02451. The following seven (7) addresses (herein referred to as Subject Properties) are included in this agreement for access to the Subject Property.

[redacted]

RECITALS:
Environmental investigations are being conducted in the Chicago Heights Neighborhood to evaluate the presence of potential environmental impacts, as requested by the Missouri Department of Natural Resources ("MDNR"). PerkinElmer seeks access to the Subject Property to install temporary groundwater monitoring points and soil gas sampling points and collected corresponding samples. The temporary groundwater monitoring points and soil gas sampling point will be installed outdoors using standard direct-push equipment and completed to a depth to be determined. Also, PerkinElmer seeks to access the basement of the Subject Property to install sub-slab vapor monitoring points and collect corresponding samples and collect indoor air samples. The sub-slab vapor monitoring points will be installed using a hand-held hammer drill and will be completed to a depth immediately below the concrete basement slab. No installation is necessary for indoor air samples.

NOW, THEREFORE, for and in consideration of the mutual covenants set forth herein, the parties agree as follows:

1. Purpose of Agreement. The purpose of this Agreement is to provide the terms and conditions under which PerkinElmer, or its representative, may enter the Subject Property to conduct the above-described activities at the Subject Property.

2. Access. PerkinElmer is authorized to have access to the Subject Property, for the above-described purposes. PerkinElmer will give Owner reasonable advance notice of its desire to enter each property so that Owner may schedule the entry with the property's tenant. The Owner, or their agent, shall have the right to be present during and to observe all of PerkinElmer's activities at the Subject Property.

3. Right to refuse access. The Owner may refuse to allow entry by PerkinElmer onto the Subject Property, provided that it agrees to grant PerkinElmer access at another reasonable time, and with reasonable prior notice.

4. PerkinElmer representative. PerkinElmer has contracted with an Environmental consultant, Burns & McDonnell, to conduct the Work at the Property. For purposes of this Agreement, Burns & McDonnell shall be considered a representative of PerkinElmer.

5. Manner of carrying out drilling and monitoring activities. All activities performed by PerkinElmer shall be conducted in a good and workmanlike manner so as minimize interference

with Property Owner or other tenant activities at the subject property. PerkinElmer shall comply with all applicable laws and regulations, including applicable guidance of the U.S. Environmental Protection Agency ("USEPA") and MDNR, in carrying out the activities authorized by this Agreement. PerkinElmer or its representative shall be responsible for proper disposal of any materials (e.g., soil or groundwater samples) generated during the Work.

6. Copies of analytical data. Upon request, PerkinElmer shall provide the Owner with copies of reports or any monitoring data and chemical analytical data generated from the monitoring and sampling activities that PerkinElmer conducts on Subject Property pursuant to this Agreement.

7. Completion of monitoring and sampling activities. At the conclusion of investigation activities, PerkinElmer shall return the Subject Property to a condition substantially similar to that existing prior to its activities authorized by this Agreement. PerkinElmer shall, at its sole cost and expense, plug bore holes and monitoring points in accordance with all applicable laws and regulations. All equipment and monitoring points shall be removed prior to expiration of this Agreement.

8. Indemnification. PerkinElmer shall indemnify and hold the Owner harmless from and against any injury, damage, claim, lien, cost and/or expense (including attorney's fees) incurred by, or claimed against, the Owner by reason of the acts or omissions of PerkinElmer or its contractors or subcontractors, including any negligent acts or omissions, in carrying out the activities authorized by this Agreement.

9. Effect of Agreement. Nothing in this Agreement shall constitute an admission of fact, responsibility, fault or liability of any kind, or constitute a waiver or limitation of any legal claim or defense available to either party.

10. Notices. All notices required or made under this Agreement shall be in writing, except where noted, and shall be made as follows:

To Owner: [redacted]

To PerkinElmer: Mr. Arthur Wallace
Director, Environmental Safety & Health
PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451
781-663-5779

Either party may change the above designations by written notice to the other party. Notifications to request physical access to the Subject Property under this Agreement will be made in writing, via electronic mail with confirmation, or via telephone call a minimum of ten (10) days in advance. Notifications shall be made by either PerkinElmer or PerkinElmer's authorized representatives by notifying the Owner or other Owner authorized representatives. Written notice may be accomplished through a written schedule for Work to be agreed upon by Burns & McDonnell and Owner.

11. Parties bound. This Agreement shall be binding upon and insure to the benefit of the parties and their respective successors and assigns. Neither party may assign the rights and obligations provided for herein without the prior written consent of the other party.

12. Enforceability by third parties. This Agreement is expressly not intended for the benefit of any third party and is expressly not enforceable by any third party.

13. Entire agreement. This Agreement contains the entire understanding of the parties and supersedes all prior agreements and understands between the parties relating to the subject matter of this Agreement.

14. Severability. If any provision of this Agreement is determined by a court of competent jurisdiction to be invalid or otherwise unenforceable, all remaining provisions of the Agreement shall remain in full force and effect.

15. Term of agreement. The term of this Agreement shall be for three years, unless extended by a written amendment signed by both parties. The parties anticipate that they will extend the Agreement if PerkinElmer or MDNR determines that further sampling will be required at the subject property beyond the date of this agreement.

IN WITNESS WHEREOF, the parties hereby execute this Agreement.

[redacted]

PERKINELMER, INC.

By Arthur Wallace

Name Arthur Wallace

Title EHS Director

AGREEMENT FOR SITE ACCESS

THIS AGREEMENT, made and entered into this 26th day of January, 2012, by and between the [redacted] (herein referred to as Owner) and PerkinElmer, Inc., a Massachusetts corporation ("PerkinElmer"), with its corporate headquarters at 940 Winter Street, Waltham, Massachusetts, 02451. The following three (3) addresses (herein referred to as Subject Properties) are included in this agreement for access to the Subject Property.

[redacted]

RECITALS:

Environmental investigations are being conducted in the Chicago Heights Neighborhood to evaluate the presence of potential environmental impacts, as requested by the Missouri Department of Natural Resources ("MDNR"). PerkinElmer seeks access to the Subject Property to install temporary groundwater monitoring points and soil gas sampling points and collected corresponding samples. The temporary groundwater monitoring points and soil gas sampling point will be installed outdoors using standard direct-push equipment and completed to a depth to be determined. Also, PerkinElmer seeks to access the basement of the Subject Property to install sub-slab vapor monitoring points and collect corresponding samples and collect indoor air samples. The sub-slab vapor monitoring points will be installed using a hand-held hammer drill and will be completed to a depth immediately below the concrete basement slab. No installation is necessary for indoor air samples.

NOW, THEREFORE, for and in consideration of the mutual covenants set forth herein, the parties agree as follows:

1. Purpose of Agreement. The purpose of this Agreement is to provide the terms and conditions under which PerkinElmer, or its representative, may enter the Subject Property to conduct the above-described activities at the Subject Property.

2. Access. PerkinElmer is authorized to have access to the Subject Property, for the above-described purposes. PerkinElmer will give Owner reasonable advance notice of its desire to enter each property so that Owner may schedule the entry with the property's tenant. The Owner, or their agent, shall have the right to be present during and to observe all of PerkinElmer's activities at the Subject Property.

3. Right to refuse access. The Owner may refuse to allow entry by PerkinElmer onto the Subject Property, provided that it agrees to grant PerkinElmer access at another reasonable time, and with reasonable prior notice.

4. PerkinElmer representative. PerkinElmer has contracted with an Environmental consultant, Burns & McDonnell, to conduct the Work at the Property. For purposes of this Agreement, Burns & McDonnell shall be considered a representative of PerkinElmer.

5. Manner of carrying out drilling and monitoring activities. All activities performed by PerkinElmer shall be conducted in a good and workmanlike manner so as minimize interference with Property Owner or other tenant activities at the subject property. PerkinElmer shall comply with all applicable laws and regulations, including applicable guidance of the U.S. Environmental Protection Agency ("USEPA") and MDNR, in carrying out the activities authorized by this

Agreement. PerkinElmer or its representative shall be responsible for proper disposal of any materials (e.g., soil or groundwater samples) generated during the Work.

6. Copies of analytical data. Upon request, PerkinElmer shall provide the Owner with copies of reports or any monitoring data and chemical analytical data generated from the monitoring and sampling activities that PerkinElmer conducts on Subject Property pursuant to this Agreement.

7. Completion of monitoring and sampling activities. At the conclusion of investigation activities, PerkinElmer shall return the Subject Property to a condition substantially similar to that existing prior to its activities authorized by this Agreement. PerkinElmer shall, at its sole cost and expense, plug bore holes and monitoring points in accordance with all applicable laws and regulations. All equipment and monitoring points shall be removed prior to expiration of this Agreement.

8. Indemnification. PerkinElmer shall indemnify and hold the Owner harmless from and against any injury, damage, claim, lien, cost and/or expense (including attorney's fees) incurred by, or claimed against, the Owner by reason of the acts or omissions of PerkinElmer or its contractors or subcontractors, including any negligent acts or omissions, in carrying out the activities authorized by this Agreement.

9. Effect of Agreement. Nothing in this Agreement shall constitute an admission of fact, responsibility, fault or liability of any kind, or constitute a waiver or limitation of any legal claim or defense available to either party.

10. Notices. All notices required or made under this Agreement shall be in writing, except where noted, and shall be made as follows:

To Owner: [redacted]

To PerkinElmer:
Mr. Arthur Wallace
Director, Environmental Safety & Health
PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451
781-663-5779

Either party may change the above designations by written notice to the other party. Notifications to request physical access to the Subject Property under this Agreement will be made in writing, via electronic mail with confirmation, or via telephone call a minimum of ten (10) days in advance. Notifications shall be made by either PerkinElmer or PerkinElmer's authorized representatives by notifying the Owner or other Owner authorized representatives. Written notice may be accomplished through a written schedule for Work to be agreed upon by Burns & McDonnell and Owner.

11. Parties bound. This Agreement shall be binding upon and insure to the benefit of the parties and their respective successors and assigns. Neither party may assign the rights and obligations provided for herein without the prior written consent of the other party.

12. Enforceability by third parties. This Agreement is expressly not intended for the benefit of any third party and is expressly not enforceable by any third party.

13. Entire agreement. This Agreement contains the entire understanding of the parties and supersedes all prior agreements and understands between the parties relating to the subject matter of this Agreement.

14. Severability. If any provision of this Agreement is determined by a court of competent jurisdiction to be invalid or otherwise unenforceable, all remaining provisions of the Agreement shall remain in full force and effect.

15. Term of agreement. The term of this Agreement shall be for three years, unless extended by a written amendment signed by both parties. The parties anticipate that they will extend the Agreement if PerkinElmer or MDNR determines that further sampling will be required at the subject property beyond the date of this agreement.

IN WITNESS WHEREOF, the parties hereby execute this Agreement.

[redacted]

PerkinElmer, Inc.

By [signature]

Name Arthur Wallace

Title EHS Director

AGREEMENT FOR SITE ACCESS

THIS AGREEMENT, made and entered into this 28 day of December 2011, by and between [redacted] (herein referred to as Owner) and PerkinElmer, Inc., a Massachusetts corporation ("PerkinElmer"), with its corporate headquarters at 940 Winter Street, Waltham, Massachusetts, 02451. The following address (herein referred to as Subject Propertie) is included in this agreement for access to the Subject Property.

- [redacted]

RECITALS:

Environmental investigations are being conducted in the Chicago Heights Neighborhood to evaluate the presence of potential environmental impacts, as requested by the Missouri Department of Natural Resources ("MDNR"). PerkinElmer seeks access to the Subject Property to install temporary groundwater monitoring points and soil gas sampling points and collected corresponding samples. The temporary groundwater monitoring points and soil gas sampling point will be installed outdoors using standard direct-push equipment and completed to a depth to be determined. Also, PerkinElmer seeks to access the basement of the Subject Property to install sub-slab vapor monitoring points and collect corresponding samples and collect indoor air samples. The sub-slab vapor monitoring points will be installed using a hand-held hammer drill and will be completed to a depth immediately below the concrete basement slab. No installation is necessary for indoor air samples.

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2. Access. PerkinElmer is authorized to have access to the Subject Property, for the above-described purposes. PerkinElmer will give Owner reasonable advance notice of its desire to enter each property so that Owner may schedule the entry with the property's tenant. The Owner, or their agent, shall have the right to be present during and to observe all of PerkinElmer's activities at the Subject Property.

3. Right to refuse access. The Owner may refuse to allow entry by PerkinElmer onto the Subject Property, provided that it agrees to grant PerkinElmer access at another reasonable time, and with reasonable prior notice.

4. PerkinElmer representative. PerkinElmer has contracted with an Environmental consultant, Burns & McDonnell, to conduct the Work at the Property. For purposes of this Agreement, Burns & McDonnell shall be considered a representative of PerkinElmer.

5. Manner of carrying out drilling and monitoring activities. All activities performed by PerkinElmer shall be conducted in a good and workmanlike manner so as minimize interference with Property Owner or other tenant activities at the subject property. PerkinElmer shall comply with all applicable laws and regulations, including applicable guidance of the U.S. Environmental Protection Agency ("USEPA") and MDNR, in carrying out the activities authorized by this Agreement. PerkinElmer or its representative shall be responsible for proper disposal of any materials (e.g., soil or groundwater samples) generated during the Work.

6. Copies of analytical data. Upon request, PerkinElmer shall provide the Owner with copies of reports or any monitoring data and chemical analytical data generated from the monitoring and sampling activities that PerkinElmer conducts on Subject Property pursuant to this Agreement.

7. Completion of monitoring and sampling activities. At the conclusion of investigation activities, PerkinElmer shall return the Subject Property to a condition substantially similar to that existing prior to its activities authorized by this Agreement. PerkinElmer shall, at its sole cost and expense, plug bore holes and monitoring points in accordance with all applicable laws and regulations. All equipment and monitoring points shall be removed prior to expiration of this Agreement.

8. Indemnification. PerkinElmer shall indemnify and hold the Owner harmless from and against any injury, damage, claim, lien, cost and/or expense (including attorney's fees) incurred by, or claimed against, the Owner by reason of the acts or omissions of PerkinElmer or its contractors or subcontractors, including any negligent acts or omissions, in carrying out the activities authorized by this Agreement.

9. Effect of Agreement. Nothing in this Agreement shall constitute an admission of fact, responsibility, fault or liability of any kind, or constitute a waiver or limitation of any legal claim or defense available to either party.

10. Notices. All notices required or made under this Agreement shall be in writing, except where noted, and shall be made as follows:

To Owner: [redacted]

To PerkinElmer:

Mr. Arthur Wallace
Director, Environmental Safety & Health
PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451
781-663-5779

Either party may change the above designations by written notice to the other party. Notifications to request physical access to the Subject Property under this Agreement will be made in writing, via electronic mail with confirmation, or via telephone call a minimum of ten (10) days in advance. Notifications shall be made by either PerkinElmer or PerkinElmer's authorized representatives by notifying the Owner or other Owner authorized representatives. Written notice may be accomplished through a written schedule for Work to be agreed upon by Burns & McDonnell and Owner.

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12. Enforceability by third parties. This Agreement is expressly not intended for the benefit of any third party and is expressly not enforceable by any third party.

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14. Severability. If any provision of this Agreement is determined by a court of competent jurisdiction to be invalid or otherwise unenforceable, all remaining provisions of the Agreement shall remain in full force and effect.

15. Term of agreement. The term of this Agreement shall be for three years, unless extended by a written amendment signed by both parties. The parties anticipate that they will extend the Agreement if PerkinElmer or MDNR determines that further sampling will be required at the subject property beyond the date of this agreement.

IN WITNESS WHEREOF, the parties hereby execute this Agreement.

[redacted]

PerkinElmer, Inc.

By Arthur Wallace

Name Arthur Wallace

Title EHS Director

APPLICATION FOR SPECIAL USE PERMIT

TO THE DIRECTOR OF HIGHWAYS AND TRAFFIC, ST. LOUIS COUNTY, MISSOURI
41 South Central Avenue, 6th Floor, Clayton, Missouri 63105
Phone: (314) 615-8515 Fax: (314) 615-7084

1) Name of Applicant: ______________________________

2) Address of Applicant: ______________________________

City: ____________ State: ______ Zip: ________ Phone No.: ( ) _____ - ________ Ext: ______

Emergency Contact: ______________________ Emergency No.: ( ) _____ - ________

Contractor (if applicable): ______________________________

3) Type of Development (check boxes): ☐ New ☐ Existing ☐ Residential ☐ Commercial ☐ Industrial

4) Description of Work:

5) Location of Work: ______________________________

6) Master Drainlayers Name: ________________ License Number: ***D-***__________ ***P-***__________

7) Proposed Starting Date: ______________ 8) Days Required to Complete: ______________

9) SL #__________ WL #__________ 10) Plumbing Permit Number: ______________

11) PAC Number: ______________ 12) MLD Number: ______________

13) Applicant hereby agrees to restore and replace such street, avenue, boulevard, road, alley, public easement or highway disturbed or affected, and to conduct all work in accordance with the conditions of this permit. Permit Inspection Section shall be notified **24 hours prior** to commencement of work at (314) 615-1102.

14) Applicant hereby acknowledges its responsibility to incur all costs which may result from damages to applicant's facilities at the location described herein, which may be caused by maintenance, construction, reconstruction, signing and any other work performed by the St. Louis County Department of Highways and Traffic employees upon the County right-of-way over, under or across the location described herein.

15) Applicant agrees to perform all work in accordance with this permit and to indemnify and hold harmless St. Louis County, its officers, agents and employees from all liability, judgments, costs, expenses and claims growing out of damage, or alleged damages of any nature to any person or property arising out of performance or non-performance of said work or the existence of facilities and/or appurtenances thereof.

16) By typing or signing my name, I acknowledge that I have read and understand the above conditions and attached general provisions.

Company Name	**Applicant's Signature**	**Date**

- THE FOLLOWING IS FOR OFFICE USE ONLY -

☐ Arterial Road System ☐ County Road System

Fees Collected: __________ Number of Units:______ Grading: _______ Date: __________ By: ________

Special Use Permit Number: ______________ Map Location: ______________

Special Use Permit General Provisions

SECTION 1 The Department as referred to herein is the St. Louis County Department of Highways and Traffic.

SECTION 2 The Director as referred to herein is the Director of the Department of Highways and Traffic or his authorized representative.

SECTION 3 The Applicant shall be the owner of the individual or legal entity having the legal right to the control of the facilities being constructed and repaired herein: provided, however, in the case of reshaping back slopes, the Applicant shall be the owner or the individual of legal entity having the legal right to the possession and control of the property adjacent to the Right-of-Way.

SECTION 4 If the Special Use Permit Application is countersigned by Applicant's contractor, or the authorized representative of the Applicant's contractor. The contractor shall be held jointly responsible with all the requirements of this permit until the Director releases it.

SECTION 5 At all times while any work is under construction with in the County's Right-of-Way, Applicant shall display applicable warning signs, barricades, lights, and flares as described in the Manual of Uniform Traffic Control Devices ASA D6, 1-2000, which has been adopted by the Department, and shall provide flagman and/or other warning devices satisfactory to the Director.

SECTION 6 All work shall be performed without unreasonable delay and in a workmanlike manner.

SECTION 7 Applicant agrees to perform all work in accordance with this permit and to indemnify and hold harmless St. Louis County, it's officers, agents and employees from all liability, judgments, costs, expenses and claims growing out of damages, or alleged damages of any nature to any persons so property arising out of performance or non-performance of said work of the existence of facilities and/or appurtenances thereof.

SECTION 8 All utility facilities shall be installed and located and all other work performed in accordance with the policies of the St. Louis County Department of Highways and Traffic. All work shall be as directed by the Director or his authorized representatives.

SECTION 9 The vertical clearance of overhead installation shall be no less than fifteen (15) feet - six (6) inches from the road surface.

SECTION 10 All underground water lines installation shall have a minimum cover of 42 inches. All other underground installation shall have a minimum cover of 30 inches, except parallel direct burial underground telephone cable, which may have a minimum of 24 inches of cover. The Director may request greater minimums.

SECTION 11 The Director, when deemed necessary may specify encasement requirements.

SECTION 12 Cable, wire, small diameter pipe and other such appurtenances extending from the surface of the ground shall be equipment with covers or guards to improve their visibility, as permitted by this Department.

SECTION 13 Roadway ditches, culvert and other such devices used to carry surface run-off shall be kept open, free and clean of debris, growth or other materials at all times.

SECTION 14 All crossing of classified county roads shall be bored of pushed. Any voids occurring as a result of boring or pushing castings or other facilities under roadways or approached shall be filled to the satisfaction of the Director by a method and with material approved by the Director.

SECTION 15 Open cuts in pavements or stabilized shoulders shall be made only of specifically authorized by the Director.

SECTION 16 Granular backfill to comply with the Standard Aggregate Specifications for Highway and Structures of St. Louis County and graded to comply with size No. 4 of said specifications shall be used under pavement, stabilized shoulders and compacted by mechanical tamping methods on the lifts no greater than six inches, when pavement cuts are allowed.

SECTION 17 Pavement replacement shall comply with the St. Louis County Department of Highways and Traffic's Construction Specifications and Standards for Temporary Openings in Roadway Pavement and Details for concrete patches. Other improved surfaces shall be a material equal to or better than the type removed.

SECTION 18 Frame and cover for manholes shall conform to the transverse and longitudinal pavement, slope and the top shall be on the exact finish grade.

SECTION 19 Applicant shall protect roadway plant material, including trees and shrubs. Such materials and turf that are disturbed shall be restored as directed by the Director. Trees and scrubs shall not be trimmed, cut, moved or sprayed without specific permission from the Director.

SECTION 20 All sidewalks, steps, driveway approaches, drainage facilities, erosion protection and/or roadway appurtenances in general which are removed of damaged as a result of the herein shall be repaired to the satisfaction of the Director. Applicants shall be responsible for such repairs.

SECTION 21 In case of damage to other facilities located on County Right-of-Way that are placed with the permission of the Director. Applicant shall repair or replace such property to the satisfaction of the owner. In all cases, Applicant shall notify the owner of such damage immediately

SECTION 22 Construction materials and equipment shall not be stored on the roadway pavement, shoulders, of any portions of the Right-of-Way. If the Applicant is performing work on or has a right to the property adjacent to the County's Right-of-Way, all materials and equipment shall be stored on that property.

SECTION 23 Utility poles shall be allowed in medians of canalization islands.

SECTION 24 The total cost of all construction, maintenance and removal of facilities and their appurtenances installed or placed under this permit shall be borne by the Applicant, his grantees, successors, heirs, and assigns.

SECTION 25 The issuance of this permit by the Department does not relieve the Applicant of the responsibility obtaining other permits required by this or any other agency having jurisdiction.

SECTION 26 No public way shall obstructed or closed so as to inconvenience traffic, whether vehicular of pedestrian, contrary to these provisions, without specific permission of the Director.

SECTION 27 Surety bonds are required for oversize and/or over weight applicants and other major operations. The Director shall establish Bond amounts and other requirements.

SECTION 28 Except as otherwise provided by state law, Applicant and any Contractors shall maintain in effect from the beginning of construction continuously throughout the term of the Special Use Permit general liability insurance, with limits of not less that Two Million ($2,000,000) per occurrence, covering bodily injury and property damage. Such insurance obligation may be satisfied from either a primary or an excess liability policy. Such insurance shall provide liability coverage for both the Applicant and County as additional insured and shall be so endorsed as to create the same liability coverage on the part of the insurer as though separate policies had written for the Applicant and County. Applicant shall provide the County with an updated Certificates of Insurance on an annual basis. The Certificate shall indicate the County as additional insured. Applicants shall increase the limits of liability of required by state statutory limits of liability for public entities. If any part of the work is sublet, similar insurance shall be provided by or in behalf of the Subcontractor to cover their operations.

APPENDIX B

Standard Field Forms

DAILY QUALITY CONTROL REPORT

Site: ____________________
Project No: ____________________
Date: ____________________
Crew No: ____________________
Crew Mem: ____________________

Weather (circle)

	Bright Sun	Clear	Overcast	Rain	T-storm	Snow
Temp:	to 32	32-50	50-70	70-85	85+	
Wind:	Still	Gusty	Moder.	High	Direction	South
Humidity:	Dry	Moder.	Humid			

Subcontractors and Equipment on Site: ____________________

Health and Safety Levels: (circle)

D	Mod. D.	C	B	A

Summary of Health and Safety Activities: ____________________

Instrument Used: (circle)	PID	Fe	pH	Cond.	Temp.	Turbidity	DO	ORP
Calibrated: (check)								

For actual calibration results, see field calibration forms.

Summary of Work Performed: ____________________

All Samples Were Collected According to Procedures Outlined in the Work Plan?
Yes ________ No ________

Problems Encountered/Corrective Action Taken: ____________________

Time Project Manager Contacted: ____________________

Tomorrow's Expectations: ____________________

Name: ____________________ Signature: ____________________

Field Calibration Record

Equipment Item:		Mfr. Serial #: B&M Equip. #:			Site: Project No:	
Date Calibrated	Time	Known Standard	Instrument Reading	Adjustments Made	Calibrated By	Comments

Comments:

Burns & McDonnell SINCE 1898

090705 Form WCD-KC1

Request for Chemical Analysis and Chain of Custody Record

Burns & McDonnell Engineering
9400 Ward Parkway
Kansas City, Missouri 64114
Phone: (816) 333-9400 Fax: (816) 822-3494

Attention:

Laboratory:

Address:

City/State/Zip:

Telephone:

Document Control No:

Lab. Reference No. or Episode No.:

Project Number:

Client Name:

Sample Number			Sample Event		Sample Depth (in feet)		Sample Collected		Sample Type: Matrix			Number of Containers	Analysis						Remarks
Group or SWMU Name	Sample Point	Sample Designator	Round	Year	From	To	Date	Time	Liquid	Solid	Gas								

Sampler *(signature)*:

Sampler *(signature)*:

Special Instructions:

Relinquished By *(signature)*:
1.

Date/Time

Relinquished By *(signature)*:

Date/Time

Ice Present in Container:
Yes ☐ No ☐

Temperature Upon Receipt:

Relinquished By *(signature)*:
2.

Date/Time

Relinquished By *(signature)*:

Date/Time

Laboratory Comments:

Route to		Analysis

Sample Number:
Medium Sampled:
Date Sampled:
Time Sampled:
Preservative:
Sample Personnel:
Sample Personnel:

Typical Sample Label

Company:	Sample Personnel
	Signature
	Signature
	Date

Typical Custody Seal

WELL DEVELOPMENT/PURGING AND SAMPLING RECORD

Site Name:			**Well Number:**
Client:		**Project no.**	**Date:**

Well Depth (ft.):		Casing Volume (gal.):		**Casing Volume Multipliers**
Initial DTW (ft.)		Volume to be removed (gal:)		1" I.D. casing = 0.04 gal/ft
Height of Water Column (ft.):		Method of Development/Purging:		2" I.D. casing = 0.16 gal/ft
Well Diameter (in.)		Placement of Pump (ft.):		4" I.D. casing = 0.65 gal/ft

Field Parameters

Time	Depth to Water	Depth to NAPL	Flow Rate	Total Volume	pH	Temp	Conductivity	Turbidity	ORP	D.O.	
UNITS	*(ft)*	*(ft)*	*(gpm)*	*(gal)*		*c*	*(mS/cm)*	*(NTU)*	*(mv)*	*(%)*	*(mg/L)*

QA/QC Samples Collected: MS/MSD - *Sample ID/Time:* Duplicate - *Sample ID/Time*:

Color: Clear Sheen Other: **Turbidity:** None Low Medium High

Odor: Yes No *Description*:

Filtration: 0.45u filter Prefiltration Jug Laboratory filtration

Disposal Method: Ground POTW Drum Other:

Notes:

Sample Date/Time:

Signed/Sampler:

CREATED: 6/6/00

FIELD DATA AIR SAMPLING FORM

Site Name:______________________ Sampler:____________

Sample Identification:________/_______ Date Sampled:_________

Sample Location(s):____

____

Canister Serial #:________/________ Flow Regulator Serial #:________/________

Environmental Conditions

Outdoor Temperature:_____ Barometric Pressure:_____ Relative Humidity:_____

Wind Speed/Direction:________ Comments:______________________________

Preliminary Screening

Instrumentation:________ Calibration Date:_______ Time:_____ am/pm

Field Reading(s):_____(ppm)/_____(ppm)/_____(ppm)/_____(ppm)

Location(s):____

____

Mechanical Leak Test

	Time	Pressure
Start:	______ am/pm	______ "Hg
Stop:	______ am/pm	______ "Hg

Chemical Leak Test

Leak Test Compound:__________

Field Reading(s):_____(ppm)/_____(ppm)/

_____(ppm)/_____(ppm)

Instrumentation Calibration Date & Time:__________

Air Sampling

	Time	Pressure	Controller Flow
Start:	______ am/pm	______ "Hg	______
Stop:	______ am/pm	______ "Hg	______
Start:	______ am/pm	______ "Hg	______
Stop:	______ am/pm	______ "Hg	______

BUILDING QUESTIONNAIRE

Building Type: Residential/Commercial/Multi-Use

Owner/Tenant:____

Address:____

Describe Building Uses:______________________________________
____

Smoker(s): Y/N   Product (Cigars, Pipe, Cigarettes):_______   Number Smoked/Day:___

Basement/Crawl Space: Y/N Ventilated: Y/N Living Quarters: Y/N
Basement Acitivities:____

Private Well: Y/N Sump: Y/N Cistern: Y/N In Use/Plugged: Y/N

Recent Remodeling: Y/N Activities (painting, new carpet, new cabinets): Y/N ____________

VOC sources (hobbies, paints, solvents, gasoline, etc):____
____

Cleaning Products and Storage:____

Attached Garage: Y/N   Garage Storage (cars, lawn mower, etc):_____________________

Furnace Type (Oil, Natural Gas, Propane):_______   Furnace Intake: Inside/Outside

Addidtional Heating Sources (space heater, etc):__________   Fuel Type:_______

Comments:____
____
____
____
____

BUILDING QUESTIONNAIRE (cont.)

CHEMICAL INVENTORY

CHEMICAL NAME	DESCRIPTION	MSDS OBTAINED
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N
		Y/N

APPENDIX C

Sampling Instructions for Canisters with Pneumatic Flow Controllers

Sampling Instructions for Canisters With Pneumatic Flow Controllers

1. Inspect your canister shipment upon arrival. Compare the contents with the packing slip and notify the lab of any discrepancy or damage

2. Familiarize yourself with this diagram and the equipment that you received. The flow controller will be set for the appropriate sampling rate in the laboratory and should not require adjustment.

3. Remove the brass caps from the flow controller and canister. Connect the flow controller to the canister by inserting the "canister connection" into the "canister inlet" and hand tighten the swagelock nut being careful not to cross the threads. Using two open end wrenches (1/2" & 9/16") tighten the nut no more than 1/8 turn past finger tight. DO NOT use adjustable wrenches or pliers.

4. The fittings are swagelock compression fittings. Do not use teflon tape or other sealants, they are not necessary. DO NOT over-tighten any connection. Over-tightening causes leaks, not fixes them.

5. The canister and controller are now ready for ambient air sampling. If you intend to sample a remote location or source, you will need to attach a sampling line. This should be 1/4" O.D. tubing of virgin Teflon or cleaned stainless steel.

6. If arranged with your canister order, the lab will provide a swagelock nut and set of nylon ferrules for connecting line. Slide the nut, the back ferrule, then the front ferrule onto the tubing. Insert the tubing into the sample inlet and slide the ferrules into the fitting. Secure the nut being careful not to cross the threads. When using nylon ferrules, a snug finger tight should be sufficient for a leak free connection.

7. To begin sampling, simply open the canister valve by turning clock-wise. One full turn is sufficient. Note the vacuum gauge reading. The vacuum gauge reading should be near the barometric pressure.

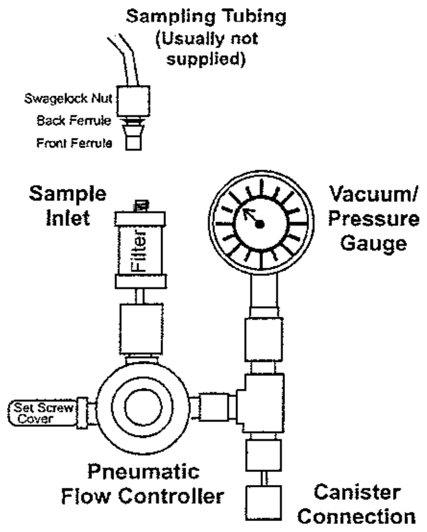
8. You can watch the decline in the vacuum to gauge the sampling rate. A one hour sample should drop in vacuum at a rate of 0.5" Hg per minute (i.e. 30"/60 min). Remember this is a rough estimate. The sampling rate is normally set in the laboratory. Occasionally the controller will lose calibration in shipment. If necessary contact the lab for assistance.

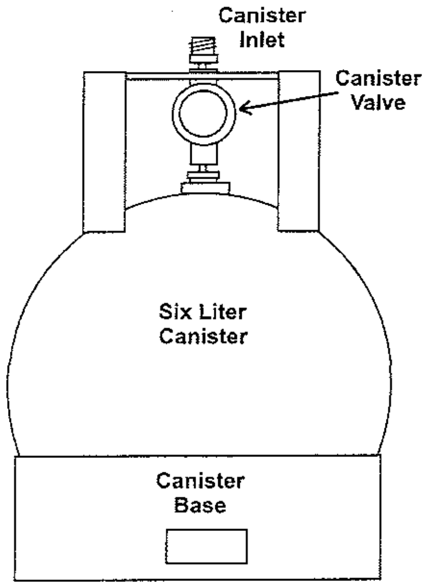
9. After sampling is complete, close the canister valve by turning clockwise until finger tight. DO NOT over-tighten as this WILL damage a very expensive valve.

10. Disassemble the components in reverse order of the above assembly instructions. Return all components to the original shipping containers and package them as received

11. Verify that all parts are packed for return by referencing the packing slip. The project will be charged for all missing or damaged components.

12. Complete a Chain-of-Custody Record and return the sample to the laboratory for analyses.





Teflon will sometimes have very low level freon contamination

APPENDIX D

MDNR Illustration of the In-Home Sampling Locations

(provided in a letter from MDNR dated November 8, 2011)

STATE OF MISSOURI

Jeremiah W. (Jay) Nixon, Governor • Sara Parker Pauley, Director

DEPARTMENT OF NATURAL RESOURCES

www.dnr.mo.gov

November 8, 2011

Mr. Thomas Zychinski, RG
Burns & McDonnell
425 S. Woods Mill Road, Suite 300
Chesterfield, MO 63017-3441

Re: PerkinElmer Site, Overland, Missouri
Sub-Slab Soil Gas, Indoor Air, and Sump Water Sampling

Dear Mr. Zychinski:

Based on discussions with the U.S. Environmental Protection Agency (EPA) Region VII Vapor Intrusion technical staff, and staff with the Missouri Department of Health and Senior Services and the Missouri Department of Natural Resources, we want to move forward to have sub-slab soil gas and indoor air and sump water sampled from those homes or dwellings located north of the line shown on the attached map, referred to as the Chicago Heights Boulevard Neighborhood. Shallow groundwater sampling conducted by Burns & McDonnell in August and September 2011 was considered in this decision to proceed with sub-slab soil gas and indoor air and sump water sampling in lieu of the installation of soil gas wells. This does not preclude sampling of soil gas, using soil gas wells installed in the future to assess the potential for vapor intrusion as originally proposed in the work plan and schedule.

A sufficient number of sub-slab soil gas and indoor air and sump water sampling events must be completed to evaluate fluctuations in soil gas concentrations, due to different weather conditions (e.g., seasonal effects), changes in building conditions (e.g., various operating conditions of a building's HVAC system) and worst case conditions (e.g., where perched groundwater layers which are separated from more deeply located water by an impermeable layer are effected by seasonal conditions). Within a home or dwelling, at a minimum, sub-slab vapor samples must be collected in at least two locations from each representative area in a home or dwelling. The locations must consider preferential pathways coming into the home or dwelling from the outside (e.g., gas, water, sewer, refrigerant, and electrical lines). Sub-slab soil gas and indoor air sampling must be conducted using accepted EPA guidelines and policies and standard operating procedures. Sump water and ambient air immediately above the sump water must also be sampled during each sampling event in those homes or dwellings with sumps using accepted EPA guidelines and policies and standard operating procedures.

If sump water is not available at the time of sampling in sufficient quantity to collect a representative water sample, ambient air must still be sampled immediately above the sump.

The agencies expect to have a completed work plan for conducting the sub-slab soil gas, indoor air and sump water sampling within two weeks from the date of this letter or sooner. The Department is currently reviewing the revised Workplan submitted by Burns & McDonnell for completeness and may have additional comments on this Workplan. The two week period can be used to address any remaining comments that the Department may have regarding the Workplan. In the meantime, we recommend working toward obtaining access agreements with those homes or dwelling owners not included under the current access agreement. After this two week period or sooner, PerkinElmer would be expected to provide a firm schedule for installing the sub-slab soil gas sampling probes and propose date(s) for conducting the first sampling event.

In summary, the immediate concern is the potential threat of vapor intrusion to off-site residents in the northern part of the Chicago Heights Boulevard Neighborhood. To address this concern, sub-slab soil gas, indoor air and sump water sampling must be implemented as soon as possible. If you have any questions or would like to discuss this matter, please contact me at (573) 526-7309, or by email, wane.roberts@dnr.mo.gov, to arrange a meeting or conference call.

Sincerely,

HAZARDOUS WASTE PROGRAM

Wane Roberts

Wane Roberts
Project Manager

cc: Arthur Wallace, PerkinElmer
Dennis Stinson, MDNR
Michelle Hartman, MDHSS
Robert Hinkson, MDNR
Christine Kump-Mitchell, MDNR

Attachment

[redacted]

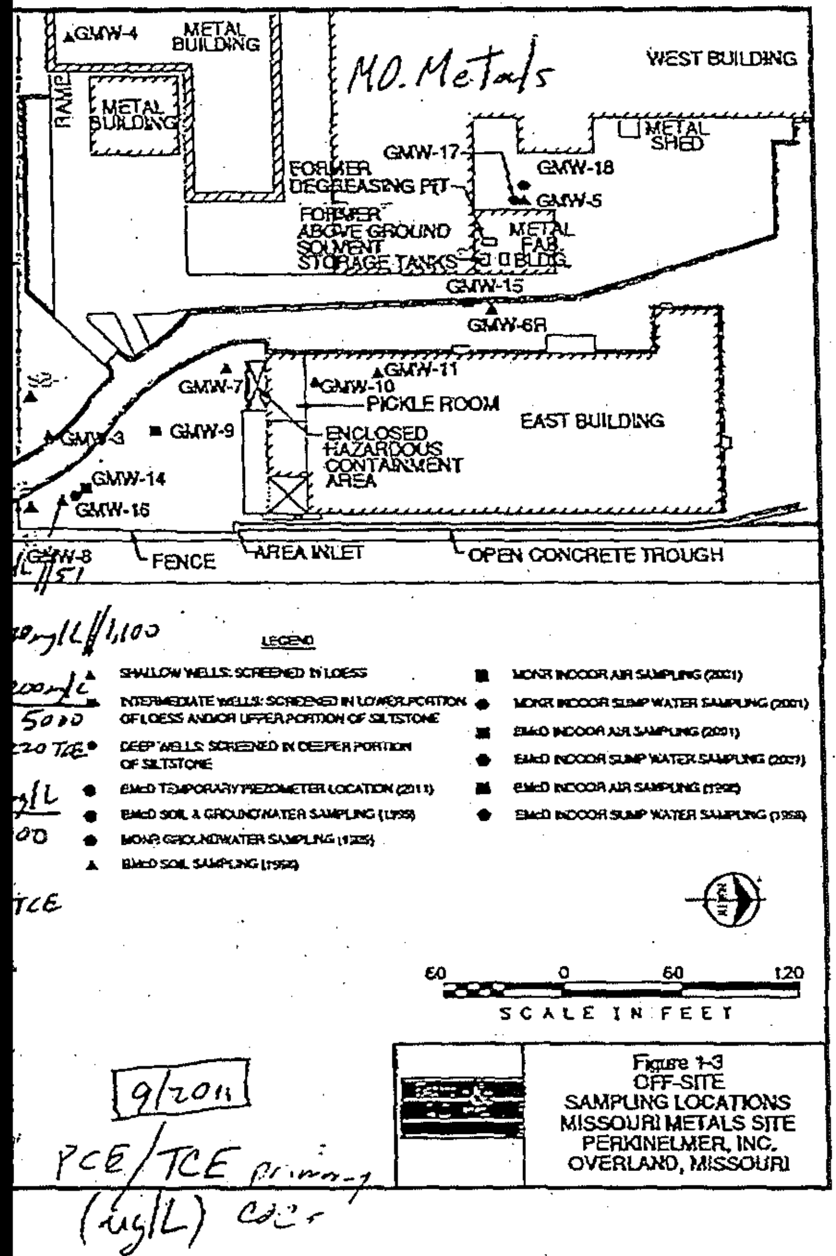


Figure 1-3
OFF-SITE
SAMPLING LOCATIONS
MISSOURI METALS SITE
PERKINELMER, INC.
OVERLAND, MISSOURI

APPENDIX E

MDNR MRBCA for Petroleum Storage Tanks - Soil Gas Sampling Protocol

Missouri Department of Natural Resources

MISSOURI RISK-BASED CORRECTIVE ACTION (MRBCA) FOR PETROLEUM STORAGE TANKS

SOIL GAS SAMPLING PROTOCOL

April 21, 2005

TABLE OF CONTENTS

MISSOURI RISK-BASED CORRECTIVE ACTION (MRBCA)
PROCESS FOR PETROLEUM STORAGE TANK SITES

Soil Gas Sampling Protocol

April 21, 2005

C.1 Introduction and Scope

The *Missouri Risk-Based Corrective Action (MRBCA) Process for Petroleum Storage Tanks* (January 2004) guidance document ("Guidance") requires evaluation of the indoor air inhalation pathway at sites having petroleum contamination in soil, groundwater, or both. For sites where the indoor air inhalation pathway is complete currently or in the future and soil or groundwater representative concentrations exceed Tier 2 Site-Specific Target Levels ("SSTLs") for the indoor air inhalation pathway, the guidance allows the pathway to be further evaluated through soil gas sampling. Such sampling must be conducted under a work plan approved by the Missouri Department of Natural Resources (MDNR).

The purpose of this document is to provide guidance for conducting soil gas sampling at petroleum storage tank sites. The routine evaluation of the indoor inhalation pathway at contaminated sites is a relatively recent development. As a result, methods, procedures, and technology related to evaluating the pathway continue to evolve. While this guidance is, in part, prescriptive, MDNR does not intend for this guidance to be overly limiting with respect to the use of other appropriate methods, procedures, and equipment for measuring concentrations of chemicals of concern in soil gas. Even so, departures from this guidance must be presented in a work plan submitted to MDNR and utilized only with MDNR approval.

A work plan is required for all soil gas sampling at MRBCA sites. The work plan must be submitted to and approved by MDNR prior to the occurrence of the soil gas sampling event.

This protocol does not specifically pertain to sub-slab vapor sampling (a means of collecting soil gas samples from beneath a building via the installation of monitoring points through the foundation of the building). If site conditions warrant collection of sub-slab vapor samples, MDNR recommends that procedures under development by the United States Environmental Protection Agency ("USEPA") be used. USEPA's current sub-slab sampling guidance is included as Attachment 1. Sub-slab sampling, whether in accordance with USEPA or other guidance or procedures, must be conducted under a MDNR-approved work plan.

In 2005, EPA will publish more detailed and comprehensive sub-slab vapor sampling guidance. When such guidance becomes available, it shall be used in lieu of, or in addition to, the SOP attached to this guidance.

This protocol is not intended to prohibit those conducting evaluations under the MRBCA process from using means other than those specified herein to measure soil gas concentrations at a petroleum storage tank site. However, departures from this guidance must be specifically detailed in a written work plan submitted to MDNR and may be implemented at a regulated petroleum storage tank site only with the written approval of MDNR. For consistency, MDNR prefers that soil gas sampling be conducted in accordance with this protocol unless extenuating circumstances make application of this protocol impractical.

This protocol is designed to facilitate a quantitative evaluation of soil gas. Passive soil gas monitoring is generally a qualitative activity used to guide the installation of permanent sampling points. As such, passive soil gas monitoring may not be used to quantitatively monitor soil gas or assess risks associated with vapor intrusion. Passive soil gas monitoring may be used preliminarily to assist in planning a quantitative soil gas sampling event.

C.2. Soil Gas Probe Installation

C.2.1 Installation Requirements.

A. The Missouri Well Construction Rules at 10 CSR 23-1.010 through 10 CSR 23-6.060 govern the installation and abandonment of monitoring wells, the definition of which includes wells used for soil gas monitoring. Refer to these rules prior to installing soil gas sampling points in the field.

B. Installation of monitoring wells greater than 10 feet in depth and having a riser less than 2 inches in diameter or installed in a borehole less than 6 inches in diameter require a variance issued by MDNR's Geological Survey and Resources Assessment Division (GSRAD).

C.2.2 Sampling Depth.

A. To the extent possible, soil gas sample depths should be chosen to minimize the effects of changes in barometric pressure, temperature, or breakthrough of ambient air from the surface, and to ensure that consistent and representative samples are collected. In determining appropriate sampling depths, strong consideration should be given to the lithology of the subsurface. Under no circumstances may soil gas samples be collected from a depth of less than 18 inches.

B. Soil gas sampling depths must be consistent from sampling point to sampling point.

C. Generally, soil gas samples must be collected at a minimum of two discrete depths at each sampling point. Where contamination in soil is very shallow or groundwater is very shallow (i.e., less than approximately 5 feet below the ground surface), one sample from a single depth might be sufficient.

D. One of the two soil gas samples collected at each sampling point must be collected at a depth no greater than 3 feet below the foundation of the enclosed space or potential future enclosed space. The depth at which the second sample is collected will be dependent on site conditions, primarily the depth to contamination.

E. For structures having basements, one or more soil gas samples must be collected adjacent to basement walls (i.e., no further than 5 feet from the wall and, generally, at a depth approximately equal to the midpoint of the wall; this depth might need to vary depending on the characteristics of the structure). Unless soil or groundwater contamination is found below the building, soil gas sampling adjacent to the basement walls need only occur on the side or sides of the building where the contamination is found (e.g., if the soil or groundwater contamination is south of the building, soil gas sampling must, at a minimum, occur on the south side of the building). If soil or groundwater contamination is found below the elevation of the basement floor, soil gas samples must also be collected just below the elevation of the floor.

F. For structures without basements, soil gas samples should be collected below the depth of the foundation, with the first sample collected at a depth of no more than 3 feet.

G. For hypothetical future buildings, if there is no other information available to select depth, soil gas samples should be taken at target depths of approximately 3 feet and 10 feet below ground surface. This method assures that data is available to assess vapor intrusion threats to both "slab-on-grade" buildings and those having basements. If groundwater is too shallow to allow sampling at one or both of these depths, samples should be collected immediately above the capillary fringe or the top of soil contamination. If soil contamination extends to the surface, sample at a depth approximately equal to the anticipated depth of the future structure's foundation.

H. In all cases, if groundwater is too shallow to allow soil gas sampling at the depths specified above, samples shall be collected immediately above the capillary fringe. If soil contamination extends to the surface, sample at a depth just below the expected or actual foundation or floor of the structure.

C.2.3 Lateral Spacing of Soil Gas Sampling Points

A. Soil gas sampling is intended to assess vapor intrusion threats from soil and groundwater to existing or hypothetical future buildings. Therefore, sampling points should be laterally spaced to adequately represent soil gas concentrations proximate to such structures, taking into consideration the location of contamination relative to the structures. The actual number of soil gas sampling points necessary for a given site will depend on the size and number of buildings, the location of the buildings relative to soil and groundwater contamination, and, for the evaluation of hypothetical future structures, the extent or size of the contamination plume. The following provisions should be considered as general guidelines rather than specific requirements. The locations and spacing of soil gas sampling points will ultimately be dependent on site-specific characteristics.

B. Generally, soil gas sampling points should be located along each side of each existing building that is proximate to soil or groundwater contamination. In addition, for existing buildings, samples should be collected above the area of highest contamination. However, if contamination is located to one side of an existing structure, the collection of samples only from that side of the structure might be adequate. If any wall of the structure exceeds 50 feet in length, a minimum of two sampling points is required along that wall.

C. To assess vapor intrusion threats to future structures, sampling points must be installed in the area having the highest contaminant concentrations on the site. Generally, four sampling points should be utilized to evaluate future structures. However, if the size of the plume exceeds 2,500 square feet, more than four sampling points will be required, with the total number dependent on the overall size of the plume. In general, sampling points should be spaced no greater than 50 feet apart and preferentially placed within the anticipated footprint of the future structure, if known.

C.2.4 Probe Construction Materials.

A. Sample probes consist of a probe tip through which the soil gas sample is collected, and probe tubing that extends from the probe tip to the ground surface.

B. Sample probe tubing should be of a small diameter (1/8 to 1/4 inch). Diameter selection should consider site soil types. In general, smaller tubing diameters can result in higher sample vacuum conditions, which can make sample collection more difficult.

C. The sample probe should be constructed of materials that will not react or interact with target compounds. Suggested materials are nylon, polyethylene, copper, poly vinyl chloride (PVC), or stainless steel. If copper is used, the copper must first be adequately cleaned to remove oil residue that might be present from the manufacturing process. Generally, nylon tubing should be used

D. The probe tip should be covered with fine screen or connected to a short (< 2 feet) section of perforated pipe, glass frit, tubing, or screen mesh.

C.2.5 Probe Installation.

A. MDNR recommends that permanent probes, wells, or other soil gas sampling devices be installed to allow for the assessment of seasonal variability (MDNR requires that a minimum of two soil gas sampling events occur at any site at which soil gas sampling is conducted, as discussed at C.3 below). However, temporary sampling points, such as through the probe rods of a direct push drill machine, may be used with the permission of MDNR.

B. Boreholes may be installed using direct push or hollow-stem auger drilling equipment or hand-driven using a rotary hammer or a hand auger. Note, however, that direct push probes might not be suitable for all soil conditions, as smearing of the sidewalls can occur in fine-grained soils. Such smearing could preclude passage of gases from the soil into the borehole.

C. Before any drilling activities, utility clearance for the installation area should be obtained. In addition, utilities proximate to the contamination must be identified and assessed as possible soil gas conduits. Utilities near or above contamination must be screened using a PID or FID (as appropriate) and the results recorded.

D. The borehole is advanced to the target sampling depth. If samples will be collected at multiple depths within the same borehole, the borehole is initially advanced to the deepest sampling point and the deepest sampling point installed first.

E. The probe tip is placed midway between the top and bottom of the sampling interval within a sand pack extending 6 inches above and below the sampling interval. The grain size of the sand pack should be appropriately sized (for example, no smaller than the adjacent formation) and installed to minimize disruption of airflow to the sampling tip.

F. At least 1 foot of dry granular bentonite should be placed on top of the sand pack to preclude the infiltration of hydrated bentonite grout into the sand pack. Refer to Figure 1 for an illustration of this sealing method.

G. The borehole should be grouted to the surface (or, for nested samplers, the bottom of the next sampling interval) with hydrated bentonite. Adequately sealing soil gas sampling probes is very important to minimize the exchange of atmospheric air with the soil gas and to maximize the representativeness of the sample. The surface seal should be a minimum of 2.5 feet thick. If conditions warrant shallow sampling depths, great care should be taken in installing the surface seal to limit atmospheric infiltration.

H. If multiple sampling points are installed within a single borehole, the borehole must be grouted between sampling points. One foot of dry granular bentonite must be placed between the filter pack and the grout at each sampling location within the borehole, as illustrated by Figure 1.

I. Tubing must be properly marked at the surface to identify the probe location and depth. Particularly when multiple probes are installed within a single borehole, tubing must be labeled immediately upon installing each separate probe.

J. To minimize any separation between the soils and the outside of the probe, avoid lateral movement of probes once they have been installed.

K. Examples of a single depth soil gas probe and a multi-depth or "nested" soil gas probe are shown in Figure 1. Figure 1 is only an example: soil gas sampling points need not necessarily be constructed in strict accordance with the figure.

L. Documentation of subsurface soil stratigraphy via borehole logging and other methods can be very important in evaluating soil gas data. While delineation of contamination should be largely complete at any site undergoing soil gas sampling, MDNR recommends that soils be logged, field screened, and sampled for COC analysis during probe installation for the purpose of providing further information regarding the distribution of contamination. Soil stratigraphy data can be very important in determining soil gas fate and transport.

C.2.6 Surface Completion.

A. Unless soil gas probes are properly abandoned the same day they are installed, probes must be properly secured, capped, and completed to prevent infiltration of water or ambient air into the subsurface and to prevent accidental damage or vandalism. For surface completions, the following components may be installed, as necessary:

i. Gas-tight valve or fitting for capping the vapor point;

ii. Fitting for connection to above ground sampling equipment;

iii. Protective flush mounted or above ground well vaults, and/or

iv. Guard posts.

C.2.7 Probe Abandonment

A. All monitoring wells, including those used for soil gas monitoring, must be abandoned in accordance with Missouri Well Construction Rule 10 CSR 23-4.080, "Plugging of Monitoring Wells." This rule states, in part, that monitoring wells less than 10 feet in depth must be plugged with grout or by returning uncontaminated native material into the hole it was taken from.

B. 10 CSR 23-4.080 also states, in part, that temporary monitoring wells (i.e., closed within 30 days) greater than 10 feet in depth must be plugged by removing any temporary pipe and filling the well from total depth to 10 feet from the surface with approved grout, with the remainder of the well filled with uncontaminated native material or grout. The plugging of all monitoring wells greater than 10 feet in depth must be reported to MDNR on a registration report form supplied by GSRAD.

C. A monitoring well that is abandoned in accordance with 10 CSR 23-1.010 must be plugged immediately.

C.3 Sampling Frequency

C.3.1 Factors affecting soil-gas values.

A. Certain atmospheric and seasonal factors that are not within the evaluator's control can affect soil gas values. For instance, temperature, barometric pressure, and precipitation can affect soil gas values as these factors fluctuate over time. Because these factors will fluctuate, actions must be taken to ensure soil gas data collected at a site is representative of a variety of atmospheric conditions. MDNR has determined that the best way to account for these factors is to require multiple soil gas sampling events over time.

C.3.2 Sampling frequency.

A. At a minimum, two soil gas sampling events must occur at any given site, with no less than three months between events. In cases where measured soil gas values vary significantly from the first to the second event, MDNR may require that additional sampling be conducted. In most cases, the maximum number of sampling events will be four, with the events spaced evenly over a period of one year. Samples must be collected from the same location and depth during each sampling event.

C.3.3 Duplication of sampling events.

A. Under this guidance, soil gas samples may be collected from either permanent or temporary sampling points. Clearly, sampling may be easily duplicated if permanent sampling points are installed. However, if temporary points are used (i.e., those closed within at most 30 days), actions must be taken to ensure that subsequent samples are collected from the same location and depth as the initial samples. To do so, MDNR requires that the location and depth of temporary sampling points be accurately and durably recorded. Sampling points should be marked in the field to ensure that they can be subsequently found. MDNR recommends that the location of each sampling point be recorded using Global Positioning System (GPS) coordinates. GPS coordinates should be accurate to ± 5 feet. The methods used to record the temporary sampling locations and depths and a copy of the actual written record of such information must be included in the soil gas sampling report submitted to MDNR.

C.4 Soil Gas Probe Equilibration and Purging

C.4.1 Monitoring Point Equilibration.

A. During probe installation, subsurface conditions are unavoidably disturbed. The subsurface soil gas profile should be allowed to equilibrate following this disturbance. The following equilibration times are recommended:

- For probes installed using the direct push method, soil gas sampling should not be conducted for at least 30 minutes following probe installation. MDNR recommends waiting several hours.
- For probes installed with hollow stem auger drilling methods, soil gas sampling should not be conducted for at least 48 hours following probe installation.

B. Prior to sampling, soil gas sampling probes should be purged to ensure that stagnant or ambient air is removed from the sampling system and to assure samples collected are representative of subsurface conditions. The following purge procedure is recommended:

- Calculate the volume of the sampling system by summing the volume of the probe screened interval (including filter pack void space, accounting for porosity of sand pack), the volume of tubing from the probe tip to the ground surface, and the volume of above ground tubing connecting the soil probe to the sample collection device.
- Purge the monitoring point until at least three volumes of the full sampling system have been evacuated. Purging should be conducted at flow rates and vacuum conditions similar to those for sample collection (described below).
- If the soil matrix is such that purging as recommended above is not possible due to low or no flow conditions (i.e., gas will not flow or flow is severely restricted), the probe should be advanced deeper to look for zones of higher permeability. If the deeper probe does not encounter a higher permeability zone and low or no flow conditions persist, the probe should be abandoned and a new probe advanced elsewhere on the site.
- If low or no flow conditions are found across the site and soil gas sampling is therefore not possible, the evaluator may propose an alternative method of soil gas sampling, such as sub-slab sampling. Because sub-slab gas samples are generally extracted from the porous granular material underlying a slab, sub-slab sampling may be a practical method of soil gas sampling when subsurface sampling is not. As discussed at C. 1 above, if site conditions warrant sub-slab sampling, the sampling should be conducted in accordance with current EPA sub-slab sampling guidance.

C.5 Soil Gas Sample Collection Procedures

C.5.1 Sample Containers.

A. Samples may be collected in Tedlar bags or gas-tight syringes if samples are analyzed on-site in a mobile laboratory. Syringes may not be used if samples are analyzed off-site at a fixed laboratory. For samples to be analyzed off-site at a fixed laboratory, Summa canisters or Tedlar bags may be used. MDNR recommends working with the laboratory that will analyze the samples in choosing appropriate sample containers. MDNR prefers that small volume – 1 L or 500 mL – Summa canisters be used. Certain situations might warrant the use of a larger Summa canister but, in general, the small volume canisters should be used.

B. The analytical laboratory or other supplier of sample containers must certify that all sample containers supplied by them are free of contaminants at concentrations exceeding contaminant detection levels.

C.5.2 Sampling Flow Rate.

A. An initial sampling rate of 200 milliliters per minute (mL/min) or less is recommended.

B. A regulated flow meter should be placed between the probe and the sample container to control and measure the flow rate.

C. The sampling rate may be modified based on specific field conditions, including the vacuum observed. Data for samples collected at a flow rate exceeding the recommended rate of 200 mL/min shall be flagged in the report submitted to MDNR. MDNR will not necessarily reject flagged data. Flagging is intended to facilitate a more thorough review of the data.

C.5.3 Vacuum Conditions.

A. To measure sample collection vacuum, a vacuum gauge must be placed between the probe and the sample container. MDNR recommends a sampling vacuum of less than 100 inches of water. Note, however, that, when using a Summa canister, the vacuum gauge reading is dominated by the vacuum in the canister and does not reflect the vacuum at the probe tip. Therefore, with a canister, the vacuum gauge reading becomes meaningless as does the 100 inches of water requirement at C.5.3.C below.

B. To achieve the target sampling vacuum, the sampling flow rate should be adjusted using the flow regulator.

C. If the sampling vacuum exceeds 100 inches of water, and a reduction in the sampling flow rate does not reduce the vacuum, continue to attempt to collect the sample, recording flow rate and vacuum conditions. Data for samples collected under a vacuum of greater than 100 inches of water must be flagged. MDNR will not necessarily reject or consider such data suspect. Flagging will simply facilitate a more thorough review of the data.

D. If the sample container cannot be filled within an expected time frame, such time being dependent on the size and type of the sample container and sampling equipment (e.g., tube diameter), discontinue sampling and document vacuum observations. Generally, data from samples collected under such conditions will not be valid.

C.5.4 Field Conditions.

A. Generally, soil gas sampling should not be conducted within 48 hours of a significant precipitation event (for example, 0.5 inch or greater of rain) or comparable on-site watering. However, whether sampling is conducted is dependent on the depth to which soil is wetted relative to the planned depth of sample collection. The depth to which the soil is wetted is dependent, at least in part, on the ground cover, the type of soil, and the soil moisture content prior to the precipitation event. Sampling should not occur if soils are wetted at a depth equal to or greater than the planned sampling depth.

C.5.5 Sample Collection.

A. Aboveground sampling equipment consists of connector tubing, regulated flow meter, pressure gauge, and purging equipment. An example sampling train is shown in Figure 2.

B. Connect aboveground sampling equipment to probe at the surface. Check all sampling system connections and fittings for tightness and obvious deterioration.

C. Quick connect fittings and nylon tubing should be used to ensure vacuum tightness of the system and that chemicals in the air stream are not reacting with or adsorbing to the tubing. Compression fittings should be avoided for all connections except at the Summa canister (if used).

D. Purge at least three volumes of air from the sampling system as described at C.4.1.B above. After purging is complete, close the valve to the purge line and/or disconnect purge apparatus, as appropriate.

E. Connect the sample container to the sampling line, using quick-connect, airtight fittings.

F. Follow the leak test procedures described in Section C.6, below.

G. Open valve and collect sample into sample container, following the sample flow rate and vacuum guidelines discussed above. During sampling, measure and record sample flow rate and vacuum every two to five minutes.

H. Disconnect sample container and immediately label the container with sample identification information.

I. If Summa canisters are used, measure the final pressure of the canister using a pressure gauge. Record the final canister pressure.

J. Store sample containers out of direct sunlight, and do not chill.

C.5.6 Quality Control Samples.

A. The collection of at least one field duplicate per sampling event or one per twenty samples, whichever is greater, is required.

B. Duplicate samples shall be collected in separate sample containers, using the same procedures and at the same location and depth as the original sample.

C. Preferably, duplicate samples should be collected simultaneous to collection of the primary sample using a sampling tee. Alternatively, the duplicate may be collected immediately after the collection of the primary sample.

D. At least one equipment blank must be collected per sampling event or per 25 samples, whichever is greater.

C.5.7 Recordkeeping.

The following information should be recorded in a field notebook or on sampling forms (Figure 3 shows an example field form) and reported to MDNR as necessary to facilitate MDNR's understanding of the procedures utilized at a specific site to collect soil gas data.

A. MDNR recommends that the evaluator construct a relatively simple conceptual site model related to the indoor inhalation pathway. Such a model can be very useful before, during, and after a soil gas sampling investigation. The conceptual site model should, at a minimum, include information on the location of utility corridors and other potential preferential pathways for soil gas migration, depth to groundwater, distances between sources and receptors (include both current and potential future structures), and soil type and soil stratigraphy.

B. Sample identification information, including the locations and depths at which the samples were collected, sample identifiers, date, and time.

C. Field personnel involved in sample collection.

D. Weather conditions (e.g., temperature, wind speed, barometric pressure, precipitation, etc.).

E. Sampling methods, devices, and equipment used.

F. Purge volumes prior to sample collection. Relate the purge volumes to the volume of the sampling equipment, including the tubing connecting the sampling interval to the surface.

G. Volume of soil gas extracted (i.e., volume of each sample).

H. Vacuum of canisters before and after samples collected.

I. If observable, the apparent moisture content of the sampling zone (e.g., dry, moist, saturated). An alternative to a qualitative measurement of soil moisture is to collect a soil sample from the soil gas sampling interval for laboratory measurement of soil moisture. If a soil sample is collected for this purpose, include a copy of the laboratory data sheet.

J. Shipment information, including chain of custody protocols and records.

C.6 Leak Testing

C.6.1 Requirements.

A. Leakage during soil gas sampling may dilute samples with ambient air and produce results that underestimate actual site concentrations or contaminate the sample with external contaminants. Therefore, MDNR is requiring that a leak test be conducted each time a soil gas sample is collected to determine whether leakage has occurred.

B. For each sample, use a hand pump to vacuum test the sampling equipment after assembly.

C. A leak check, or tracer, compound such as isopropanol is recommended to determine if leaks are present. Other compounds such as pentane, isobutane, propane, and butane, may be used as leak check compounds. MDNR may approve the use of other leak check compounds on a request-specific basis.

D. Select a leak check compound that is not known or suspected to be site-related or otherwise associated with the site or nearby properties.

E. Immediately before sampling, place the leak check compound at each location where ambient air could enter the sampling system or where cross contamination may occur. For liquid compounds (for example, isopropanol), wet a paper towel with the leak check compound and place the towel over each location where ambient air could enter the sampling system. These areas include: the base of the soil probe at ground surface, the connection from the soil gas probe to the sampling line, and any connections within the sampling line. Leak check compounds that are vapors require a device to hold the vapor near the test location (such as a cover at the surface). The type of device to be used must be specified in the soil gas sampling work plan.

F. The leak check compound must be included in the list of analytes looked for during laboratory analysis of each sample.

C.6.2 Detection of leak check compound.

A. If greater than 100 ug/L of the leak check compound is detected in a sample, the following actions must be taken:

- Review the analytical results that show a detection of the leak check compound.
- If a review of the data indicates that the analytical data is accurate, evaluate the cause of the leak through system testing.
- Based on the concentration of the leak check compound detected, evaluate the impacts of the leak on sample collection and sample integrity. Document the findings and the evaluation in the soil gas investigation report submitted to MDNR.
- In certain cases, MDNR will reject data in which a leak check compound has been detected at a concentration in excess of 100 ug/m^3. In such cases, resampling will generally be required.

C.7 Laboratory Analysis

C.7.1 Off-site and On-site Analysis.

A. Samples may be analyzed either off-site in a fixed laboratory or on-site in a mobile laboratory. On-site analyses can provide for a more timely indication of problems with sample system leaks or short-circuiting, thus allowing corrections to be made and resampling to occur while drilling and sampling equipment remains on the site. If samples are analyzed on-site, the probes from which the samples are collected should either be installed as permanent sampling points or clearly and durably marked so that sampling can be duplicated during subsequent gas sampling events. Procedures for on-site sampling and analysis must be clearly documented in the work plan submitted to MDNR and approved by MDNR prior to implementation.

C.7.2 Analyses Required.

A. Contaminants of concern (“COCs”): For petroleum product spills, COCs include benzene, toluene, xylenes, ethylbenzene, MTBE, and naphthalene.

B. Leak test compound.

C. The entity performing the work may also analyze vapor samples for oxygen, carbon dioxide, nitrogen, methane, and other indicators of the biodegradation of hydrocarbon vapors, though these analyses are not required. Of these, MDNR recommends analyzing for oxygen, at least. If samples for oxygen analysis are collected, the oxygen sample should be collected after the COC sample, as oxygen sampling requires the use of an oxygen meter and pump.

C.7.3 Analytical Methods.

A. Fixed laboratory analysis: Gas chromatograph by EPA Method TO-14A, TO-15, or an equivalent air analysis method. Summa canisters are required for these analytical methods. SW-846 Methods 8260B and 8021 may be used if detection limits below applicable target levels can be achieved. The soil gas sampling work plan submitted to MDNR for review and approval must specify the analytical methods to be used.

B. On-site laboratory analysis: Gas chromatography using SW-846 Methods 8260B or 8021. Method detection limits must be below applicable target levels. Other methods may be used only with prior approval of MDNR.

C. Selected laboratory analyses must meet detection limits that support site objectives (i.e., detection limits must be lower than applicable target levels).

D. Regardless of whether the analyses are conducted at an off-site, fixed laboratory or an on-site mobile laboratory, the laboratory must provide adequate and complete Quality Assurance and Quality Control (QA/QC) data for each analysis. QA/QC data should be developed in accordance with the provisions of the analytical method used or as stipulated in SW-846.

C.8 Documentation of Soil Gas Sampling Event.

C.8.1 Soil gas investigation report.

A. A soil gas investigation report that includes a discussion of field operations, deviations from the approved work plan, data inconsistencies, and other significant procedural and analytical details must be prepared and submitted to MDNR. The report should stand alone, though the document may be included as an attachment or appendix of a risk assessment report.

B. At a minimum, the soil gas investigation report must contain the following:

- A site plan map, a map identifying soil gas probe locations, and a map showing soil and groundwater contamination relative to the locations of the soil gas probes and any current or future structures.
- A site map on which soil gas concentration data has been plotted. The map must be at the same scale as the maps discussed above.
- A narrative description of probe installation and sampling procedures, including leak check testing.
- Analytical data summary tables.
- Laboratory data sheets.
- A table showing applicable target levels and appropriate documentation showing how the target levels were calculated.
- A narrative discussion of analytical results, including a comparison of soil gas sampling results to soil vapor target levels.

- Legible copies of field forms, logs, and associated notes pertinent to probe installation and soil gas sampling.
- As-built diagrams of probes or wells showing overall construction and depth of each sampling point.
- QA/QC data.
- Conclusions and recommendations.

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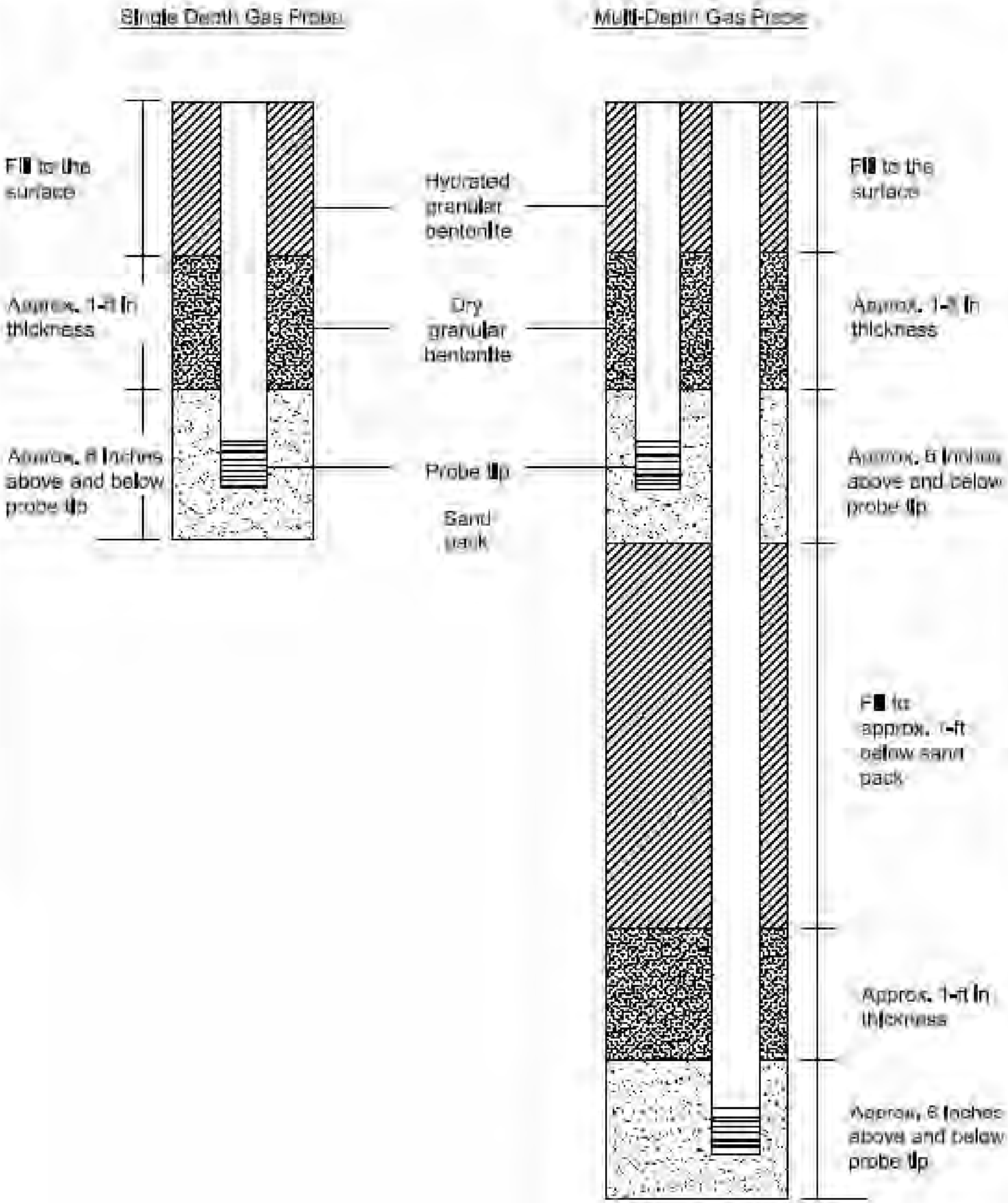

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FIGURE 1
SOIL GAS PROBE CONSTRUCTION DIAGRAM

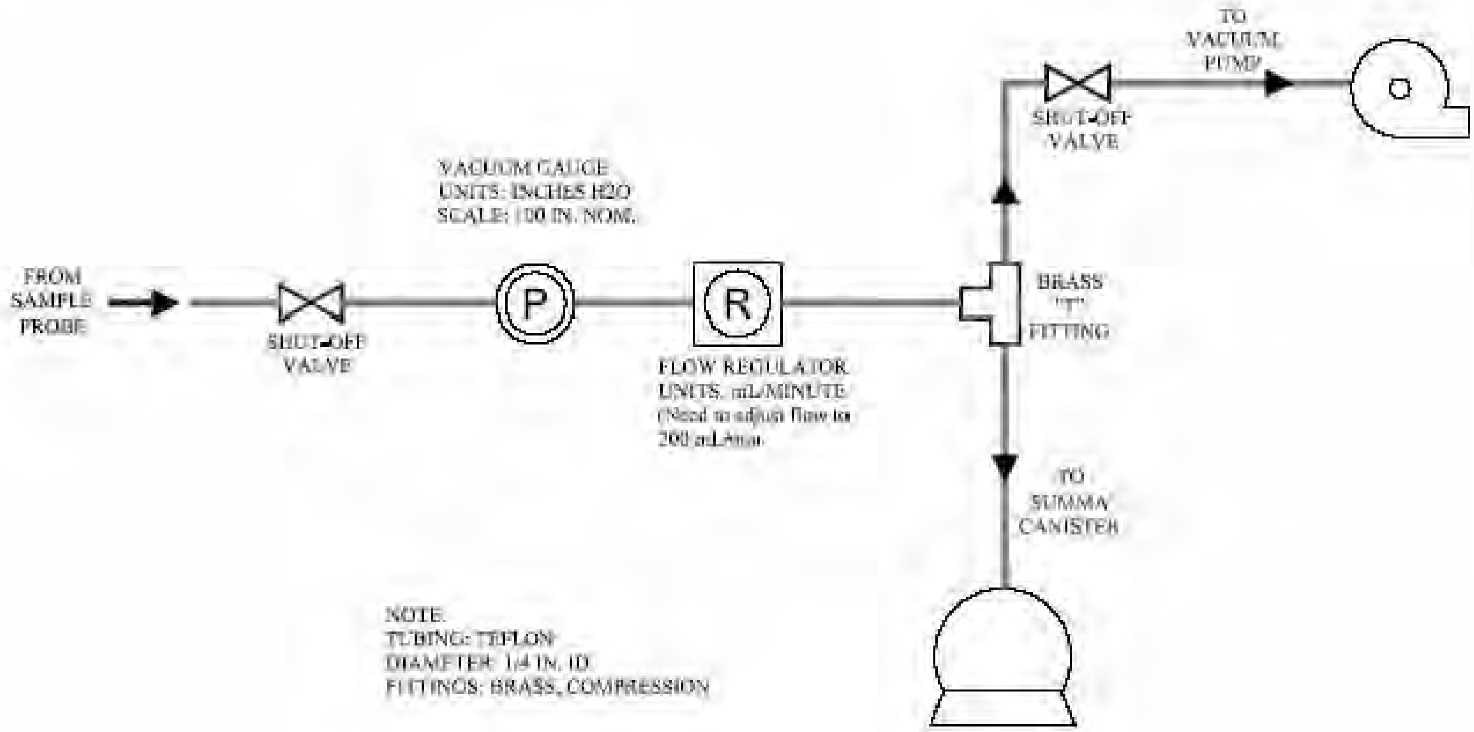

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FIGURE 2
EXAMPLE SOIL GAS SAMPLING PLAN

Figure 3
Example Soil Gas Sampling Form

Date		Sampler	
Client		Project#:	
Container Type		Container ID:	
Sample ID:			
Weather Conditions:	Temperature:	Precipitation:	
Sampling Device:			
Purge Start Time:		End Time:	
Sample Start Time:		End Time:	
Canister start pressure:		End pressure:	
Volume gas extracted:			

Field Measurements

Time	Flow (mL/min)	Pressure (in H20)	Comments

Comments:

ATTACHMENT

Draft

Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations

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Background

Vapor intrusion is defined as vapor phase migration of volatile organic and/or inorganic compounds into occupied buildings from underlying contaminated ground water and/or soil. Until recently, this transport pathway was not routinely considered in RCRA, CERCLA, or UST investigations. Therefore the number of buildings or homes where vapor intrusion has occurred or is occurring is undefined. However, considering the vast number of current and former industrial, commercial, and waste processing facilities in the United States capable of causing volatile organic or inorganic ground-water or soil contamination, contaminant exposure via vapor intrusion could pose a significant risk to the public. Also, consideration of this transport pathway may necessitate review of remedial decisions at RCRA and CERCLA sites as well as implementation of risk-reduction technologies at Brownsfield sites where future development and subsequent potential exposure may occur. EPA's Office of Solid Waste and Emergency Response (OSWER) recently (2002) developed guidance to facilitate assessment of vapor intrusion at sites regulated by RCRA and CERCLA where halogenated organic compounds constitute the bulk of risk to human health. EPA's Office of Underground Storage Tanks (OUST) is considering modifying this guidance to include underground storage tank sites where petroleum compounds primarily determine risk and biodegradation in subsurface media may be a dominant fate process.

The OSWER guidance recommends indoor air and sub-slab gas sampling in potentially affected buildings at sites containing elevated levels of soil-gas and ground-water contamination. To support the guidance and improve site-characterization and data interpretation methods to assess vapor intrusion, EPA's Office or Research and Development is developing a protocol for sub-slab gas sampling. When used in conjunction with indoor air, outdoor air, and soil gas and/or ground-water sampling, sub-slab gas sampling can be used to differentiate indoor and outdoor sources of volatile organic and/or inorganic compounds from compounds emanating from contaminated subsurface media. This information can then be used to assess the need for sub-slab depressurization or other risk-reduction technologies to reduce present or potential future indoor air contamination due to vapor intrusion.

Sub-Slab Vapor Probe Construction and Installation

1. Prior to drilling holes in a foundation or slab, contact local utility companies to identify and mark utilities coming into the building from the outside (e.g., gas, water, sewer, refrigerant, and electrical lines). Consult with a local electrician and plumber to identify the location of utilities inside the building.

2. Prior to fabrication of sub-slab vapor probes, drill a pilot hole to assess the thickness of a slab. As illustrated in **Figure 1**, use a rotary hammer drill to create a "shallow" (e.g., 2.5 cm or 1 in) "outer" hole (e.g., 2.2 cm or 7/8 in diameter) that partially penetrates the slab. Use a small portable vacuum cleaner to remove cuttings from the hole if penetration has not occurred. Removal of cuttings in this manner in a competent slab will not compromise sampling because of lack of pneumatic communication between sub-slab material and the source of vacuum.

3. Then use the rotary hammer drill to create a smaller diameter "inner" hole (e.g., 0.8 cm or 5/16 in) through the remainder of the slab and some depth (e.g., 7 to 8 cm or 3 in) into sub-slab material. **Figure 2** illustrates the appearance of "inner" and "outer" holes. Drilling into sub-slab material will create an open cavity which will prevent obstruction of

probes during sampling by small pieces of gravel.

4. The basic design of a sub-slab vapor probe is illustrated in **Figure 3**. Once the thickness of the slab is known, tubing should be cut to ensure that probes "float" in the slab to avoid obstruction of the probe with sub-slab material. Construct sub-slab vapor probes from small diameter (e.g., 0.64 cm or 1/4 in OD x 0.46 cm or 0.18 in ID) chromatography grade 316 stainless steel tubing and stainless-steel compression to thread fittings (e.g., 0.64 cm or 1/4 in OD x 0.32 cm or 1/8 in NPT Swagelok female thread connectors) as illustrated in **Figure 4**. Use of stainless-steel materials to ensure that construction materials are not a source of VOCs.

5. Set sub-slab vapor probes in holes. As illustrated in **Figure 5**, the top of the probes should be completed flush with the slab and have recessed stainless steel or brass plugs so as not interfere with day-to-day use of buildings. Mix a quick-drying portland cement which expands upon drying (to ensure a tight seal) with water to form a slurry and inject or push into the annular space between the probe and outside of the "outer" hole. Allow cement to cure for at least 24 hours prior to sampling.

6. Install at least 3 sub-slab vapor probes in each residence. As illustrated in **Figure 6**, create a schematic identifying the location of each sub-slab probe.

Sub-Slab Sampling

1. Connect dedicated a stainless-steel fitting and tubing (e.g., 1/8 in NPT to 1/4 in tube Swagelok fitting and 30 cm or 1 ft of 1/4 in I.D. Teflon tubing to a sub-slab vapor probe as illustrated in **Figure 7**. Use of dedicated fitting and tubing will avoid cross-contamination issues.

2. Connect the Teflon tubing to 1/4" ID Masterflex (e.g., 1.4 in ID high performance Tygon LFL) tubing and a peristaltic pump and 1-L Tedlar bag as illustrated in **Figure 8**. Use of a peristaltic pump will ensure that sampled air does not circulate through a pump causing potential cross contamination and leakage.

3. Purge vapor probe by filling two dedicated 1-L Tedlar bags. The internal volume of sub-slab probes is insignificant (< 5 cm^3). A purge volume of 2 L was chosen based on the assumption of a 0.64 cm (1/4") air space beneath a slab and an affected sample diameter of 0.61 m (2 ft).

4. Use a portable landfill gas meter to analyze for O_2, CO_2 and CH_4 in Tedlar bags as illustrated in **Figure 9**.

5. Collect sub-slab vapor samples in evacuated 10% or 100% certified 1-L Summa polished canisters and dedicated particulate filters as illustrated in **Figure 10**. Check vacuum in canisters prior to sampling. Sampling will cease when canister pressure reaches atmospheric pressure. Submit canisters to a commercial laboratory for analysis by EPA Method TO-15.

6. Collect at least one duplicate sub-slab sample per building using dedicated stainless-steel tubing as illustrated in **Figure 11**.

Figure 1. Drilling through a slab

Figure 2. "inner and "outer

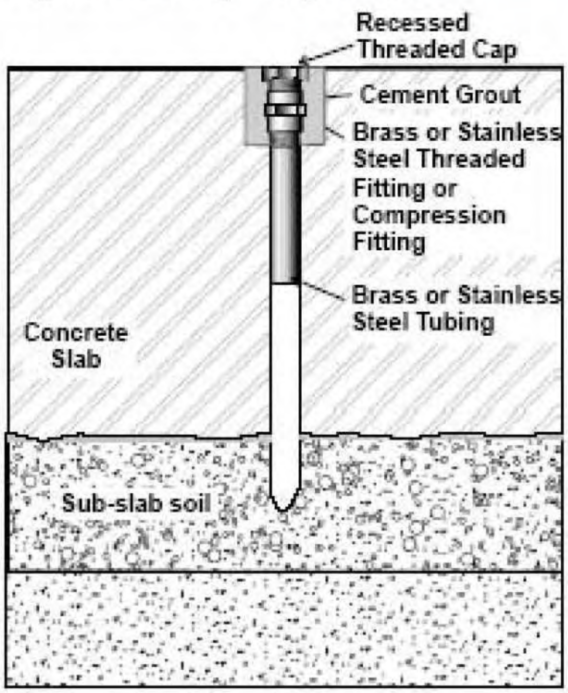


Figure 3. General schematic of sub-slab vapor probe

Figure 4. Stainless steel sub-slab vapor probe components

Figure 5. Competed vapor probe installation

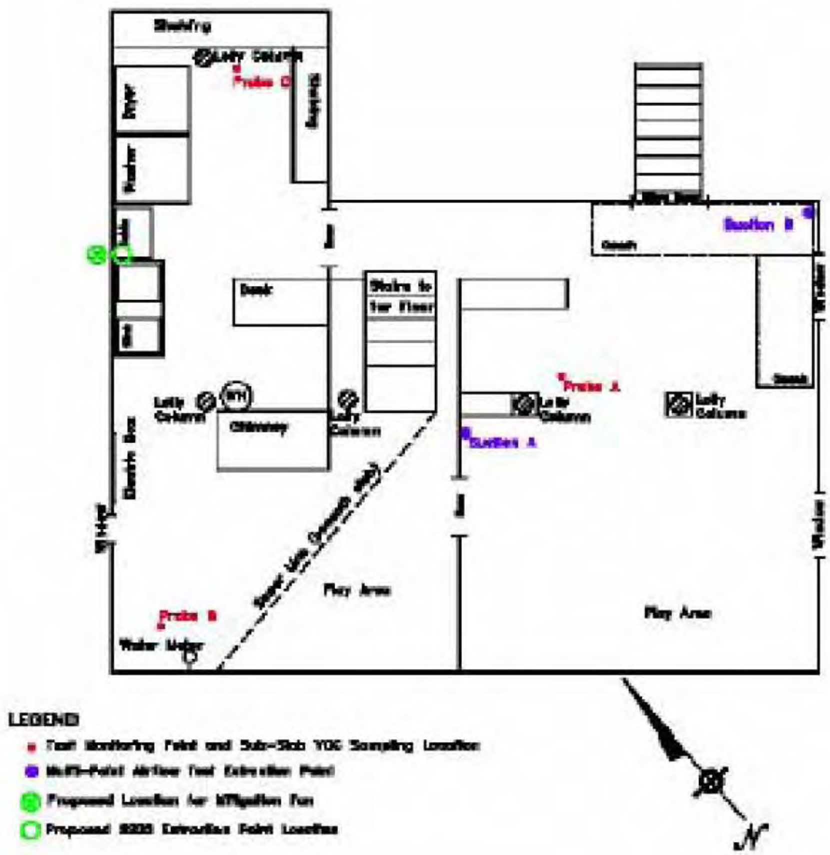


Figure 6. Schematic illustration location of vapor probes in a basement

Figure 7. Compression fitting to probe

Figure 8. Purge prior to sampling

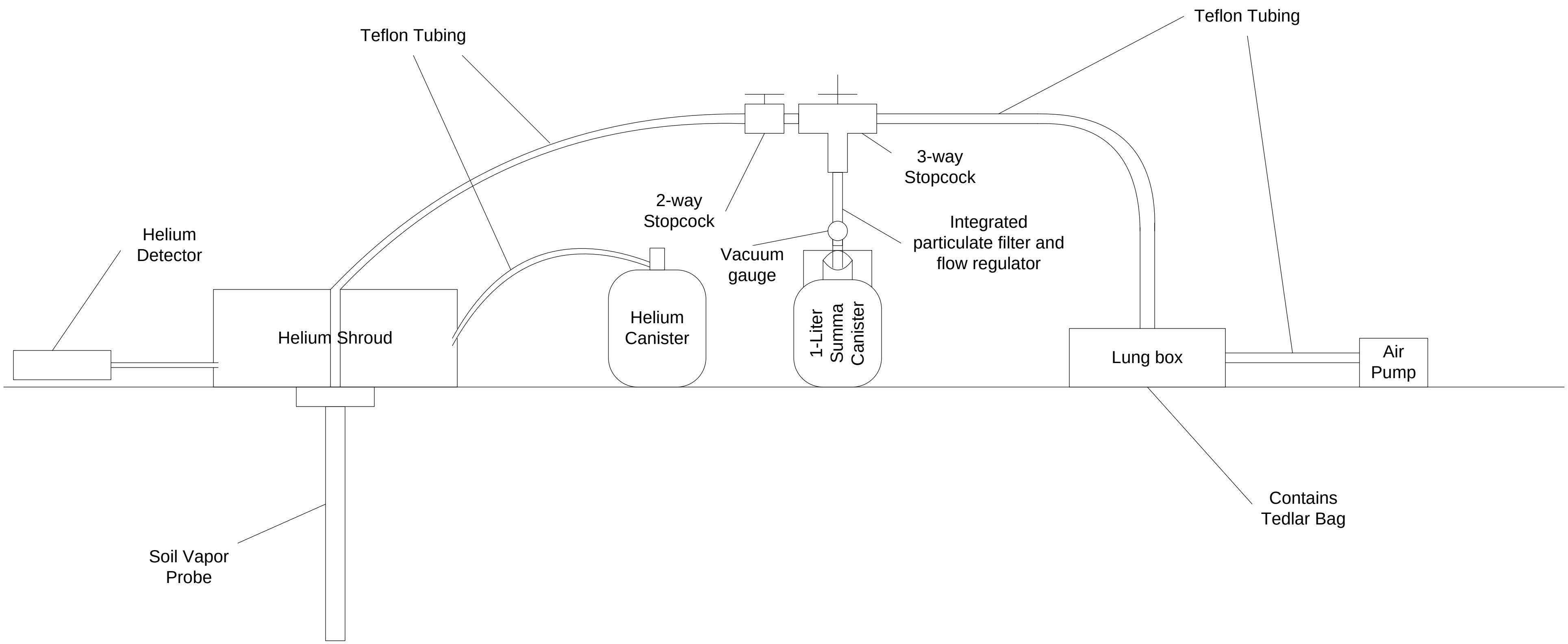
Figure 9. Analysis of O2, CO2, and CH4

Figure 10. Sampling in 1-L evacuated canister for TO-15 analysis

Figure 11. Collection of duplicate sample

APPENDIX F

Typical Soil Gas and Sub-Slab Sample Train Assembly



Burns & McDonnell SINCE 1898

Sample Train Assembly

APPENDIX G

Cox-Colvin & Associates, Inc. *Standard Operating Procedure – Installation and Extraction of the Vapor Pin™*

Cox-Colvin & Associates, Inc. Environmental Services

Standard Operating Procedure Installation and Extraction of the Vapor Pin™

May 20, 2011

Scope:

This standard operating procedure describes the installation and extraction of the Vapor Pin™[1] for use in sub slab soil gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin™ for the collection of sub slab soil gas samples.

Equipment Needed:

- Assembled Vapor Pin™ [Vapor Pin™ and silicone sleeve (Figure 1)];
- Hammer drill;
- 5/8 inch diameter hammer bit (Hilti™ TE YX 5/8" x 22" #00206514 or equivalent);
- 1½ inch diameter hammer bit (Hilti™ TE YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾ inch diameter bottle brush;
- Wet/dry vacuum with HEPA filter (optional);
- Vapor Pin™ installation/extraction tool;
- Dead blow hammer;
- Vapor Pin™ flush mount cover, as necessary;
- Vapor Pin™ protective cap; and
- VOC free hole patching material (hydraulic cement) and putty knife or trowel.

Figure 1. Assembled Vapor Pin™.

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½ inch diameter hole at least 1¾ inches into the slab.

4) Drill a 5/8 inch diameter hole through the slab and approximately 1 inch into the underlying soil to form a void.

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of Vapor Pin™ assembly into the drilled hole. Place the small hole located in the handle of the extraction/installation tool over the Vapor Pin™ to protect the barb fitting and cap, and tap the Vapor Pin™ into place using a

[1] Cox Colvin & Associates, Inc., designed and developed the Vapor Pin™; a patent is pending.

dead blow hammer (Figure 2). Make sure the extraction/installation tool is aligned parallel to the Vapor Pin™ to avoid damaging the barb fitting.

Figure 2. Installing the Vapor Pin™.

For flush mount installations, unscrew the threaded coupling from the installation/extraction handle and use the hole in the end of the tool to assist with the installation (Figure 3).

Figure 3. Flush-mount installation.

During installation, the silicone sleeve will form a slight bulge between the slab and the Vapor Pin™ shoulder. Place the protective cap on Vapor Pin™ to prevent vapor loss prior to sampling (Figure 4).

Figure 4. Installed Vapor Pin™.

7) For flush mount installations, cover the Vapor Pin™ with a flush mount cover.

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub slab soil gas conditions to equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the Vapor Pin™ (Figure 5).

Figure 5. Vapor Pin™ sample connection.

10) Conduct leak tests [(e.g., real time monitoring of oxygen levels on extracted sub slab soil gas, or placement of a water

dam around the Vapor Pin™) Figure 6]. Consult your local guidance for possible tests.

Figure 6. Water dam used for leak detection.

11) Collect sub slab soil gas sample. When finished sampling, replace the protective cap and flush mount cover until the next sampling event. If the sampling is complete, extract the Vapor Pin™.

<u>Extraction Procedure:</u>

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the Vapor Pin™ (Figure 7). Continue

Figure 7. Removing the Vapor Pin™.

turning the tool to assist in extraction, then pull the Vapor Pin™ from the hole (Figure 8).

Figure 8. Extracted Vapor Pin™.

2) Fill the void with hydraulic cement and smooth with the trowel or putty knife.

3) Prior to reuse, remove the silicone sleeve and discard. Decontaminate the Vapor Pin™ in a hot water and Alconox® wash, then heat in an oven to a temperature of 130° C.

The Vapor Pin™ to designed be used repeatedly; however, replacement parts and supplies will be required periodically. These parts are available on line at www.CoxColvin.com.

<u>Replacement Parts:</u>

Vapor Pin™ Kit Case VPC001
Vapor Pins™ VPIN0522
Silicone Sleeves VPTS077
Installation/Extraction Tool VPIE023
Protective Caps VPPC010
Flush Mount Covers VPFM050
Water Dam VPWD004
Brush VPB026