BOW
ENVIRONMENTAL
SOLUTIONS INC.

March 4, 2011

U.S.EPA Region 5
Remediation and Reuse Branch
Land and Chemicals Division, LU-9J
77 West Jackson Blvd.
Chicago, IL 60604-3590
Attn: Ms. Mirtha Cápiro

Re: Sub-Slab and Indoor Air Sampling Work Plan – Motors Liquidation Company - Former Delphi Harrison Thermal Systems (OHD 000 817 577) and Former Moraine Engine Plant (OHD 980 569 388) and Former Moraine Assembly Plant (OHD 041 063 074)

Dear Ms. Cápiro:

BOW Environmental Solutions, Inc. (BOW) is pleased to submit this Revised Sub-Slab and Indoor Air Sampling Work Plan (Revised Work Plan) on behalf of Motors Liquidation Company (MLC). The United States Environmental Protection Agency (U.S. EPA) requested, in a letter dated December 3, 2010 "Re: RCRA 3008(h) Unilateral Administrative Order, Docket # V-W-91 R-2 Former Delphi Harrison Thermal Systems (OHD 000 817 577) and Former Moraine Engine Plant (OHD 980 569 388) and Former Moraine Assembly Plant (OHD 041 063 074)" that MLC provide a draft work plan by December 13, 2010 for sub-slab and indoor air sampling in the neighborhood southwest of the MLC Moraine Site (Site). A Sub-Slab and Indoor Air Sampling Work Plan was completed to satisfy this request and was submitted to the U.S. EPA on December 13, 2010. This Work Plan covered the scope of work for sampling sub-slab soil-gas and indoor air within residential and non-residential structures located in the neighborhood to the southwest of the Site. MLC received comments from the U.S. EPA on this Work Plan in a letter dated February 8, 2011 "Draft Sub-Slab and Indoor Air Sampling Work Plan – Motors Liquidation Company - Former Delphi Harrison Thermal Systems (OHD 000 817 577) and Former Moraine Engine Plant (OHD 980 569 388) and Former Moraine Assembly Plant (OHD 041 063 074)" providing conditional approval contingent upon MLC resolving U.S. EPA comments provided in this letter.

U.S. EPA's specific requests (italicized) from the February 8, 2011 letter and MLC's responses are provided below to assist in the review of the attached Revised Work Plan.

U.S. EPA General Comments

1. *The Conceptual Site Model (CSM) description in Section 2 is inadequate with respect to defining the nature and extent of ground water and soil-gas contamination as well as defining the preferential pathways for vapor intrusion. For the meaningful interpretation of home specific sub-slab soil-gas and indoor air results, an updated CSM is essential. The CSM specific for the vapor intrusion investigation at MLC Moraine should be revised and submitted along with revised sub-slab and indoor air work plan.*

   Critical components of the CSM include the following:

   - *The location and nature of the source of Contaminants of Concern (COC) found in the subsurface*
   - *COC properties, including degradation products*
   - *COC screening levels in indoor air and sub-slab soil-gas*
   - *A basic understanding of the lithology and stratigraphic features that influence the occurrence and movement of groundwater and soil-gas*
   - *Depth to groundwater and groundwater flow directions*
   - *General nature and extent of COCs in groundwater/or soil-gas*
   - *Site-specific map with locations and depths of major underground utilities (particularly storm sewers)*
   - *Potential background sources of COC and typical ambient air concentration ranges*
   - *Locations, ownership and general use of buildings (current and potential future) with in the area potentially impacted*

   Please refer to the conceptual site model check list (Appendix C) available from the guidance document from OEPA on the vapor intrusion Investigation at http://www.epa.state.oh.us/portals/30/rules/VI%20guidance.pdf .

   Response to Comment: The revised Conceptual Site Model (CSM) focused on the area of the investigation (neighborhood southwest of the Site) has been included in Section 2 of this Revised Work Plan. The CSM was revised to address this comment as discussed during the February 9, 2011 conference call between U.S. EPA and MLC. Specifically the critical components are discussed below:

- Section 2 of the Revised Work Plan has been edited to include a discussion of the on-site sources of COCs; sampling for the focused list of site-specific VOCs; discussion of the subsurface geology as it relates to the migration of soil-gas in the neighborhood southwest of the Site; discussion of the groundwater flow in the neighborhood southwest of the Site; and a general discussion of the nature and extent of the COCs.

- A discussion of the fate and transport, degradation, and properties of VOCs is presented in the CSM and on new Figure 3 of the Revised Work Plan.

- Table 7 (formerly Table 4) of the Revised Work Plan has been edited and includes screening levels for indoor air and sub-slab soil-gas for each of the chemical constituents on the focused list of VOCs.

- Figure 2 of the Revised Work Plan has been edited to include the locations of the available underground utilities provided by the City of Moraine and Montgomery County, including sanitary sewers, storm sewers, storm catch basins (dry wells), and water mains.

- MLC is unaware of any potential background air sources and do not suspect concentrations of the focused list of VOCs to be present at elevated levels in ambient air. Ambient air samples will be collected during the sub-slab and indoor air investigation to determine if there are background concentrations of the focused list of VOCs present.

- Table 1 of the Revised Work Plan has been edited to provide a list of the location and ownership of the buildings in the neighborhood southwest of the Site. All of the buildings, with the exception of the gas station and the church, are residential properties.

2. *The work plan identifies residential and commercial land use categories in the vapor intrusion investigation area. Please identify the sensitive populations in this area. Facilities where sensitive populations may be located include day care centers, schools and elderly care homes. The target indoor air concentration for a residential scenario, should be applied to a commercial land use if sensitive populations are exposed. In addition, U.S. EPA considers that the store from the gas station needs to be included in the sampling under the commercial land use category.*

   Further, the U.S. EPA's General Comment 2 is intended to address the comments below from the DMCPH in regards to the issue of sensitive populations. With respect to the aspect of mitigation raised in the DMCPH's comments, U.S. EPA has informed DMCPH that MLC Moraine is required to address in a subsequent work plan any vapor intrusion mitigation that may be warranted based on the *results from implementation of the proposed sub-slab soil-gas and indoor air sampling. Refer to comments from DMCPH below.*

Section 2.2 – Sub-slab and Indoor Air Sampling Objectives: The work plan proposes sampling residential homes and a church in the southwest neighborhood, noting that an active gas station/service shop will not be sampled "…due to potential interferences from daily operations".

a. If a childcare center is located in the church and sampling subsequently determines that mitigation is necessary, we believe that mitigation should be required to the residential, rather than commercial screening level in recognition of the greater sensitivity of children present.

b. Was an assessment of historical use of the contaminants of concern made at the gas station/service facility before determining that the facility would not be sampled? Contaminants commonly associated with fueling operations are not the concern here. Unless the facility has historical and current use of PCE and TCE, it is reasonable to be sampled (and mitigated if necessary) as any other commercial property.

Mitigation is not included in this work plan and we believe it should be. During the December 21st conference call, a "decision tree" of sorts for mitigation was discussed that indicated EPA thinking on how (and when) mitigation will be required. We believe mitigation should be part of this plan because:

a. Sampling is not planned to begin until later in the winter months with a separate work plan for mitigation to be developed at a later date. If mitigation methodology were included as part of this sampling plan, both could be reviewed with the public at the January public meeting providing them a better understanding of the project.

b. Property owners would have the advantage of a more complete understanding of both sampling and if necessary, mitigation. Many more questions could be answered in January allowing property owners to be in a better position to make an informed decision about granting access,

c. In the event that mitigation is needed, having it approved as part of this plan will allow project personnel to react more quickly to homes needing mitigation.

d. It is important to remember that these homes might have been impacted by something not of the owner's doing. Residents will have many questions and concerns; it is important that the project be positioned to react quickly to respond to any identified problems.

Response to Comment: Section 2.4 of the Revised Work Plan has been modified to include a discussion of sensitive populations. If, during the investigation associated with the Revised Work Plan, the church is determined to be utilized as a day care facility, the residential screening levels will be utilized for sub-slab soil-gas and indoor air. All other buildings, with exception of the gas station are residential and the results will be compared to residential screening levels for sub-slab soil-gas and indoor air.

3. *The work plan specifies that one sub-slab soil-gas sample will be collected per structure. According to OEPA guidance, at least two sub-slab samples should be collected per structure. It is reasonable that only one sample may be necessary for homes less than 1000 square feet. Structures greater than 1000 square feet and those with non-uniform foundations would require at least two sampling points. Refer to http://www.epa.state.oh.us/portals/30/rules/VI%20guidance.pdf. For any structure where fewer than two sub-slab samples are proposed in the work plan, MLC Moraine should provide justification for reduced sampling.*

Response to Comment: Consistent with the discussion during the February 9, 2011 conference call between U.S. EPA and MLC, one sub-slab soil-gas sample will be collected from structures under 1,000 square feet or structures under 1,100 square feet with partial basements. Two sub-slab soil-gas samples will be collected from structures over 1,100 square feet, structures over 1,000 square feet with a full basement, or structures with slab-on-grade construction over 1,000 square feet. A list of the number of sub-slab samples per property is presented on Table 1 of the Revised Work Plan. The final number of sub-slab samples collected per resident will be based on building construction as noted during the home evaluation.

4. *The work plan should include collection of ambient air samples. One to two ambient air sample should be collected on a day that indoor air samples are collected to provide a baseline against which the indoor air sample results can be compared. Outdoor ambient samples should be collected from a representative location, preferably upwind and away from any wind obstructions such as trees and buildings. The sampling should begin at least 1 hour and preferably 2 hours before indoor air sampling begins and continue until at least 30 minutes before indoor air sampling is complete.*

Response to Comment: Standard Operating Procedure (SOP) 22 (Appendix C [formerly Appendix A]) of the Revised Work Plan has been edited to include the collection of ambient air samples. One ambient air sample will be collected during each day that indoor air samples are collected, regardless of the number of homes sampled. Similarly to indoor air samples, ambient samples will be collected at breathing height (4 to 5 feet) in a location upwind of the buildings being sampled on a given day, as determined by wind direction. Ambient samples will be collected over the 24-hour sampling period similar to the indoor air samples.

5. *Following is the suggested sampling approach based on the building foundation type (basement/no basement). This approach should be combined with an additional indoor air sample in the main living area.*

   - *Concrete floor – Two sub-slab samples and one indoor air sample in the basement*
   - *Concrete floor with crawl space area –One sub-slab sample from concrete floor section and one indoor air sample from crawl space area*
   - *Dirt floor – No sub-slab sample is required. One indoor air sample is required in the basement*
   - *Dirt crawl space only – Structures having only a dirt crawl space require only one indoor air sample in the crawl space area*
   - *No basement / Slab foundation – Two sub-slab samples and one indoor air sample collected from the main floor in structures with no basement*

   Response to Comment: For comparison, the “concrete floor” will be sampled similarly to basements (one or two sub-slab samples depending on the size of the home), “concrete floor with crawl space” will be sampled similarly to a basement (one or two sub-slab samples depending on the size of the home and one indoor air sample in the lowest structure beneath the main living space), “dirt floor” and “dirt crawl space only” will be sampled similarly to a crawl-space (one indoor air sample below the main living space), and “no basement/slab foundation” will be sampled similarly to slab-on-grade construction (one or two sub-slab samples depending on the size of the home). Section 3.2 “Sample Locations” of the Revised Work Plan provides further details related to the sub-slab soil-gas and indoor air residential sampling protocol.

6. *The work plan indicates the analysis of only trichloroethene (TCE) and tetrachloroethene (PCE). All the analytes associated with chlorinated solvents from the site-specific volatile organic compounds (VOCs) which were detected in groundwater and/ or soil-gas from previous right-of-way sampling and the degradation products should be carried forward in further investigation of vapor intrusion into indoor. Please include 1,1-Dichloroethane (1,1-DCA), 1,1-Dichloroethylene (1,1-DCE), Trans-1,2-Dichlorethylene (Trans-1,2 DCE), 1,1,1-Trichloroethane (1,1,1-TCA), Cis-1,2-Dichloroethylene (Cis–1,2–DCE) and vinyl chloride in the analytical list. For transparency, the work plan should clarify that non-chlorinated compounds from the site-specific VOCs (Benzene, Ethylbenzene, Toluene, and Xylene) do not appear to be risk drivers based on previous right-of-way sampling results. The following table (Table A) provides the action levels for indoor air and sub-slab soil-gas at residential and commercial scenarios. Note that Table 4 of the draft Work Plan would need to be revised to incorporate any additional information and/or changes based on Table A. Further, the approach*

presented in Section 3.1 Structure Reconnaissance (including product inventories) needs to be revised to consider all above chlorinated compounds.

Table A: Action levels (ug/m3) for Sub-Slab Soil Gas and Indoor Air, MLC Moraine Site

Chemical*	**Residential**		**Commercial**	
	Indoor Air	**Sub-Slab Soil Gas**	**Indoor Air**	**Sub-Slab Soil Gas**
1,1–DCA	15.2	152	76.7	767
Trans–1,2–DCE	62.6	626	263	2630
PCE	4.1	41.2	20.8	208
1,1,1–TCA	5210	52100	21900	219000
TCE	12.2	122	61.3	613
1,1–DCE	209	2090	876	8760
Cis–1,2–DCE	Not available	Not available	Not available	Not available
VC	1.6	16	27.9	279

*Action levels based on May 2010 U.S. EPA Regional Screening levels for air.
1,1-DCA - 1,1-Dichloroethane
Trans-1,2-DCE - Trans-1,2-Dichloroethylene
PCE - Tetrachloroethylene
1,1,1-TCA - 1,1,1-Trichloroethane
TCE - Trichloroethylene
1,1-DCE - 1,1–Dichloroethylene
Cis-1,2-DCE - Cis–1,2–Dichloroethylene
VC - Vinyl Chloride

Response to Comment: Based on the soil-gas sampling results the primary COCs in soil-gas are PCE and TCE. The sub-slab and indoor air sampling will include a focused list of VOCs including PCE, TCE, 1,1-DCA, 1,1-DCE, 1,1,1-TCA, trans-1,2-DCE, cis-1,2-DCE, and vinyl chloride. The Revised Work Plan has been edited to include sampling for this list of VOCs. Additionally, new Table 7 (formerly Table 4) of the Revised Work Plan has been edited to incorporate these VOCs and respective residential and commercial indoor air and sub-slab soil-gas screening levels.

7. *Provide a decision flow chart for corrective action following sampling in residential and commercial scenarios. The decision matrix provided below could be used as a guidance in developing a decision chart. Please note that the indoor action levels are risk based and are based on the table titled “Long-term screening levels for volatile Organic Constituents potentially impacting residential structures – Former Moraine site”, per the U.S. EPA correspondence dated June 01, 2010, and the approved September 16, 2010, Vapor Intrusion Verification Work Plan – Motor Liquidation Company. MLC Moraine recommended the use of attenuation factor (AF) of 0.005 in Section 2.1 Soil-Gas Sampling Results and in Table 4 of the draft work plan. This is not acceptable. The recommended attenuation factor is not acceptable for this site. AFs for sub-slab soil gas are typically based on empirical data and generally range from 0.01 to 0.1 for residential buildings. According to the*

U.S. EPA's 2008 "Vapor Intrusion Database", only 7% of the observed sub-slab AFs are lower than two orders of magnitude below the generic screening criteria of 0.1 (that is, have AF's less than 0.001). Further, recent evaluation of the paired environmental samples in the U.S. EPA's "Vapor Intrusion Database" indicates that the default AFs in the 2002 draft guidance remain appropriate except for the AF's for deep soil-gas. Based on the above rationale a decision matrix has been put together in the following table. The matrix highlights main risk drivers such as PCE and TCE but the same logic applies to other compounds from chlorinated solvents in the investigation media.

Table B: Decision Matrix for Residential Sampling for TCE and PCE

Risk Levels and Action	**Category 1- NFA**	**Category 2- Possible Background Source**	**Category 3 - Mitigation**	**Category 4 - Mitigation**
Action Level	Lesser than the risk levels of concern	Lesser than SS SC but higher than IA SC	Greater than SS SC but lesser than the IA SC	Greater than SS and IA SC
SS CA Risk Level PCE (ug/m3) TCE (ug/m3)	$1x 10^{-05}$ < 41 < 122	$1x 10^{-05}$ < 41 < 122	$1x 10^{-05}$ > 41 > 122	$1x 10^{-05}$ > 41 > 122
IA CA Risk Level PCE (ug/m3) TCE (ug/m3)	$1x 10^{-05}$ < 4.1 < 12.2	$1x 10^{-05}$ > 4.1 > 12.2	$1x 10^{-05}$ < 4.1 < 12.2	$1x 10^{-05}$ > 4.1 > 12.2
Action	Confirmatory sampling	Worst case confirmatory sampling	Residence-specific mitigation based on discussion with owner	

SS – Sub-slab soil gas　PCE- Tetrachloroethylene　TCE- Trichlorethylene
IA – Indoor Air　CA – Cancer risk　NFA- No further action
SC – Screening Criteria

<u>Response to Comment</u>: This Decision Matrix for Residential and Commercial Sampling is included in the Revised Work Plan on new Tables 5 and 6, respectively.

8. *The soil-gas sample points near the City Building (SGP-9) and at MLC Moraine's East property boundary (SGP-10, SGP-11 and SGP-12) warrant sampling under high-water table conditions in accordance with the approved September 16, 2010 Work Plan. This round of sampling scheduled for spring 2011 is necessary for verification purposes under a worst case scenario to evaluate the potential for vapor intrusion per the goals and objectives from the approved September 16, 2010 Work Plan. Note that the results from SGP-9 should be screened using target indoor air concentration for a commercial scenario. If the 2011 Spring sampling*

results indicate that the level of soil-gas at SGP-9 exceed the sub-slab screening criteria for a commercial property, U.S. EPA would request indoor air sampling in the City Building.

Response to Comment: Nested soil-gas sampling points SGP-9 through SGP-12 will be sampled in March 2011. MLC recommends comparing the results from soil-gas sampling at SGP-9 to commercial soil-gas screening levels as soil-gas screening levels account for the attenuation that occurs between the soil gas sample location and indoor air. If the soil-gas sampling results are above these screening levels, sub-slab and indoor air sampling would be completed at the Moraine City Building.

9. *Appendix should include the instruction sheet for Occupants in preparation for indoor sampling event. Please refer to the New Jersey Department of Environmental 's instruction sheet as an example (see link below)*

http://www.state.nj.us/dep//srp/guidance/vaporintrusion/occupants_inst.pdf

Response to Comment: New Appendix B "Instructions for Occupants During Indoor Air Sampling Events" has been added to the Revised Work Plan, and corresponds to the New Jersey Department of Environmental Protection's Instruction Sheet.

10. *The work plan should include the template of the Access Agreement Form that U.S. EPA has reviewed and determined to be appropriate for this project. The template that is acceptable to U.S. EPA will capture the following comments from DMCPH. With respect to mitigation, as mentioned earlier, U.S. EPA has informed DMCPH that MLC Moraine is required to address in a subsequent work plan any vapor intrusion mitigation that may be warranted based on the results from the proposed sub-slab soil-gas and indoor air sampling. Refer to DMCPH comments below.*

Right of Entry Authorization form: Current language in the draft provides right of entry to "…perform a sub-slab soil gas and indoor air investigation". Current language does not clearly provide access for both sampling and mitigation, if the later were necessary based on the results of sampling conducted. Needed work will progress more quickly if access for both activities is authorized by signing a single document.

Section 4 – Reporting and Scheduling: Although the work plan does not contain specifics, we are supportive of the outreach effort discussed as part of the December 21st conference call. We believe it important to reach-out to the affected residents on multiple occasions to provide opportunities to secure signed access agreements. However, a couple of items not resolved during the conference call include:

a. *Rental properties – past experience has shown us that involvement and agreement on the part of both the property owner and tenant is critical to assure access for sampling and, if needed, mitigation.*

b. *Property owners who initially decline, but at a later date agree to grant access - We agree that multiple efforts will be needed in many cases to secure signed access agreements. Both the "door-knocking" event discussed in the work plan and public meetings will provide important opportunities to secure signed agreements. In our experience, some property owners who initially declined access later agreed to grant it. Some access agreements were signed more than a year after declination by both original as well as new homeowners. In our current investigations, it has been EPA's position that access for property owners into current investigations would be assured provided that work was still underway. Will EPA assure access to this investigation after an initial declination in a similar manner?*

Response to Comment: New Appendix A "Access Agreement" which includes the access agreement submitted to the residents of the neighborhood by the U.S. EPA in February 2011, has been added to the Revised Work Plan.

U.S. EPA Specific Comments

1. *Section 3.3. Sub-Slab Soil-Gas Sampling: The following comment was provided by the DMCPH: The work plan proposes to collect sub-slab soil-gas samples using 1-liter Summa canisters over a 30-minute sampling period. Our past experience with three (3) local investigations all included collecting both sub-slab and indoor air in 6-liter SUMMA canisters over a 24-hour period. We believe that sub-slab and indoor air samples should be collected following the same protocol. We understand the smaller gas volumes associated with 1-liter samples may require dilution to provide sufficient volume to complete analysis; as dilution occurs, detection levels increase. Thus, while a "hot" or high sample result would still be easily identified, a low level result might not be due to higher detection levels. To assure consistency of data collection we believe all samples should be collected using 6-liter canisters and a 24 hour sample collection period.*

U.S. EPA has informed DMCPH that the MLC Moraine's proposed scope of work for indoor air/sub-slab vapor sample collection is consistent with procedures from the State of New Jersey found at the following link:

http://www.epa.gov/region02/waste/dupont_pompton/sample_collection_procedures_sow.pdf

Response to Comment: A 1-liter SUMMA® canister matched with a 30-minute flow controller will be utilized for all sub-slab soil-gas sampling and a 6-liter SUMMA® canister matched with a 24-hour flow controller will be utilized for all indoor and ambient air sampling. The laboratory is able to provide reporting limits well below the indoor air and sub-slab soil-gas screening levels required for this investigation. Although dilution values are related to the volume of the canister, screening levels are still able to be met. No edits have been made to the Revised Work Plan. Reporting limits provided by the laboratory for target VOCs are presented below.

Compound	**TO-15 Low Level (indoor air) RL in ug/m3**	**Standard (sub-slab soil-gas) TO-15 RL in ug/m3**
1,1-Dichloroethane	0.41	2.0
1,1-Dichloroethene	0.40	2.0
1,1,1-Trichloroethane	0.55	2.8
trans-1,2- Dichloroethene	0.39	2.0
cis-1,2- Dichloroethene	0.40	2.0
Vinyl Chloride	0.26	1.3
Tetrachloroethene	0.69	3.4
Trichloroethene	0.55	2.7

2. *Section 4. Reporting and Schedule: The proposed reporting should also include copies of completed forms/documents related to the following: sample collection logs, access agreements, building surveys and product inventories, and any other information related to the implementation of the proposed structure reconnaissance approach under Section 3.1 Structure Reconnaissance.*

   Response to Comment: Section 4 “Reporting and Schedule” has been updated in the Revised Work Plan to include sample collection logs, access agreements, building surveys, product inventories, and other field notes.

3. *Section 5. Data Quality Objectives (DQO): The work plan recommends duplicate sample collection at a 5% frequency (1 in 20 samples) for quality assurance/ quality control (QA/QC) for soil-gas and air sampling. Note that with respect to soil-gas measurements, the agency considered appropriate the practice of duplicate sample collection at a 5% frequency for the previous sampling in the right-of-way areas (per the approved MLC Moraine’s September 16, 2010, Vapor Intrusion Verification Work Plan). However, for sub-slab sampling in residential and commercial building structures MLC Moraine should follow the OEPA guidance for vapor intrusion which recommends 10% frequency (1 in 10 samples). MLC Moraine should use similar frequency for duplicate sample collection related to air sampling for consistency with OEPA guidance. Table B-1 needs to be revised to address this comment.*

Appendix A

<u>Response to Comment</u>: Section 5 “Data Quality Objectives” has been edited in the Revised Work Plan to include the collection of duplicate sub-slab soil-gas, ambient air, and indoor air samples at a rate of 10% (1 per 10).

4. *SOP 20, 21 and 22 should have the following instructions for field staff: Prior to all sampling activities, the following general procedures are to be followed:*

- *Every effort shall be made to remove likely background sources of indoor air contamination from the building several days prior to the indoor air sampling.*
- *Apart from recording weather information outdoor, indoor temperature and humidity should also be recorded at the beginning of the sampling event. Record substantial changes to these conditions that may have occurred over the past 24 to 48 hours and that do occur during the course of sampling.*

<u>Response to Comment</u>: SOPs 20 and 22 (new Appendix C [formerly Appendix A]) has been updated and Instructions to Occupants during Indoor Sampling Events (new Appendix B) has been added in the Revised Work Plan to include these sampling procedures. SOP 21 did not require any revision based on comments provided by the U.S. EPA.

5. *SOP 22, Section V. Procedure, should be expanded to include the following:*

For the indoor air sample, identify the sampling location(s) on a floor plan that also identifies locations of heating, ventilation and air conditioning (HVAC) equipment, chemical storage areas, garages, doorways, stairways, sumps, drains, utility perforations, north direction, and separate footing sections. For the ambient air sample, select a location upwind of the building or other area that is being evaluated. If possible, select a location upwind or near the HVAC air intake for the building being sampled.

Photograph each canister and the area surrounding the canisters. After completing the “Building Survey and Product Inventory Form”, provide the homeowner with a copy of the survey and discuss potential background sources with also the homeowner. Accurate collection of information for completion of these forms is critical and includes discussions with the property owner to assess building characteristics, potential indoor air contaminant sources, and miscellaneous items such as “do you dry clean clothes or smoke?” The chemical inventory should document all chemical items in the sampling level of the building (at a minimum) and include gaining permission to open all cabinets and closets. Ingredients of chemicals should be recorded as well as quantity.

Additionally, for the ambient air sample, document on a field form an outdoor plot sketch that indicates the building being sampled, streets, sampling location,

location of potential outdoor air sources, north direction and paved areas. Also record pertinent observations, such as, odors, readings from field instrumentation, and significant activities in the vicinity that result in air emissions.

***Response to Comment**:* SOP 22 (new Appendix C [formerly Appendix A]) has been updated in the Revised Work Plan to include this information.

Appendix B

6. *Table B-1: Please cite the method of analysis for the standard and lower level reporting limit assuring consistency with Section X Quality Assurance from SOP 20 Sub-Slab Soil-Gas Point Installation and Sampling, and SOP 22 Indoor Air Sampling.*

Response to Comment: The laboratory has a number of instruments available with various calibration ranges. They utilize a low level instrument calibrated at 0.1 to 40 parts per billion by volume (ppbv) for indoor air samples, and a standard level instrument calibrated at 0.5 to 200 ppbv for sub-slab soil-gas samples. The laboratory also has a higher level instrument (5 to 5,000 ppbv) available for use as necessary. These instruments meet all applicable criteria for U.S. EPA Method TO-15.

Table B-2 should be revised to include all the analytical constituents in the sampling medium.

Response to Comment: Table D-2 (formerly Table B-2) has been edited in the Revised Work Plan to include all of the focused list of VOCs (PCE, TCE, 1,1-DCA, 1,1-DCE, 1,1,1-TCA, trans-1,2-DCE, cis-1,2-DCE, and vinyl chloride).

We look forward to working with U.S. EPA on the implementation of the scope of work in this Revised Work Plan. Please call 937-478-8221, if you have any questions.

Sincerely,

Pamela L. Barnett, PG
Project Manager
BOW Environmental Solutions, Inc. on behalf of MLC

cc: H. O'Connell, Ohio EPA

Enclosure

BOW
ENVIRONMENTAL
SOLUTIONS INC.

March 10, 2011

U.S.EPA Region 5
Remediation and Reuse Branch
Land and Chemicals Division, LU-9J
77 West Jackson Blvd.
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Attn: Ms. Mirtha Cápiro

Re: Sub-Slab and Indoor Air Sampling Work Plan; Replacement Tables – Motors Liquidation Company - Former Delphi Harrison Thermal Systems (OHD 000 817 577) and Former Moraine Engine Plant (OHD 980 569 388) and Former Moraine Assembly Plant (OHD 041 063 074)

Dear Ms. Cápiro:

BOW Environmental Solutions, Inc. (BOW) is pleased to submit the attached replacement tables to the Revised Sub-Slab and Indoor Air Sampling Work Plan (Revised Work Plan) on behalf of Motors Liquidation Company (MLC). MLC submitted the Revised Work Plan to the United States Environmental Protection Agency (U.S. EPA) on March 4, 2011. U.S. EPA provided comments to Tables 1, 5, and 6 of the Revised Work Plan on March 8, 2011 via an e-mail "Request for replacement tables -- MLC Moraine Sub-slab and Indoor Air Sampling Work Plan."

U.S. EPA's specific requests (italicized) from the March 8, 2011 e-mail and MLC's responses are provided below to assist in the review of the revised tables.

U.S. EPA Comments

1. *Table 1: please eliminate the information from the second column (Owner names) by using shading or other graphic tool.*

   Response to Comment: Table 1 "Property Information Details for Neighborhood Located Southwest of Site, Motors Liquidation Company, Moraine, Ohio" has been revised by shading the owner's names in the second column.

2. *Table 5: In the second column (Category 2), the second cell related to IA needs to have the comparison sign reversed from < (less than) to > (greater than). The opposite is required for the second cell from column 3 (Category 3).*

Response to Comment: Table 5 "Decision Matrix for Residential Sampling, Motors Liquidation Company, Moraine, Ohio" has been corrected as requested.

3. *Table 6: In the second column (Category 2), the second cell related to IA needs to have the comparison sign reversed from < (less than) to > (greater than). The opposite is required for the second cell from column 3 (Category 3).*

Response to Comment: Table 6 "Decision Matrix for Commercial Sampling, Motors Liquidation Company, Moraine, Ohio" has been corrected as requested.

We look forward to working with U.S. EPA on the implementation of the scope of work in this Revised Work Plan. Please call 937-478-8221, if you have any questions.

Sincerely,

Pamela L. Barnett, PG
Project Manager
BOW Environmental Solutions, Inc. on behalf of MLC

cc: H. O'Connell, Ohio EPA

Enclosure

ARCADIS
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Sub-Slab and Indoor Air Sampling Work Plan

Motors Liquidation Company

Former Delphi Harrison Thermal Systems Moraine Plant
Former General Motors Powertrain Group, Moraine Engine Plant
Former General Motors Truck Group, Moraine Assembly Plant

Moraine, Ohio

December 13, 2010
Revised March 4, 2011

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Tables

1. Introduction

The United States Environmental Protection Agency (U.S. EPA) requested, in a letter dated December 3, 2010 “Re: RCRA 3008(h) Unilateral Administrative Order, Docket # V-W-91 R-2 Former Delphi Harrison Thermal Systems (OHD 000 817 577) and Former Moraine Engine Plant (OHD 980 569 388) and Former Moraine Assembly Plant (OHD 041 063 074)” that Motors Liquidation Company (MLC) provide a draft work plan by December 13, 2010 for sub-slab and indoor air sampling in the neighborhood southwest of the MLC Moraine Site (Site). A Sub-Slab and Indoor Air Sampling Work Plan (Work Plan) was created to satisfy this request and was submitted to the U.S. EPA on December 13, 2010. The Work Plan covered the scope of work for sampling sub-slab soil-gas and indoor air within residential and non-residential structures located in the neighborhood to the southwest of the Site. MLC received comments from the U.S. EPA on this Work Plan in a letter dated February 8, 2011 “Draft Sub-Slab and Indoor Air Sampling Work Plan – Motors Liquidation Company - Former Delphi Harrison Thermal Systems (OHD 000 817 577) and Former Moraine Engine Plant (OHD 980 569 388) and Former Moraine Assembly Plant (OHD 041 063 074)” providing conditional approval contingent upon MLC resolving U.S. EPA comments provided in this letter. This Revised Sub-Slab and Indoor Air Sampling Work Plan (Revised Work Plan) including the accompanying Response to Comments cover letter addresses these comments.

Consistent with the Revised Vapor Intrusion Verification Work Plan (ARCADIS, Inc. 2010a), a soil-gas investigation was completed in October and November 2010 in the neighborhood right-of-way southwest of the Site. The overall goal of the soil-gas investigation was to provide site-specific data to provide another line of evidence to further evaluate the potential for the vapor intrusion pathway and to support the vapor intrusion risk assessment submitted in the Corrective Measures Proposal (CMP) (ARCADIS, Inc. 2008). The soil-gas field investigation provided another line of evidence (in addition to the risk assessment) to evaluate the potential for vapor intrusion into nearby buildings.

As noted above, the field investigation focused on the collection of soil-gas and groundwater table samples near potential off-site receptors (residential structures) within proximity of the Site. Specifically, two areas were included in the sampling program: the neighborhood located to the southwest of the Site (Figures 1 and 2 of the Revised Vapor Intrusion Verification Work Plan) and the eastern portion of the Site (Figures 1 and 3 of the Revised Vapor Intrusion Verification Work Plan [ARCADIS, Inc. 2010a]).

As stated in the Revised Vapor Intrusion Verification Work Plan, MLC will conduct additional sampling (sub-slab and indoor air) in residential homes and a church southwest of the Site (Figure 1). As communicated to U.S. EPA, the soil-gas data indicate that direct sampling of homes is the recommended next step for the neighborhood to the southwest of the Site. In addition, the U.S. EPA requested in the February 8, 2011 comment letter that ambient air samples be collected and that sub-slab and indoor air sampling be completed at select commercial buildings (the gas station and the church) located within the neighborhood southwest of the site. Therefore, MLC has prepared this Revised Work Plan to provide details for sub-slab soil-gas, crawl space, ambient air, and indoor air sampling at the residential properties, church, and gas station located to the southwest of the Site. The properties to be sampled and relevant structural details for each property are presented on Figure 2 and in Table 1. The soil-gas sampling results for the southwest neighborhood are presented in this Revised Work Plan to support conducting the additional sampling. A summary report that includes all sampling results will also be prepared as presented in the Revised Vapor Intrusion Verification Work Plan (ARCADIS, Inc. 2010a).

2. Site Background

2.1 Conceptual Site Model

The Conceptual Site Model (CSM), the updated human health risk assessment, the interim measures completed to date, and the final recommended site-wide corrective measures were presented in the 2008 CMP and 2010 CMP Addendum (ARCADIS, Inc. 2008 and 2010b). The CSM will be further updated to incorporate the findings of the vapor intrusion sampling presented in this Revised Work Plan.

A preliminary update to the CSM for the neighborhood southwest of the Site has been prepared that includes the soil-gas sampling results.

2.1.1 Groundwater

The neighborhood to the southwest is located hydraulically downgradient of the Site. Groundwater beneath the neighborhood was encountered at depths ranging from 21 to 23.5 feet below land surface during the drilling portion of the October 2010 vapor intrusion verification investigation. In general, groundwater flows northeast to southwest within the upper aquifer toward the Great Miami River. A detailed discussion of groundwater flow directions are located in Section 2.2.1 of the Site-Wide Groundwater Monitoring Report for 2009 (ARCADIS, Inc. 2010c), groundwater flow direction for the upper aquifer is provided in a potentiometric map on Figure 6 in that report.

Using hydraulic gradients collected during a site-wide groundwater monitoring event from November 2009, groundwater flow velocities in the upper aquifer ranged from 2.37 feet/day to 3.94 feet/day. Assuming the most extreme condition (i.e., no retardation or retardation factor [Rd] equal to 0), the rate of VOC migration could equal the rate of groundwater flow (ARCADIS, Inc. 2010c).

2.1.2 Constituents of Concern

Site-related constituents of concern (COCs) related to the vapor intrusion pathway are present at the water table within the upper aquifer. The COCs associated with the site include the following: 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), PCE, 1,1,1- trichloroethane (1,1,1-TCA), TCE, vinyl chloride, benzene, toluene, ethylbenzene, and xylenes (BTEX). These constituents were also detected in soil-gas during the first phase of the vapor intrusion verification investigation (ARCADIS, Inc. 2010a).

Sources of the COCs present in the upper aquifer are from historic waste management practices and spills at the former Delphi Thermal Moraine, former Moraine Engine, and former Moraine Assembly facilities (Site). The primary sources of COCs at the Site are the Former Oil House Area (Area of Interest [AOI] 7) and the Former Moraine Assembly Process Waste Collection Systems (AOI 26). A detailed discussion of these source areas is located in the CMP submitted to the U.S. EPA on August 25, 2008 (ARCADIS, Inc. 2008) in Sections 3.4.4.1 and 3.8.1.3, respectively. A discussion of the nature and extent of site-specific COCs in groundwater is provided in Section 3.8 of the CMP.

The sub-slab and indoor air sampling event will include a focused list of site-specific VOCs including PCE, TCE, 1,1-DCA, 1,1-DCE, 1,1,1-TCA, trans-1,2-DCE, cis-1,2-DCE, and vinyl chloride.

2.1.3 Geology

The lithology and stratigraphic features for the Site and surrounding areas are discussed in the CMP (ARCADIS, Inc. 2008) in Section 3.8.2 and displayed in cross-sections on Figure 5 of the CMP. The subsurface geology of the neighborhood southwest of the Site consists of an upper and lower aquifer comprised of outwash sand-and-gravel, a regional clay till separates the two aquifers. The shallow geology underlying the neighborhood southwest of the Site consists of silty sands and sand with gravel. These soils are not expected to limit the movement of vapors from underlying groundwater into soil gas.

2.1.4 Vapor Intrusion Pathways

A comparison of the soil-gas sample results to the generic screening levels for soil-gas at the water table indicated that all soil-gas constituent concentrations were below screening levels with exception of PCE and TCE. These results indicate that VOCs may potentially migrate from the groundwater table and volatilize upward through the soil matrix into overlying structures. Under these conditions, there is a potential for exposure of off-site receptors to VOCs via inhalation of indoor air in their home or workplace. This potentially complete exposure pathway is presented in Figure 3 and will be assessed for each of the selected buildings.

2.2 Soil-Gas Sampling Results

A preliminary evaluation of the information collected as part of the Revised Vapor Intrusion Verification Work Plan scope is provided below. A summary report will be submitted to the U.S. EPA as described in the Revised Vapor Intrusion Verification Work Plan. The soil-gas and groundwater laboratory data reports were submitted to the U.S. EPA via electronic mail "MLC Moraine - Soil-Gas Results from the Vapor Intrusion Verification Investigation" on November 30, 2010.

Soil-gas samples and groundwater table samples were collected from eight locations in the right-of-way (between the sidewalk and the street) within the neighborhood to the southwest of the Site from November 9 through 11, 2010. In addition, soil-gas and groundwater samples were also collected from three locations along the eastern boundary of the Site and one location at the City of Moraine municipal building. The soil-gas results along the eastern boundary of the Site and the City of Moraine municipal building were all below U.S. EPA generic screening levels for soil-gas at the water table (U.S. EPA, 2002). The detailed summary for these four locations will be provided in a subsequent report as discussed in the Revised Vapor Intrusion Verification Work Plan (ARCADIS, Inc. 2010a).

A comparison of the soil-gas sample results to the generic screening levels for soil-gas at the water table indicated that all soil-gas constituent concentrations were below screening levels with exception of PCE and TCE. Non-chlorinated compounds from the Site (benzene, ethylbenzene, toluene, and xylene) were found to not be risk-based drivers. The soil-gas concentrations decrease significantly (attenuate) moving away from the groundwater source. A discussion of groundwater table and soil-gas analytical results collected from sampling locations in the southwest neighborhood during the first phase of the vapor intrusion verification investigation are presented in the following sections.

The groundwater sample results for the neighborhood southwest of the Site are presented in Table 2 and on Figure 4. At each soil-gas location, sample points were installed at three discreet intervals; approximately 6, 11 and 15.5 (2 feet above the maximum groundwater table elevation) feet below land surface. Sample results were compared to U.S. EPA generic screening levels (U.S. EPA, 2002). Long-term screening levels for soil-gas at the water table are based on a target risk level of 1×10^{-5} for potential carcinogenic constituents and a hazard index of 1 for non-carcinogenic constituents, with the exception of PCE and TCE. The long-term screening levels for PCE and TCE were revised by using the California EPA's inhalation unit risk factors as recommended by U.S. EPA (CEPA, 2010 and U.S. EPA, 2010) in the Regional Screening Level (RSL) tables. An attenuation factor of 0.01 was then applied to calculate the long-term screening level for soil-gas at the water table from the residential indoor air RSL.

The soil-gas sample results are presented in Table 3 and on Figures 5 and 6. A comparison of the soil-gas sample results to the generic screening levels for soil-gas at the water table is provided in Table 3. All soil-gas constituent concentrations were below screening levels with exception of PCE and TCE. PCE concentrations ranged from <7.6B (method blank detection) to 38,000 micrograms per cubic meter (µg/m^3) and exceeded the generic screening level (410 µg/m^3) in 18 out of 24 soil-gas samples (Table 3). TCE concentrations ranged from <6.0B (method blank detection) to 16,000 µg/m^3 and exceeded the generic screening level (1,200 µg/m^3) in 9 out of 24 samples (Table 3).

Although PCE and TCE in soil-gas exceed conservative, generic screening values, the data do demonstrate that concentrations decrease significantly (attenuate) moving away from the groundwater source. To fully evaluate the decline in concentrations through the subsurface, attenuation factors were calculated for all soil-gas samples as the ratio of the results at the shallow and deeper depths. The attenuation factor represents the rate of degradation in soil-gas as the constituent, in this case PCE or TCE, migrates away from source (groundwater) to shallower subsurface materials. Table 4 presents the calculated (at an interval of 5 feet or greater) attenuation factors for soil-gas for PCE and TCE. Overall, attenuation factors are highly consistent throughout all sample locations and between sample depths (Table 4). The average attenuation factors were calculated to be 0.39 and 0.31 for PCE and TCE, respectively. Understanding attenuation factors refines the conceptual site model for the area and aids in further understanding the potential for soil-gas movement. Consistent attenuation of soil-gas concentrations is seen when subsurface materials are generally homogeneous with limited variability by depth or location. The resulting data also indicates that preferential pathways are not present in the area.

Based on the above preliminary analysis, PCE and TCE are the only two constituents with exceedances above the generic screening levels for soil-gas at the water table. However, as a conservative measure sub-slab, crawl space, indoor air, and ambient air samples will be analyzed for a focused list of VOCs including PCE and TCE and their degradation products; trans-1,2-DCE, cis-1,2-DCE, and vinyl chloride. The focused list of VOCs will also include 1,1,1-TCA, 1,1-DCA and 1,1-DCE.

2.3 Sub-Slab and Indoor Air Sampling Objectives

Although the objective of the soil-gas investigation was to use the data to aid in the selection of homes for sub-slab soil-gas and indoor air sampling, the soil-gas data results indicate that sub-slab soil-gas and indoor air sampling should be conducted at all residential homes in the neighborhood to the southwest of the Site. Therefore, access will be requested from all residential property owners, the church property owner, and the gas station property owner in the neighborhood to the southwest of the Site to sample sub-slab soil-gas, crawl space air, indoor air, and ambient air. An outreach program to communicate soil-gas sampling results and request property access to collect samples will be developed as described in Section 4, prior to implementation of this Revised Work Plan.

The overall objective of this Revised Work Plan is to collect sub-slab soil-gas, crawl space air, indoor air, and ambient air samples for evaluating the vapor intrusion pathway. The specific objectives are:

- Sample sub-slab soil-gas or crawl space air in residential structures, a gas station, and a church to evaluate the presence of the focused list of VOCs including 1,1-DCA, 1,1-DCE, trans-1,2-DCE, 1,1,1-TCA, cis-1,2-DCE, PCE, TCE, and vinyl chloride.

- Sample indoor air in basements or the first living space level if the structure is built on a slab-on-grade or has a crawl space to evaluate the presence of the focused list of VOCs including 1,1-DCA, 1,1-DCE, trans-1,2-DCE, 1,1,1-TCA, cis-1,2-DCE, PCE, TCE, and vinyl chloride.

- Determine if constituents detected in indoor air are related to outdoor air through the collection of ambient air samples.

An optimum time in the year to collect sub-slab and indoor air samples is when the groundwater elevation is relatively high and during the heating season, these conditions have the potential to exhibit the relative highest concentrations of the focused VOC list. Groundwater elevations from a monitoring well and total precipitation data managed by the Miami Conservancy District (MCD) and surface water elevations from the United States Geological Survey (USGS) stream gage 031271500 located in Miamisburg, Ohio (approximately 6 miles south of the Site) were analyzed for the years 2006 through 2010. This data was used to evaluate the monthly levels for each year to assess when groundwater elevations were at the maximum level. In this analysis, groundwater elevations were at maximum levels in late winter to early spring with peak levels observed most frequently in March. Therefore, based on the previous five years of data, groundwater elevations are at maximum levels in the early spring and it is during the heating season which supports the plan to conduct testing of sub-slab and indoor air during the month of March. The data is graphically displayed on Figure 7.

2.4 Neighborhood Southwest of the Site

The southwest neighborhood consists of 60 residential structures on 78 residential parcels. Additional properties within the neighborhood include a church located at 3001 Lakehurst Court, and an active gas station/service shop located at 2901 Sellars/Main Street. The church structure and the convenience store section of the gas station will be added to the sampling program for this Revised Work Plan. Prior to beginning sampling, the church will be evaluated to understand if sensitive populations (i.e. child care center) use the facility on a regular basis. In the event that sensitive populations use the building, data will be compared to residential screening levels; should no sensitive populations be present, data will be compared to commercial screening levels. Sample results from the gas station will be compared to commercial screening levels.

Data from the Montgomery County Auditor website was used to provide a comprehensive list of properties in the neighborhood to include structure details such as partial basements, full basements, crawl spaces or slab-on-grade construction (Table 1 and Figure 2).

3. Sub-Slab, Indoor Air, and Ambient Air Sampling Work Plan

This section presents the approach for conducting building surveys in each structure as well as the methodology for sampling sub-slab soil-gas, and indoor air, and ambient air.

3.1 Structure Reconnaissance

MLC will obtain a signed access agreement prior to entering any building (Appendix A). In addition, prior to sampling a copy of Instructions for Occupants during Indoor Air Sampling Events (Appendix B) will be provided to the building occupant. Once access is granted, a site reconnaissance will be coordinated with the property owner. The overall goal of the site reconnaissance is to complete a building survey that identifies the building and foundation condition, building materials, heating, ventilation, and air conditioning (HVAC) operation, and any preferential vapor migration pathways (i.e. sump pump). In addition, a product inventory will be completed to list all products that are stored or used within the structure. Any products that contain VOCs will be requested to be removed from the occupied structure 48 hours prior to sampling (Appendix B). A copy of the building survey and product inventory form is provided as an attachment to Standard Operating Procedure (SOP) 22 (Indoor Air Sampling) in Appendix C. This attachment was prepared in accordance with the Vapor Intrusion Conceptual Site Model Checklist presented in the Ohio EPA Sample Collection and Evaluation of Vapor Intrusion to Indoor Air Guidance Document (Ohio EPA, 2010).

During the structure reconnaissance, scheduling of the sampling activities will be arranged and confirmed with the property owner/resident and an explanation of the sampling activities provided, if necessary.

3.2 Sample Locations

All sample locations will be finalized with the home or building owner during the site reconnaissance and prior to sampling. Three foundation construction types are expected to be encountered (Figure 8) in buildings in the neighborhood. The foundation construction and size of the structure will determine the type and location of the sub-slab soil-gas samples to be collected. In general, buildings less than 1,000 square feet will have one sub-slab soil-gas sample collected. Buildings between 1,000 and 1,100 square feet will have one or two sub-slab soil-gas samples collected, based on a case-by-case analysis of the building construction. Buildings over 1,100 square feet will have two sub-slab soil-gas samples collected. Specific samples to be collected in each home or commercial building are presented in Table 1. Building construction will influence sampling as follows:

- Basement (full or partial) construction: One or two sub-slab soil-gas sample(s) and one basement indoor air sample will be collected.
- Slab-on-grade construction: One or two sub-slab soil-gas sample(s) and one first floor indoor air sample will be collected.
- Crawl space construction: One crawl space air sample and one first floor indoor air sample will be collected.

Based on square footage, sub-slab soil-gas samples will be collected from two locations in the church and one or two locations (depending on square footage) in the convenience store section of the gas station. One indoor air sample will be collected from the church and the convenience store section of the gas station.

Sub-slab soil-gas and indoor air samples will be collected as close as possible to the center of each building/home. Actual sampling locations are expected to be adjusted with information from the structure reconnaissance and input from the property owner. This includes utilities that may be present beneath the structure, in a crawl space, or underneath the slab. The structure reconnaissance will include notifying the Ohio Utility Protection Service (OUPS).

3.3 Sub-Slab Soil-Gas Sampling

All sub-slab soil-gas samples will be collected from permanent soil-gas sampling points installed as detailed in SOP 20 (Appendix C). Construction of the sub-slab soil-gas sampling point is illustrated in Figure 8. A helium leak test will be completed prior to sampling to verify the seal of the sample point. If the seal is compromised, the sample point will be re-sealed until the helium leak test passes (SOP 21, Appendix C).

Sub-slab soil-gas samples will be collected using 1-liter SUMMA® canisters with attached pre-set flow regulators. A total of three volumes of air (open space of tubing and sample point) will be purged into a Tedlar® bag prior to sampling with a flow rate not exceeding 50 milliliters per minute. Flow regulators will be pre-set by the laboratory to provide uniform sample collection over a 30-minute sampling period. The valve on the SUMMA® canister will be closed when approximately 5 inches of mercury (in of Hg) vacuum remains in the canister, leaving a vacuum in the canister as a means for the laboratory to verify the canister does not leak while in transit. Samples will be submitted under chain-of-custody protocols to Air Toxics located in Folsom, California (Air Toxics) for laboratory analysis of focused list of VOCs including 1,1-DCA, 1,1-DCE, trans-1,2-DCE, 1,1,1-TCA, cis-1,2-DCE, PCE, TCE, and vinyl chloride in accordance with U.S. EPA Method TO-15 using standard detection limits (see Section 5).

3.4 Indoor Air Sampling

Indoor air samples will be collected in accordance with SOP 22 (Appendix C). As stated above, one indoor air sample will be collected at breathing height (4 to 5 feet) in the basement (if present) or first floor of each occupied structure with the location dependent on the structure and site reconnaissance (see Section 3.2). If the structure has a crawl space, indoor air samples will be collected within the crawl space and the first floor of the structure.

Indoor air samples will be collected using 6-liter SUMMA® canisters with attached pre-set flow regulators. Flow regulators for indoor air sampling will be pre-set by the laboratory to provide uniform sample collection over a 24-hour sampling period. The SUMMA® canister should be checked, if possible, at least once during the 24-hour sampling process and the progress noted on the sampling log. The valve on the SUMMA® canister will be closed when approximately 5 in of Hg vacuum remains in the canister or when the sample duration is complete (e.g., 24 hours), leaving a vacuum in the canister as a means for the laboratory to verify the canister does not leak while in transit. Samples will be submitted under chain of custody protocols to Air Toxics for laboratory analysis of focused list of VOCs including 1,1-DCA, 1,1-DCE, trans-1,2-DCE, 1,1,1-TCA, cis-1,2-DCE, PCE, TCE, and vinyl chloride in accordance with U.S. EPA Method TO-15 using low-level detection limits (see Section 5).

3.5 Ambient Air Sampling

Ambient air samples will be collected in accordance with SOP 22 (Appendix C). Ambient air samples will be collected during each day that indoor air samples are collected. Similar to indoor air samples, ambient samples will be collected at breathing height (4 to 5 feet) in a location upwind of the neighborhood southwest of the Site on a given day. Should multiple indoor air samples be collected, one ambient sample will be considered representative of the day of sampling. The wind direction will be determined each day and the sample canister will be placed accordingly. Ambient air samples will be collected over the same 24-hour sampling period as indoor air samples.

Ambient air samples will be collected using 6-liter SUMMA® canisters with attached pre-set flow regulators. Flow regulators for ambient air sampling will be pre-set by the laboratory to provide uniform sample collection over a 24-hour sampling period. The SUMMA® canister should be checked, if possible, at least once during the 24-hour sampling process and the progress noted on the sampling log. The valve on the SUMMA® canister will be closed when approximately 5 in of Hg vacuum remains in the canister or when the sample duration is complete (e.g., 24 hours), leaving a vacuum in the canister as a means for the laboratory to verify the canister does not leak while in transit. Samples will be submitted under chain of custody protocols to Air Toxics for laboratory analysis of focused list of VOCs including 1,1-DCA, 1,1-DCE, trans-1,2-DCE, 1,1,1-TCA, cis-1,2-DCE, PCE, TCE, and vinyl chloride in accordance with U.S. EPA Method TO-15 using low-level detection limits (see Section 5).

4. Reporting and Schedule

Implementation of this work is contingent upon securing entry with an access agreement between MLC and the property owner (Appendix A). This work and outreach program will be conducted in complete coordination with the U.S. EPA. If delays are encountered because access cannot be secured, the U.S. EPA will be notified. Residents will be approached individually during a “door-knocking” event if an access agreement has not been received. During this event, project personnel will greet home owners and present them with an access agreement.

At each residence within the neighborhood, sampling is expected to be conducted over a 3 day period; these 3 days may not be consecutive based on building access. On the first day permanent sub-slab soil-gas sample ports will be installed as outlined in Section 3.3 concurrent with the completion of a building survey. After waiting a minimum of 24 hours (48 hours if VOC containing materials were required to be removed), an indoor air sample will be collected as outlined in Section 3.4 (day 2). At the completion of the indoor air sample, the sub-slab soil-gas sample will be collected and the sample program completed (day 3).

Documentation of all field activities (e.g., pre-sampling reconnaissance and sampling logs) will be implemented. Specifically, if allowed by the property owner and/or residents and in accordance with any restrictions posed by an access agreement, the field sampling team will record or document the information presented in SOP 20 and SOP 22 (Appendix C).

Following receipt of the laboratory analytical results, a decision analysis will be conducted to evaluate the potential for vapor intrusion and recommendations for additional evaluation or mitigation, if necessary. Each building will be evaluated on a case-by-case basis considering the indoor air and sub-slab soil-gas results and applicable screening levels. The decision matrices in Table 5 (residential) and Table 6 (commercial) present potential future actions including confirmatory sampling, “worst case” confirmatory sampling, and mitigation. The “worst case” confirmation sampling will be determined in consultation with the U.S. EPA and will consider the depth to water, weather, heating season, and other factors. Upon completion of the sub-slab and indoor air sampling, a data package containing the analytical results will be presented to the U.S. EPA. A summary report will be submitted to the U.S. EPA that will include:

- A summary of the scope implementation of this Revised Work Plan;

- A summary of all sub-slab soil-gas, ambient air, and indoor air sampling results;

- A comparison of constituents detected in sub-slab soil-gas and indoor air to the screening levels for focused list of VOCs including 1,1-DCA, 1,1-DCE, trans-1,2-DCE, 1,1,1-TCA, cis-1,2-DCE, PCE, TCE, and vinyl chloride (Table 7); and

- A copy of all building survey forms, product inventories, sample collection logs, access agreements, and other field notes.

5. Data Quality Objectives

Sub-slab soil-gas, ambient air, and indoor air samples will be submitted to Air Toxics Limited in Folsom, California. Air Toxics is certified in the National Environmental Laboratory Accreditation Program (NELAP). Air Toxics' primary NELAP certification number as issued by the Florida Department of Health is E87680. Air Toxics provides a quality assurance section on their website (http://www.airtoxics.com/cinfo/qc.html) and also has a laboratory quality assurance program (refer to Appendix D of the Revised Vapor Intrusion Verification Work Plan). Specific Air Toxics SOPs that will be utilized during sub-slab and indoor air sampling are as follows:

- U.S. EPA method TO-15: SOP #6-Revision 25, 6/27/2010,
- Canister cleaning and preparation: SOP #7-Revision 25, 8/20/2009, and
- Flow controller preparation: SOP #70-Revision 6, 6/27/2010.

Air Toxics Laboratory's SOPs are proprietary and are not available for public distribution. If requested, Air Toxics Laboratory would make this SOP available to the EPA with a non-disclosure agreement for access via a secure Web Portal. Please contact Ausha Scott with Air Toxics Laboratory for more information (916-605-3344).

Table D-1 summarizes the quality control (QC) samples to be collected for sub-slab soil-gas, ambient air, and indoor air samples and Table D-2 presents the reporting quantitation limits for the focused list of Site related chlorinated VOCs for both standard and low level analysis using U.S. EPA Method TO-15 (Appendix D). Each sub-slab soil-gas sample collected (standard analysis) will be in a batch certified 1L SUMMA® canister provided and analyzed by Air Toxics. Each sample collected for indoor air or ambient air analysis (low-level analysis) will be in an individually certified 6 L SUMMA® canister provided and analyzed by Air Toxics. Flow controllers are cleaned, inspected, and set by the analytical laboratory prior to the sampling event.

Documentation on completion of certification for canisters and cleaning procedures for flow controllers/regulators will be obtained from Air Toxics and will be included in the summary report. During sampling, the duration of sampling will be monitored to ensure the flow controllers are working properly. All SUMMA® canisters received from Air Toxics will be checked for correct vacuum. The vacuum gauges provided by the analytical laboratory as part of the sample train (i.e., canister and flow controller) are used to record the initial and final vacuums in the air sampling canister. Pre-sampling vacuum in the canister should be between -30 in of Hg and -25 in of Hg. In the event a canister is not within this initial range, it will be rejected and a new canister and flow controller will be used. The initial vacuum will be similarly checked on the replacement equipment. Additional quality assurance/quality control (QA/QC) samples (duplicates – 1 per 10 samples) will be collected for sub-slab soil-gas, ambient air, and indoor air samples. The laboratory analytical results will be validated per the Amended Quality Assurance Project Plan (ARCADIS, Inc. 2010d).

6. References

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ARCADIS, Inc., 2010a. Revised Vapor Intrusion Verification Work Plan, Motors Liquidation Company, Moraine, Ohio. September 16, 2010.

ARCADIS, Inc. 2010b. Draft Corrective Measures Proposal Addendum, Motors Liquidation Company, Moraine, Ohio. March 22, 2010.

ARCADIS, Inc., 2010c. Site-Wide Groundwater Monitoring Report for 2009, Motors Liquidation Company, Moraine, Ohio. February 26, 2010.

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United States Environmental Protection Agency (U.S. EPA), 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils.

United States Environmental Protection Agency (U.S. EPA), 2010. Re: Vapor Intrusion Verification Work Plan; Motors Liquidation Company – Former Delphi Harrison Thermal Systems (OHD 000 817 577), Former Moraine Engine Plant (OHD 980 569 388), and Former Moraine Assembly Plant (OHD 041 063 074). June 1, 2010.

Table 1. Property Information Details for Neighborhood Located Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

Parcel ID Number	Owner	Addresses	Acres	Basement/ Crawl Space	Year Built	Square Footage	Number of Proposed Sub-Slab Points	No. of Rooms	No. of Floors	Land Use
J441210060001	[redacted]	3005 Old Sellars Road	0.1212	Crawl	1942	780	N/A[1]	5	1	Residential
J441210060002			0.1136							
J441210060003		3009 Old Sellars Road	0.1136	Full	1942	989	1	5	1	Residential
J441210060004		3013 Old Sellars Road	0.1136	None	1942	1728	2	8	2	Residential
J441210060005		3017 Old Sellars Road	0.1136	Crawl	1967	1008	N/A[1]	5	1	Residential
J441210060006		3021 Old Sellars Road	0.1136	None	1937	1200	2	5	2	Residential
J441210060007			0.079							
J441210060024		3022 Lakehurst	0.1061	Full	1957	780	1	5	1	Residential
J441210060025										
J441210060026		3020 Lakehurst	0.1061	Part	1943	720	1	4	1	Residential
J441210060027		3018 Lakehurst	0.1061	Part	1942	945	1	4	1	Residential
J441210060028		3016 Lakehurst	0.1061	Crawl	1967	1404	N/A[1]	7	1	Residential
J441210060029		3010 Lakehurst	0.1061	Crawl	1968	1008	N/A[1]	5	1	Residential
J441210060030		3000 Lakehurst	0.1061	Full	1942	897	1	5	1	Residential
J441210060031			0.0985							
J441210060032		2920 Lakehurst	0.146	Part	1940	1296	2	7	1.5	Residential
J441210060033		2916 Lakehurst	0.1229	Part	1944	528	1	4	1	Residential
J441210060034		2912 Lakehurst	0.1212	Full	1942	997	1	4	1	Residential
J441210060035		2908 Lakehurst	0.1858	Crawl	1925	816	N/A[1]	4	1	Residential
J441210060042		2909 Sellars Road	0.2314	None	1937	1095	2	5	1	Residential
J441210060044		2917 Old Sellars	0.1157	Full	1939	840	1	5	1	Residential
J441210060045		2921 Old Sellars	0.1157	Full	1933	1072	2	6	1	Residential
J441210060046			0.1074							
J441210060041		2901 Dryden Rd./Main	0.1157	None	Various	960	2	N/A	1	Commercial
J441210060056			0.2925			9000		N/A	1	
J441210060057			0.352			3120		N/A	1	
J441210060058		2900 Lakehurst	0.186			3024		N/A	1	
J441210070001		2924 Telhurst	0.1377	Part	1940	1080	1	5	1	Residential
J441210070002			0.124							
J441210070003		2916 Telhurst	0.124	Full	1944	874	1	6	1	Residential
J441210070004		2912 Telhurst	0.124	Full	1944	1159	2	6	1	Residential
J441210070005		2908 Telhurst	0.124	Crawl	1935	1210	N/A[1]	5	1	Residential
J441210070006			0.0634	None	1960	480	1	1	1	Residential
J441210070007		2900 Telhurst	0.1295	Part	1910	1174	2	6	1	Residential
J441210070021			0.0909							
J441210070008		2925 Lakehurst	0.1405	Crawl	1945	1180	N/A[1]	6	1	Residential
J441210070009		2921 Lakehurst	0.1157	None	1950	720	1	4	1	Residential

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Table 1. Property Information Details for Neighborhood Located Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

Parcel ID Number	Owner	Addresses	Acres	Basement/ Crawl Space	Year Built	Square Footage	Number of Proposed Sub-Slab Points	No. of Rooms	No. of Floors	Land Use
J441210070010	[redacted]	2917 Lakehurst	0.1157	None	1940	720	1	5	1	Residential
J441210070011	[redacted]	2913 Lakehurst	0.1157	Part	1942	1022	1	5	1	Residential
J441210070012 J441210070013	[redacted]	2905 Lakehurst	0.1157	Part	1939	1208	2	6	1	Residential
J441210070014	[redacted]	2901 Lakehurst	0.146	Crawl	1942	1085	N/A[1]	6	1	Residential
J441210070015 J441210070016	[redacted]	3413 Dryden Road	0.1056	Part	1940	1078	1	5	1	Residential
J441210070017 J441210070018	[redacted]	3409 Dryden	0.1056	Crawl	1940	720	N/A[1]	5	1	Residential
J441210070019 J441210070020	[redacted]	3401 Dryden	0.1056	Crawl	1935	1924	N/A[1]	6	2	Residential
J441210080001	[redacted]	2925 Telhurst	0.1736	None	1971	909	1	5	1	Residential
J441210080002	[redacted]	2921 Telhurst	0.124	None	1971	962	1	5	1	Residential
J441210080003	[redacted]	2913 Telhurst	0.2479	Part	1971	1272	2	6	1	Residential
J441210080005	[redacted]	2909 Telhurst	0.124	Crawl	1948	1008	N/A[1]	6	1	Residential
J441210080006	[redacted]	2905 Telhurst	0.124	Crawl	1948	700	N/A[1]	4	1	Residential
J441210080007	[redacted]	2901 Telhurst	0.1295	None	1953	912	1	5	1	Residential
J441210080008 J441210080009 J441210080010	[redacted]	3391 Dryden Road	0.1148	None	1944	806	1	5	1	Residential
J441210080014	[redacted]	2900 Hoylake	0.1488	Full	1950	1092	2	5	1	Residential
J441210080015	[redacted]	2904 Hoylake	0.1157	Full	1950	956	1	5	1	Residential
J441210080016	[redacted]	2908 Hoylake	0.1157	Crawl	1954	800	N/A[1]	4	1	Residential
J441210080017	[redacted]	2912 Hoylake	0.1157	Crawl	1950	576	N/A[1]	4	1	Residential
J441210080018	[redacted]	2916 Hoylake	0.1157	None	1950	1690	2	6	1	Residential
J441210080019 J441210080020	[redacted]	2924 Hoylake	0.1157	Part	1950	996	1	6	1	Residential
J441210080021	[redacted]	2928 Hoylake	0.135	Part	1956	1152	2	6	1.5	Residential
J441210080022	[redacted]	3001 Telhurst	0.1488	Crawl	1949	876	N/A[1]	6	1	Residential
J441210080023 J441210080024	[redacted]	3005 Telhurst	0.1157	Part	1948	982	1	5	1	Residential
J441210080025	[redacted]	3009 Telhurst	0.1157	Part	1957	760	1	5	1	Residential
J441210080026	[redacted]	3013 Telhurst	0.1157	Crawl	1947	870	N/A[1]	4	1	Residential
J441210080027 J441210080028	[redacted]	3015 Telhurst	0.1157	Crawl	1947	624	N/A[1]	4	1	Residential
J441210080049	[redacted]	3020 Hoylake	0.124	Crawl	1973	912	N/A[1]	5	1	Residential
J441210080050	[redacted]	3018 Hoylake	0.124	Crawl	1973	912	N/A[1]	5	1	Residential

Table 1. Property Information Details for Neighborhood Located Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

Parcel ID Number	Owner	Addresses	Acres	Basement/ Crawl Space	Year Built	Square Footage	Number of Proposed Sub-Slab Points	No. of Rooms	No. of Floors	Land Use
J441210080051	[redacted]	3016 Hoylake	0.124	Full	1947	672	1	4	1	Residential
J441210080052		3012 Hoylake	0.1157	Crawl	1947	640	N/A[1]	4	1	Residential
J441210080053		3008 Hoylake	0.1157	Crawl	1947	1016	N/A[1]	6	1	Residential
J441210080054			0.124							
J441210080055		3000 Hoylake	0.1185	Crawl	1953	528	N/A[1]	4	1	Residential
J441210090014		3012 Telhurst	0.2287	Part	1963	1380	2	6	1	Residential
J441210090015		3006 Telhurst	0.2287	Part	1963	1380	2	6	1	Residential
J441210090001		3001 Lakehurst	0.2369	None	Not available	1755	2	1	1	Commercial
J441210090002			0.4573							
J441210090016			0.2204							
J441282230001		3901 Dryden Road	0.3444	None	Not available	1216	2	6	1	Residential

ID - Identification.
Parcel IDs, addresses, owners, and acreage found on Montgomery County Auditors web site (www.mcauditor.org.).
No. - Number
Crawl - Crawl space underneath structure.
Part - Partial basement underneath structure.
Full - Full basement underneath structure.
None - No sub-grade construction underneath structure.
N/A - Not applicable.
1 - Sub-slab points are not installed in a crawl space.

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Table 2. Summary of Groundwater Table Sampling Results from Neighborhood Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

	Units	SGP-1 10/26/2010	SGP-2 10/25/2010	SGP-3 10/20/2010	SGP-4 10/22/2010	SGP-5 10/29/2010	SGP-6 10/28/2010	SGP-7 10/21/2010	SGP-8 11/1/2010
Volatile Organic Compounds									
1,1,1-Trichloroethane	µg/L	<1.4	1.3 J	<1.0	<3.3	1.2 J	1.3 J	0.73 J	0.53 J
1,1-Dichloroethane	µg/L	0.92 J	0.96 J	<1.0	1.2 J	2.5 J	1.2 J	3.4	2.9
1,1-Dichloroethene	µg/L	<1.4	<4.0	<1.0	<3.3	<3.3	<2.5	<1.7	<1.4
Benzene	µg/L	<1.4	<4.0	<1.0	<3.3	<3.3	<2.5	<1.7	<1.4
cis-1,2-Dichloroethene	µg/L	2.8	1.9 J	0.44 J	1.7 J	8.2 J	2.5	8.1	4.5
Ethylbenzene	µg/L	<1.4	<4.0	<1.0	<3.3	<3.3	<2.5	<1.7	<1.4
Tetrachloroethene	µg/L	39 J	100	2.1	100	72	74	49	21
Toluene	µg/L	0.32 J	<4.0	<1.0	<3.3	<3.3	<2.5	0.32 J	<1.4
trans-1,2-Dichloroethene	µg/L	0.53 J	<4.0	<1.0	0.91 J	<3.3	0.53 J	<1.7	<1.4
Trichloroethene	µg/L	17	130	1.7	72	90	87	46	25
Vinyl chloride	µg/L	<1.4	<4.0	<1.0	<3.3	<3.3	<2.5	<1.7	<1.4
Xylene (m,p and o)	µg/L	<2.9	<8.0	<2.0	<6.7	<6.7	<5.0	<3.3	<2.9

µg/L - Micrograms per Liter.
< - Constituent not detected above laboratory reporting limit shown.
J - Value is estimated.

Table 3. Summary of Soil-Gas Sampling Results from Neighborhood Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

Volatile Organic Compounds	Units	Long -Term Screening Level Soil-Gas at Water Table (1)	SGP-1 11/10/2010 16 feet bls	SGP-1 11/10/2010 11 feet bls	SGP-1 11/10/2010 6 feet bls	SGP-2 11/11/2010 15.4 feet bls	SGP-2 11/11/2010 11 feet bls	SGP-2 11/11/2010 6 feet bls
1,1,1-Trichloroethane	µg/m³	220,000	23	13	10	260	140	77
1,1-Dichloroethane	µg/m³	50,000	6.8	2.3J	<4.9	82	26J	6.3J
1,1-Dichloroethene	µg/m³	20,000	<4.9	<4.8	<4.8	<64	<38	<13
Benzene	µg/m³	310	3.0J	1.3J	2.0J	<52	<31	8.9J
cis-1,2-Dichloroethene	µg/m³	3,500	8.6	<4.8	<4.8	54J	10J	2.3J
Ethylbenzene	µg/m³	2,200	1.9J	<5.3	2.2J	<70	<42	<14
Tetrachloroethene	µg/m³	410	2,400	970	370	38,000	21,000	5,700
Toluene	µg/m³	40,000	3.2J	1.8J	8.2	<61	<36	21
trans-1,2-Dichloroethene	µg/m³	7,000	12	4.9	<4.8	110	41	9.8J
Trichloroethene	µg/m³	1,200	620	250	86	16,000	6,800	2,000
Vinyl chloride	µg/m³	280	<3.1	<3.1	<3.1	<41	<25	<8.2
Xylenes (m,p and o)	µg/m³	700,000	3.2JB	<10.6	10	<140	<84	<28B

µg/m³ - Micrograms per cubic meter.

(1) These values are based on the "Generic Screening Levels" from Table 2b of the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (U.S. EPA 2002). For the constituents Tetrachloroethene and Trichloroethene, the Indoor Air screening levels were revised by applying EPA's current practice of employing the California EPA Inhalation Unit Risk Factors as the provisional inhalation cancer potency factors. The attenuation factor for Indoor Air to Soil-Gas at the Water Table is 0.01.

For Tetrachloroethene - the California EPA IUR is 5.9E-06 (ug/m^3)^-1

For Trichloroethene - the California EPA IUR is 2.0E-06 (ug/m^3)^-1

bls - Below land surface.

< - Constituent not detected above laboratory reporting limit shown.

J - Value is estimated.

B - Method blank detection.

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Table 3. Summary of Soil-Gas Sampling Results from Neighborhood Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

		Long -Term Screening Level Soil-Gas at Water Table (1)	SGP-3			SGP-4		
			11/9/2010			11/10/2010		
Volatile Organic Compounds	Units		16.26 feet bls	11 feet bls	6 feet bls	16.2 feet bls	11 feet bls	6 feet bls
1,1,1-Trichloroethane	$\mu g/m^3$	220,000	32	20	5.6J	40	18	11
1,1-Dichloroethane	$\mu g/m^3$	50,000	3.0J	<4.5	<4.6	<10	<6.3	<4.5
1,1-Dichloroethene	$\mu g/m^3$	20,000	<4.5	<4.4	<4.5	<9.8	<6.2	<4.4
Benzene	$\mu g/m^3$	310	0.98J	0.87J	<3.6	1.7J	<5.0	1.0J
cis-1,2-Dichloroethene	$\mu g/m^3$	3,500	<4.5	<4.4	<4.5	<9.8	<6.2	<4.4
Ethylbenzene	$\mu g/m^3$	2,200	<4.9	<4.9	2.8J	<11	<6.8	<4.8
Tetrachloroethene	$\mu g/m^3$	410	170	100	41	5,600	3,200	880
Toluene	$\mu g/m^3$	40,000	<4.2	1.0J	2.7J	<9.3	<5.8	4.8
trans-1,2-Dichloroethene	$\mu g/m^3$	7,000	1.8J	<4.4	<4.5	12	<6.2	<4.4
Trichloroethene	$\mu g/m^3$	1,200	120	70	8.8	1,200	600	180
Vinyl chloride	$\mu g/m^3$	280	<2.9	<2.9	<2.9	<6.3	<4.0	<2.8
Xylenes (m,p and o)	$\mu g/m^3$	700,000	<9.8	<9.8	17.2	<22	<13.6	<9.6

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

(1) These values are based on the "Generic Screening Levels" from Table 2b of the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (U.S. EPA 2002). For the constituents Tetrachloroethene and Trichloroethene, the Indoor Air screening levels were revised by applying EPA's current practice of employing the California EPA Inhalation Unit Risk Factors as the provisional inhalation cancer potency factors. The attenuation factor for Indoor Air to Soil-Gas at the Water Table is 0.01.

For Tetrachloroethene - the California EPA IUR is 5.9E-06 (ug/m^3)^-1
For Trichloroethene - the California EPA IUR is 2.0E-06 (ug/m^3)^-1
bls - Below land surface.
< - Constituent not detected above laboratory reporting limit shown.
J - Value is estimated.
B - Method blank detection.

Table 3. Summary of Soil-Gas Sampling Results from Neighborhood Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

		Long -Term Screening Level Soil-Gas at Water Table [(1)]	SGP-5			SGP-6		
			11/11/2010			11/11/2010		
Volatile Organic Compounds	**Units**		**14.8 feet bls**	**11 feet bls**	**6 feet bls**	**15 feet bls**	**11 feet bls**	**6 feet bls**
1,1,1-Trichloroethane	$\mu g/m^3$	220,000	340	180	0.87J	130	61	20
1,1-Dichloroethane	$\mu g/m^3$	50,000	120	34	<4.5	1.9J	<4.8	<4.7
1,1-Dichloroethene	$\mu g/m^3$	20,000	<47	<24	<4.4	<4.6	<4.7	<4.6
Benzene	$\mu g/m^3$	310	<38	5.8J	1.1J	4.2	<3.8	<3.7
cis-1,2-Dichloroethene	$\mu g/m^3$	3,500	140	31	<4.4	<4.6	<4.7	<4.6
Ethylbenzene	$\mu g/m^3$	2,200	<52	<26	<4.9	4.2J	0.64J	2.3J
Tetrachloroethene	$\mu g/m^3$	410	22,000	12,000	<7.6B	2,700	990	100
Toluene	$\mu g/m^3$	40,000	<45	7.3J	5.3	16	1.0J	16
trans-1,2-Dichloroethene	$\mu g/m^3$	7,000	<47	<24	<4.4	1.9J	<4.7	<4.6
Trichloroethene	$\mu g/m^3$	1,200	9,700	3,200	<6.0B	1,100	270	29
Vinyl chloride	$\mu g/m^3$	280	<30	<15	<2.9	<3.0	<3.0	<3.0
Xylenes (m,p and o)	$\mu g/m^3$	700,000	<104	<52	<9.8B	6.7J	<10.4B	9.3

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

[(1)] These values are based on the "Generic Screening Levels" from Table 2b of the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (U.S. EPA 2002). For the constituents Tetrachloroethene and Trichloroethene, the Indoor Air screening levels were revised by applying EPA's current practice of employing the California EPA Inhalation Unit Risk Factors as the provisional inhalation cancer potency factors. The attenuation factor for Indoor Air to Soil-Gas at the Water Table is 0.01.

For Tetrachloroethene - the California EPA IUR is 5.9E-06 (ug/m^3)^-1
For Trichloroethene - the California EPA IUR is 2.0E-06 (ug/m^3)^-1
bls - Below land surface.
< - Constituent not detected above laboratory reporting limit shown.
J - Value is estimated.
B - Method blank detection.

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Table 3. Summary of Soil-Gas Sampling Results from Neighborhood Southwest of Site, Motors Liquidation Company, Moraine, Ohio.

		Long -Term Screening Level Soil-Gas at Water Table	SGP-7			SGP-8		
			11/10/2010			11/11/2010		
Volatile Organic Compounds	**Units**		**15.65 feet bls**	**11 feet bls**	**6 feet bls**	**14.25 feet bls**	**11 feet bls**	**6 feet bls**
1,1,1-Trichloroethane	µg/m^3	220,000	73	56	12	290	210	82
1,1-Dichloroethane	µg/m^3	50,000	37	21	2.0J	210	79	4.4
1,1-Dichloroethene	µg/m^3	20,000	<9.3	<6.1	<4.6	<18	<12	<4.4
Benzene	µg/m^3	310	1.7J	1.8J	6.5	6.0J	4.9J	1.1J
cis-1,2-Dichloroethene	µg/m^3	3,500	15	7.0	<4.6	120	33	<4.4
Ethylbenzene	µg/m^3	2,200	<10	<6.7	19	<19	<13	<4.9
Tetrachloroethene	µg/m^3	410	4,800	3,400	710	11,000	5,800	1,600
Toluene	µg/m^3	40,000	<8.8	<5.8	25	<17B	<12B	1.2J
trans-1,2-Dichloroethene	µg/m^3	7,000	<9.3	<6.1	<4.6	<18	<12	<4.4
Trichloroethene	µg/m^3	1,200	1,700	1,000	160	3,600	1,600	260
Vinyl chloride	µg/m^3	280	<6.0	<3.9	<3.0	<11	<7.8	<2.9
Xylenes (m,p and o)	µg/m^3	700,000	<20	<13.4	80	<38	<26	<9.8

µg/m^3 - Micrograms per cubic meter.

(1) These values are based on the "Generic Screening Levels" from Table 2b of the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (U.S. EPA 2002). For the constituents Tetrachloroethene and Trichloroethene, the Indoor Air screening levels were revised by applying EPA's current practice of employing the California EPA Inhalation Unit Risk Factors as the provisional inhalation cancer potency factors. The attenuation factor for Indoor Air to Soil-Gas at the Water Table is 0.01.

For Tetrachloroethene - the California EPA IUR is 5.9E-06 (ug/m^3)^-1
For Trichloroethene - the California EPA IUR is 2.0E-06 (ug/m^3)^-1
bls - Below land surface.
< - Constituent not detected above laboratory reporting limit shown.
J - Value is estimated.
B - Method blank detection.

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Table 4. Attenuation Factors for PCE and TCE in Soil-Gas, Motors Liquidation Company, Moraine, Ohio.

Soil-Gas Sampling Point	Depth (ft bgs)	PCE		TCE	
		PCE (ug/m³)	Attenuation Factor	TCE (ug/m³)	Attenuation Factor
SGP-1	6	370	0.38	86	0.34
	11	970	0.40	250	0.40
	16	2,400	--	620	--
SGP-2	6	5,700	0.27	2,000	0.29
	11	21,000	0.55	6,800	0.43
	15.4	38,000	--	16,000	--
SGP-3	6	41	0.41	8.8	0.13
	11	100	0.59	70	0.58
	16.26	170	--	120	--
SGP-4	6	880	0.28	180	0.30
	11	3,200	0.57	600	0.50
	16.2	5,600	--	1,200	--
SGP-5	6	2.1	0.0002	2.6	0.0008
	11	12,000	0.55	3,200	0.33
	14.8	22,000	--	9,700	--
SGP-6	6	100	0.10	29	0.11
	11	990	0.37	270	0.25
	15	2,700	--	1,100	--
SGP-7	6	710	0.21	160	0.16
	11	3,400	0.71	1,000	0.59
	15.65	4,800	--	1,700	--
SGP-8	6	1,600	0.28	260	0.16
	11	5,800	0.53	1,600	0.44
	14.25	11,000	--	3,600	--
Average AF:			**0.39**		**0.31**

AF - attenuation factor calculated by dividing shallower interval by the lower interval.
ft bgs- feet below ground surface.
ug/m³ - micrograms per meter cubed.
-- not applicable.

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Table 5. Decision Matrix for Residential Sampling, Motors Liquidation Company, Moraine, Ohio.

Risk Levels and Action	Category 1 - No Further Action	Category 2 - Possible Background Source	Category 3 - Mitigation	Category 4 - Mitigation
Action Level	**Lesser than the risk levels of concern**	**Lesser than SS SC but higher than IA SC**	**Greater than SS SC but lesser than the IA SC**	**Greater than SS and IA SC**
SS CA Risk Level[a]	1×10^{-05}	1×10^{-05}	1×10^{-05}	1×10^{-05}
1,1-Dichloroethane	< 152	< 152	> 152	> 152
Trans-1,2-Dichloroethene	< 626	< 626	> 626	> 626
Tetrachloroethene	< 41.2	< 41.2	> 41.2	> 41.2
1,1,1-Trichloroethane	< 52100	< 52100	> 52100	> 52100
Trichloroethene	< 122	< 122	> 122	> 122
1,1–Dichloroethene	< 2090	< 2090	> 2090	> 2090
Cis–1,2–Dichloroethene	Not Available	Not Available	Not Available	Not Available
Vinyl Chloride	< 16	< 16	> 16	> 16
IA CA Risk Level[a]	1×10^{-05}	1×10^{-05}	1×10^{-05}	1×10^{-05}
1,1-Dichloroethane	< 15.2	> 15.2	< 15.2	> 15.2
Trans-1,2-Dichloroethene	< 62.6	> 62.6	< 62.6	> 62.6
Tetrachloroethene	< 4.1	> 4.1	< 4.1	> 4.1
1,1,1-Trichloroethane	< 5210	> 5210	< 5210	> 5210
Trichloroethene	< 12.2	> 12.2	< 12.2	> 12.2
1,1–Dichloroethene	< 209	> 209	< 209	> 209
Cis–1,2–Dichloroethene	Not Available	Not Available	Not Available	Not Available
Vinyl Chloride	< 1.6	> 1.6	< 1.6	> 1.6
Action	**Confirmatory sampling**	**Worst case confirmatory sampling[b]**	**Residence-specific mitigation based on discussion with owner**	

SS - Sub-slab soil gas.
IA - Indoor air.
SC - Screening criteria.
CA - Cancer risk.
Action levels based on May 2010 U.S. EPA Regional Screening Levels for air.
All action levels presented in micrograms per cubic meter (μg/m^3).
a - 1,1,1-Trichloroethane and Trans-1,2-Dichloroethene are non-carcinogen and their action level is based on a hazard quotient of 1.
b - The worst case confirmation sampling will be determined in consultation with the U.S. EPA and will consider the depth to water, weather, heating season, and other factors.

ARCADIS

Table 6. Decision Matrix for Commercial Sampling, Motors Liquidation Company, Moraine, Ohio.

Risk Levels and Action	Category 1 - No Further Action	Category 2 - Possible Background Source	Category 3 - Mitigation	Category 4 - Mitigation
Action Level	**Lesser than the risk levels of concern**	**Lesser than SS SC but higher than IA SC**	**Greater than SS SC but lesser than the IA SC**	**Greater than SS and IA SC**
SS CA Risk Level[(a)]	1×10^{-05}	1×10^{-05}	1×10^{-05}	1×10^{-05}
1,1-Dichloroethane	< 767	< 767	> 767	> 767
Trans-1,2-Dichloroethene	< 2630	< 2630	> 2630	> 2630
Tetrachloroethene	< 208	< 208	> 208	> 208
1,1,1-Trichloroethane	< 219000	< 219000	> 219000	> 219000
Trichloroethene	< 613	< 613	> 613	> 613
1,1–Dichloroethene	< 8760	< 8760	> 8760	> 8760
Cis–1,2–Dichloroethene	Not Available	Not Available	Not Available	Not Available
Vinyl Chloride	< 279	< 279	> 279	> 279
IA CA Risk Level[(a)]	1×10^{-05}	1×10^{-05}	1×10^{-05}	1×10^{-05}
1,1-Dichloroethane	< 76.7	> 76.7	< 76.7	> 76.7
Trans-1,2-Dichloroethene	< 263	> 263	< 263	> 263
Tetrachloroethene	< 20.8	> 20.8	< 20.8	> 20.8
1,1,1-Trichloroethane	< 21900	> 21900	< 21900	> 21900
Trichloroethene	< 61.3	> 61.3	< 61.3	> 61.3
1,1–Dichloroethene	< 876	> 876	< 876	> 876
Cis–1,2–Dichloroethene	Not Available	Not Available	Not Available	Not Available
Vinyl Chloride	< 27.9	> 27.9	< 27.9	> 27.9
Action	**Confirmatory sampling**	**Worst case confirmatory sampling[(b)]**	**Residence-specific mitigation based on discussion with owner**	

SS - Sub-slab soil gas.
IA - Indoor air.
SC - Screening criteria.
CA - Cancer risk.
Action levels based on May 2010 U.S. EPA Regional Screening Levels for air.
All action levels presented in micrograms per cubic meter ($\mu g/m^3$).
a - 1,1,1-Trichloroethane and Trans-1,2-Dichloroethene are non-carcinogen and their action level is based on a hazard quotient of 1.
b - The worst case confirmation sampling will be determined in consultation with the U.S. EPA and will consider the depth to water, weather, heating season, and other factors.

Table 7. Residential and Non-Residential Screening Levels for Sub-Slab Soil-Gas and Indoor Air, Motors Liquidation Company, Moraine, Ohio.

Chemical Constituent*	Residential Long-Term Screening Level		Non-Residential Long-Term Screening Level	
	Indoor Air[(a)] (ug/m^3)	Sub-Slab Soil-Gas[(b)] (ug/m^3)	Indoor Air[(a)] (ug/m^3)	Sub-Slab Soil-Gas[(b)] (ug/m^3)
1,1-Dichloroethane	15.2	152	76.7	767
Trans-1,2-Dichloroethene	62.6	626	263	2630
Tetrachloroethene	4.1	41.2	20.8	208
1,1,1-Trichloroethane	5,210	52,100	21,900	219,000
Trichloroethene	12.2	122	61.3	613
1,1–Dichloroethene	209	2,090	876	8,760
Cis–1,2–Dichloroethene	Not available	Not available	Not available	Not available
Vinyl Chloride	1.6	16	27.9	279

Action levels based on May 2010 U.S. EPA Regional Screening Levels for air.

ug/m^3 - Micrograms per cubic meter.

a - For Tetrachloroethene and Trichloroethene, the Indoor Air screening levels were revised by employing the California EPA Inhalation Unit Risk Factors as the provisional inhalation cancer potency factors and assuming a cancer risk level of 1×10^{-5}.

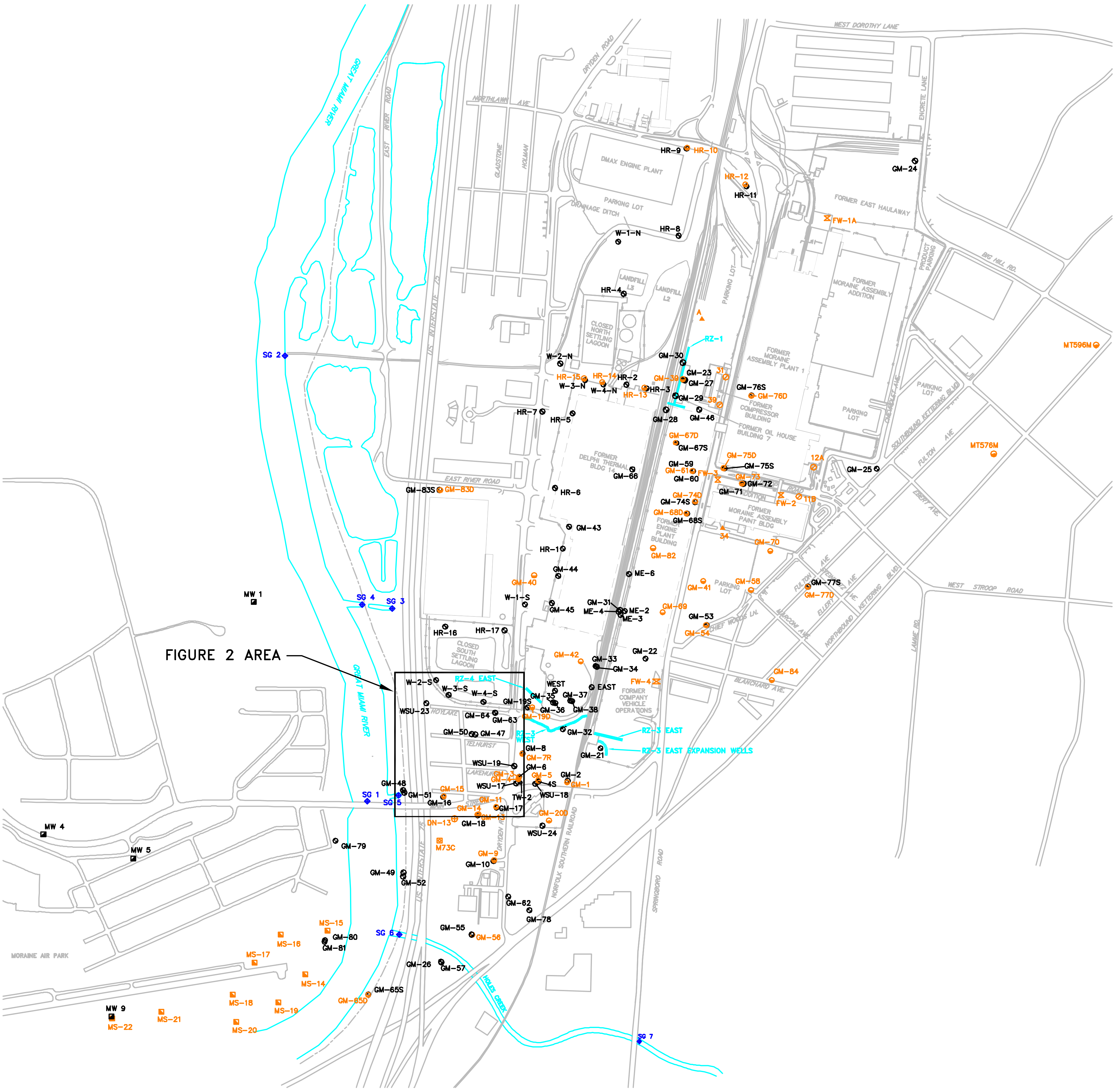
For Tetrachloroethene - the California EPA IUR is 5.9E-06 (ug/m^3)^-1.

For Trichloroethene - the California EPA IUR is 2.0E-06 (ug/m^3)^-1.

b - The Sub-Slab Soil-Gas Screening Levels are calculated from Indoor Air Screening Levels using an attenuation factor of 0.1.

CITY:DUBLIN DIV/GROUP:SER2 DB:R. SMITH LD:(Opt) PIC:(Opt) PM:N. GILLOTTI TM:T. FORTNER LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Columbus-OH\ACT\OH000294-MOTORS LIQUIDATION COMPANY\2010\OH29410-42.dwg LAYOUT: FIG 1 SITELAYOUT SAVED: 12/13/2010 4:00 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ACAD.CTB PLOTTED: 2/14/2011 10:31 AM BY: SMITH, BOB

XREFS: PROJECTNAME: ----
MLCBASE MAP 2010



LEGEND

- MONITORING WELL (UPPER AQUIFER)
- RECOVERY WELL (TW-2)
- MONITORING WELL (LOWER AQUIFER)
- PIEZOMETER
- CARBON SOURCE INTRODUCTION WELLS, REACTIVE ZONES (RZ-1, RZ-3, AND RZ-4)
- FIRE WELL
- PRODUCTION WELL CONVERTED TO MONITORING WELL (34, A)
- INACTIVE PRODUCTION WELL (31, 39, 11B, 12A)
- MONTGOMERY COUNTY WELL (USED BY MLC FOR PUMP TO WASTE PROGRAM)
- MONTGOMERY COUNTY WELL (INACTIVE MIAMI SHORES WELL FIELD – DAYTON PRIMARY PUBLIC SUPPLY BACKUP)
- STREAM GAUGE
- RIVER LEVEE
- CITY OF MORAINE MONITORING WELL
- FORMER BUILDING FOOTPRINT
- SURFACE WATER FEATURE

NOTES:
1. ORANGE INDICATES LOWER AQUIFER WELLS.
2. BLACK INDICATES UPPER AQUIFER WELLS.

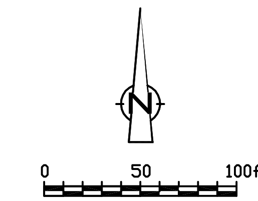
0 200 1000ft

MOTORS LIQUIDATION COMPANY
MORAINE, OHIO
OH000294.2011

SITE LAYOUT

ARCADIS

FIGURE
1



LEGEND

3413 ADDRESS NUMBER

S RESIDENTIAL FOUNDATION STRUCTURE ON SLAB

C RESIDENTIAL FOUNDATION STRUCTURE WITH CRAWL SPACE

B RESIDENTIAL FOUNDATION STRUCTURE WITH BASEMENT

SECONDARY STRUCTURE

NON-RESIDENTIAL STRUCTURE

PARCEL OUTLINE

SOIL-GAS SAMPLING POINT LOCATIONS

WATER MAIN

FIRE HYDRANT

PLUG

SANITARY SEWER

SANITARY SEWER MANHOLE

STORM CATCH BASIN (DRY WELL)

STORM SEWER

NOTES:
1. INFORMATION FOR FOUNDATION STRUCTURE BASED ON DATA FROM MONTGOMERY COUNTY AUDITOR WEB SITE (www.mcauditor.org); INFORMATION WILL BE VERIFIED DURING RECONNAISSANCE.
2. SANITARY AND WATER UTILITY LINES OBTAINED FROM MONTGOMERY COUNTY UTILITY MAP.
3. STORM SEWER INFORMATION OBTAINED FROM CITY OF MORAINE UTILITY MAP.

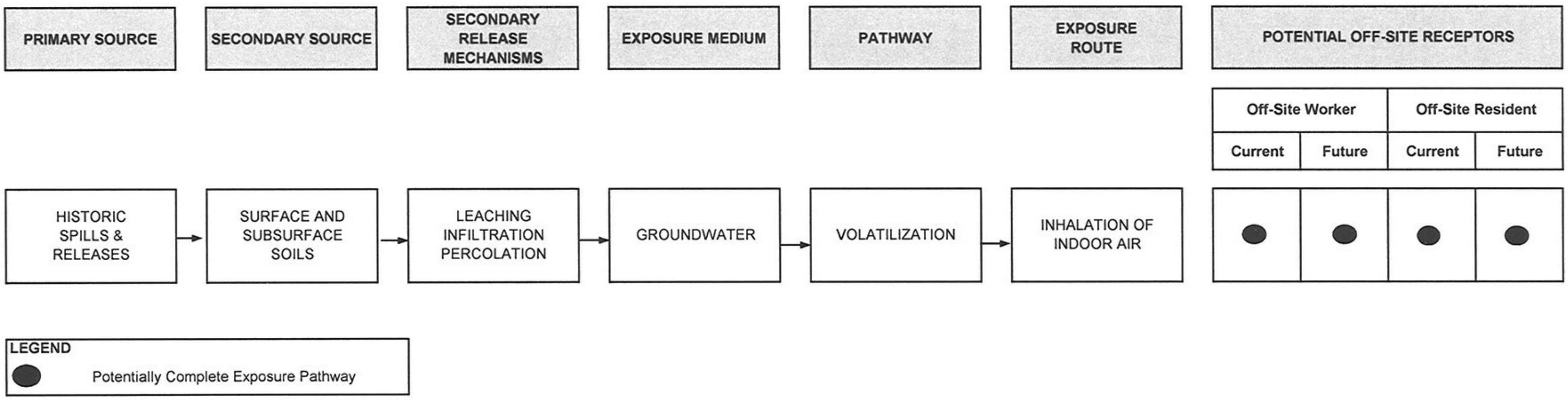
MOTORS LIQUIDATION COMPANY
MORAINE, OHIO

OH000294.2011

SOUTHWEST NEIGHBORHOOD AREA DETAIL MAP WITH UTILITIES

ARCADIS

FIGURE
2

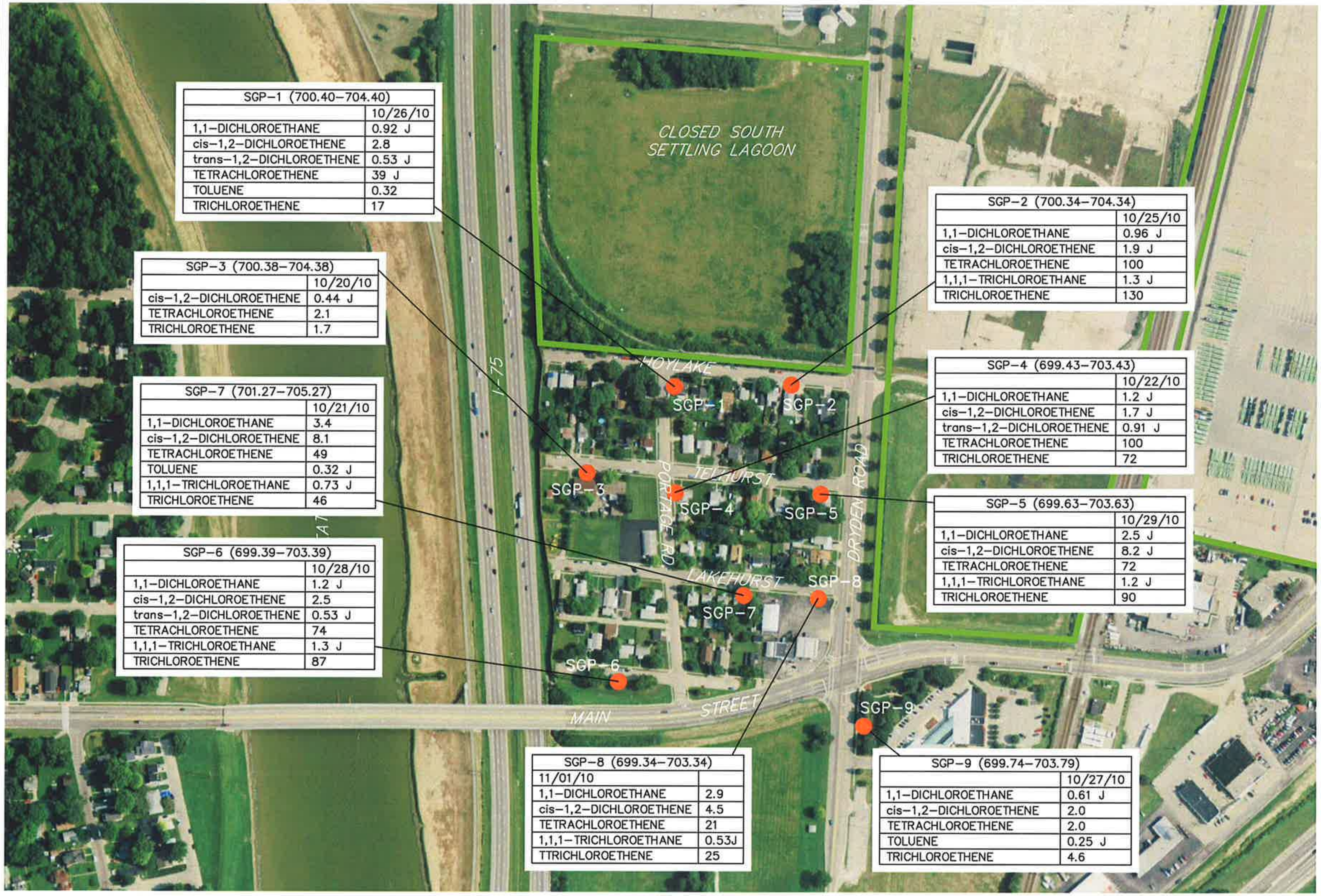


MOTORS LIQUIDATION COMPANY
MORAINE, OHIO
OH000294.2011

Conceptual Site Model of Potential Exposure Pathways in the Neighborhood Southwest of Site

ARCADIS

FIGURE
3



SGP-1 (700.40-704.40)	
	10/26/10
1,1-DICHLOROETHANE	0.92 J
cis-1,2-DICHLOROETHENE	2.8
trans-1,2-DICHLOROETHENE	0.53 J
TETRACHLOROETHENE	39 J
TOLUENE	0.32
TRICHLOROETHENE	17

SGP-2 (700.34-704.34)	
	10/25/10
1,1-DICHLOROETHANE	0.96 J
cis-1,2-DICHLOROETHENE	1.9 J
TETRACHLOROETHENE	100
1,1,1-TRICHLOROETHANE	1.3 J
TRICHLOROETHENE	130

SGP-3 (700.38-704.38)	
	10/20/10
cis-1,2-DICHLOROETHENE	0.44 J
TETRACHLOROETHENE	2.1
TRICHLOROETHENE	1.7

SGP-4 (699.43-703.43)	
	10/22/10
1,1-DICHLOROETHANE	1.2 J
cis-1,2-DICHLOROETHENE	1.7 J
trans-1,2-DICHLOROETHENE	0.91 J
TETRACHLOROETHENE	100
TRICHLOROETHENE	72

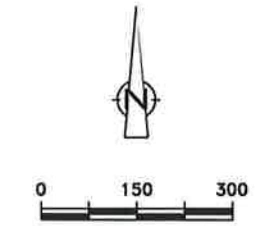
SGP-7 (701.27-705.27)	
	10/21/10
1,1-DICHLOROETHANE	3.4
cis-1,2-DICHLOROETHENE	8.1
TETRACHLOROETHENE	49
TOLUENE	0.32 J
1,1,1-TRICHLOROETHANE	0.73 J
TRICHLOROETHENE	46

SGP-5 (699.63-703.63)	
	10/29/10
1,1-DICHLOROETHANE	2.5 J
cis-1,2-DICHLOROETHENE	8.2 J
TETRACHLOROETHENE	72
1,1,1-TRICHLOROETHANE	1.2 J
TRICHLOROETHENE	90

SGP-6 (699.39-703.39)	
	10/28/10
1,1-DICHLOROETHANE	1.2 J
cis-1,2-DICHLOROETHENE	2.5
trans-1,2-DICHLOROETHENE	0.53 J
TETRACHLOROETHENE	74
1,1,1-TRICHLOROETHANE	1.3 J
TRICHLOROETHENE	87

SGP-8 (699.34-703.34)	
11/01/10	
1,1-DICHLOROETHANE	2.9
cis-1,2-DICHLOROETHENE	4.5
TETRACHLOROETHENE	21
1,1,1-TRICHLOROETHANE	0.53J
TTRICHLOROETHENE	25

SGP-9 (699.74-703.79)	
	10/27/10
1,1-DICHLOROETHANE	0.61 J
cis-1,2-DICHLOROETHENE	2.0
TETRACHLOROETHENE	2.0
TOLUENE	0.25 J
TRICHLOROETHENE	4.6



LEGEND

- (orange dot) SOIL-GAS SAMPLING POINT LOCATIONS
- (green line) MLC PROPERTY BOUNDARY
- (701.93-705.93) TEMPORARY WELL SCREEN INTERVAL ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- J ESTIMATED VALUE
- ALL CONCENTRATIONS IN MICROGRAMS PER LITER

MOTORS LIQUIDATION COMPANY
MORAINE, OHIO

OH000294.2011

GROUNDWATER TABLE SAMPLE RESULTS OF NEIGHBORHOOD SOUTHWEST OF SITE (OCTOBER THROUGH NOVEMBER 2010)

ARCADIS

FIGURE 4

CITY:(COLUMBUS) DIV/GROUP:(SER1) DB:(R. SMITH) LD:(Opt) PIC:(Opt) PM:(N. GILLOTTI) TM:(OPT) LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\Columbus-OH\ACT\OH000294-MOTORS LIQUIDATION COMPANY\2010\OH29410-22.dwg LAYOUT: NEIGHBORHOOD SW OF SITE -DATA (2) SAVED: 2/14/2011 11:31 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: ACAD.CTB PLOTTED: 3/4/2011 8:36 AM BY: SMITH, BOB
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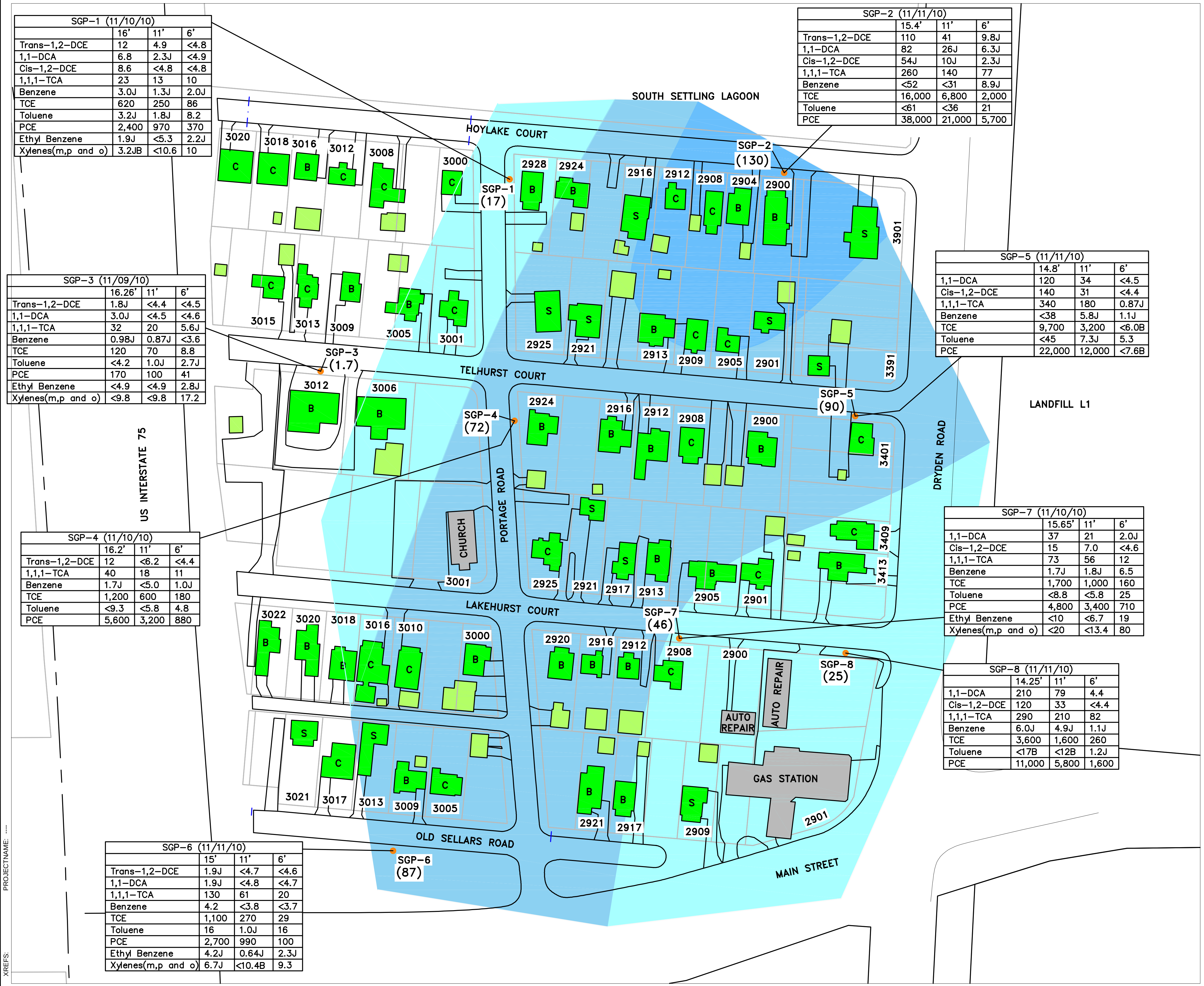


SGP-1 (11/10/10)	16'	11'	6'
Trans-1,2-DCE	12	4.9	<4.8
1,1-DCA	6.8	2.3J	<4.9
Cis-1,2-DCE	8.6	<4.8	<4.8
1,1,1-TCA	23	13	10
Benzene	3.0J	1.3J	2.0J
TCE	620	250	86
Toluene	3.2J	1.8J	8.2
PCE	2,400	970	370
Ethyl Benzene	1.9J	<5.3	2.2J
Xylenes(m,p and o)	3.2JB	<10.6	10

SGP-2 (11/11/10)	15.4'	11'	6'
Trans-1,2-DCE	110	41	9.8J
1,1-DCA	82	26J	6.3J
Cis-1,2-DCE	54J	10J	2.3J
1,1,1-TCA	260	140	77
Benzene	<52	<31	8.9J
TCE	16,000	6,800	2,000
Toluene	<61	<36	21
PCE	38,000	21,000	5,700

SGP-3 (11/09/10)	16.26'	11'	6'
Trans-1,2-DCE	1.8J	<4.4	<4.5
1,1-DCA	3.0J	<4.5	<4.6
1,1,1-TCA	32	20	5.6J
Benzene	0.98J	0.87J	<3.6
TCE	120	70	8.8
Toluene	<4.2	1.0J	2.7J
PCE	170	100	41
Ethyl Benzene	<4.9	<4.9	2.8J
Xylenes(m,p and o)	<9.8	<9.8	17.2

SGP-4 (11/10/10)	16.2'	11'	6'
Trans-1,2-DCE	12	<6.2	<4.4
1,1,1-TCA	40	18	11
Benzene	1.7J	<5.0	1.0J
TCE	1,200	600	180
Toluene	<9.3	<5.8	4.8
PCE	5,600	3,200	880

SGP-5 (11/11/10)	14.8'	11'	6'
1,1-DCA	120	34	<4.5
Cis-1,2-DCE	140	31	<4.4
1,1,1-TCA	340	180	0.87J
Benzene	<38	5.8J	1.1J
TCE	9,700	3,200	<6.0B
Toluene	<45	7.3J	5.3
PCE	22,000	12,000	<7.6B

SGP-6 (11/11/10)	15'	11'	6'
Trans-1,2-DCE	1.9J	<4.7	<4.6
1,1-DCA	1.9J	<4.8	<4.7
1,1,1-TCA	130	61	20
Benzene	4.2	<3.8	<3.7
TCE	1,100	270	29
Toluene	16	1.0J	16
PCE	2,700	990	100
Ethyl Benzene	4.2J	0.64J	2.3J
Xylenes(m,p and o)	6.7J	<10.4B	9.3

SGP-7 (11/10/10)	15.65'	11'	6'
1,1-DCA	37	21	2.0J
Cis-1,2-DCE	15	7.0	<4.6
1,1,1-TCA	73	56	12
Benzene	1.7J	1.8J	6.5
TCE	1,700	1,000	160
Toluene	<8.8	<5.8	25
PCE	4,800	3,400	710
Ethyl Benzene	<10	<6.7	19
Xylenes(m,p and o)	<20	<13.4	80

SGP-8 (11/11/10)	14.25'	11'	6'
1,1-DCA	210	79	4.4
Cis-1,2-DCE	120	33	<4.4
1,1,1-TCA	290	210	82
Benzene	6.0J	4.9J	1.1J
TCE	3,600	1,600	260
Toluene	<17B	<12B	1.2J
PCE	11,000	5,800	1,600

LEGEND

3413 ADDRESS NUMBER

S RESIDENTIAL FOUNDATION STRUCTURE ON SLAB

C RESIDENTIAL FOUNDATION STRUCTURE WITH CRAWL SPACE

B RESIDENTIAL FOUNDATION STRUCTURE WITH BASEMENT

SECONDARY STRUCTURE

NON-RESIDENTIAL STRUCTURE

PARCEL OUTLINE

NOTE: INFORMATION FOR FOUNDATION STRUCTURE BASED ON DATA FROM MONTGOMERY COUNTY AUDITOR WEB SITE (www.mcauditor.org); INFORMATION WILL BE VERIFIED DURING RECONNAISSANCE.

SOIL-GAS SAMPLING POINT

(25) GROUNDWATER TABLE TCE CONCENTRATION IN ug/L

SOIL-GAS CONCENTRATIONS

SGP-11 (11/11/10)	SAMPLE IDENTIFICATION (DATE)
11'	DEPTH IN FEET
cis-1,2-DCE	cis-1,2-DICHLOROETHENE
trans-1,2-DCE	trans-1,2-DICHLOROETHENE
1,1-DCA	1,1-DICHLOROETHANE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
TCE	TRICHLOROETHENE
PCE	TETRACHLOROETHENE
J	BELOW LABORATORY DETECTION LIMIT; ESTIMATED VALUE
B	METHOD BLANK DETECTION

ALL SOIL-GAS CONCENTRATIONS IN MICROGRAMS PER CUBIC METER AND PRESENTED IN TABLE 3

TCE GROUNDWATER TABLE CONCENTRATIONS

>100 ug/L TRICHLOROETHENE

50 TO 100 ug/L TRICHLOROETHENE

5 TO 50 ug/L TRICHLOROETHENE

ALL GROUNDWATER TABLE CONCENTRATIONS IN MICROGRAMS PER LITER (ug/L) AND PRESENTED IN TABLE 2

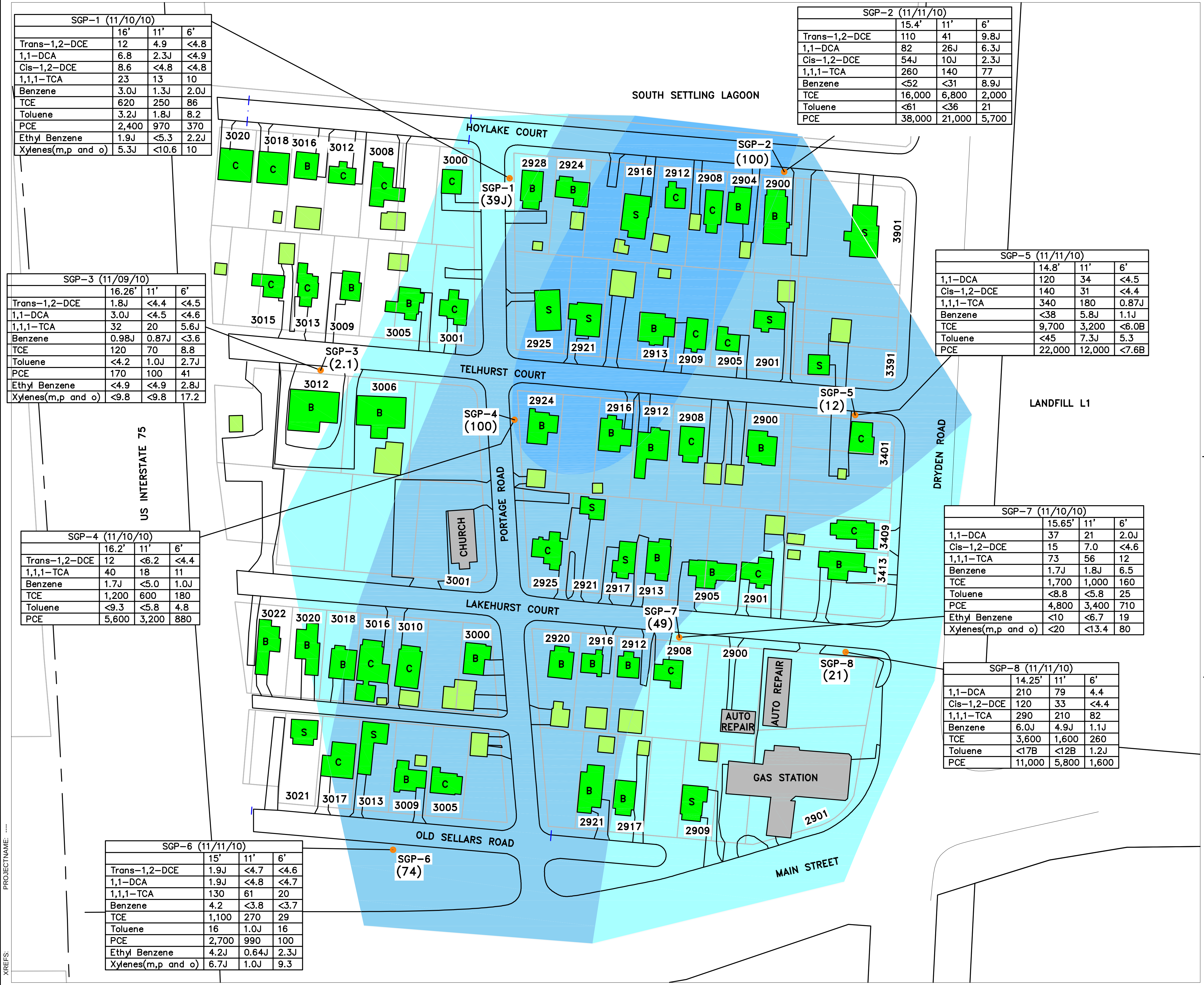
MOTORS LIQUIDATION COMPANY
MORAINE, OHIO

OH000294.2011

SOIL-GAS SAMPLE RESULTS AND TCE GROUNDWATER TABLE PLUME IN NEIGHBORHOOD SOUTHWEST OF SITE (OCTOBER - NOVEMBER 2010)

ARCADIS

FIGURE
5



SGP-1 (11/10/10)			
	16'	11'	6'
Trans-1,2-DCE	12	4.9	<4.8
1,1-DCA	6.8	2.3J	<4.9
Cis-1,2-DCE	8.6	<4.8	<4.8
1,1,1-TCA	23	13	10
Benzene	3.0J	1.3J	2.0J
TCE	620	250	86
Toluene	3.2J	1.8J	8.2
PCE	2,400	970	370
Ethyl Benzene	1.9J	<5.3	2.2J
Xylenes(m,p and o)	5.3J	<10.6	10

SGP-2 (11/11/10)			
	15.4'	11'	6'
Trans-1,2-DCE	110	41	9.8J
1,1-DCA	82	26J	6.3J
Cis-1,2-DCE	54J	10J	2.3J
1,1,1-TCA	260	140	77
Benzene	<52	<31	8.9J
TCE	16,000	6,800	2,000
Toluene	<61	<36	21
PCE	38,000	21,000	5,700

SGP-3 (11/09/10)			
	16.26'	11'	6'
Trans-1,2-DCE	1.8J	<4.4	<4.5
1,1-DCA	3.0J	<4.5	<4.6
1,1,1-TCA	32	20	5.6J
Benzene	0.98J	0.87J	<3.6
TCE	120	70	8.8
Toluene	<4.2	1.0J	2.7J
PCE	170	100	41
Ethyl Benzene	<4.9	<4.9	2.8J
Xylenes(m,p and o)	<9.8	<9.8	17.2

SGP-4 (11/10/10)			
	16.2'	11'	6'
Trans-1,2-DCE	12	<6.2	<4.4
1,1,1-TCA	40	18	11
Benzene	1.7J	<5.0	1.0J
TCE	1,200	600	180
Toluene	<9.3	<5.8	4.8
PCE	5,600	3,200	880

SGP-5 (11/11/10)			
	14.8'	11'	6'
1,1-DCA	120	34	<4.5
Cis-1,2-DCE	140	31	<4.4
1,1,1-TCA	340	180	0.87J
Benzene	<38	5.8J	1.1J
TCE	9,700	3,200	<6.0B
Toluene	<45	7.3J	5.3
PCE	22,000	12,000	<7.6B

SGP-6 (11/11/10)			
	15'	11'	6'
Trans-1,2-DCE	1.9J	<4.7	<4.6
1,1-DCA	1.9J	<4.8	<4.7
1,1,1-TCA	130	61	20
Benzene	4.2	<3.8	<3.7
TCE	1,100	270	29
Toluene	16	1.0J	16
PCE	2,700	990	100
Ethyl Benzene	4.2J	0.64J	2.3J
Xylenes(m,p and o)	6.7J	1.0J	9.3

SGP-7 (11/10/10)			
	15.65'	11'	6'
1,1-DCA	37	21	2.0J
Cis-1,2-DCE	15	7.0	<4.6
1,1,1-TCA	73	56	12
Benzene	1.7J	1.8J	6.5
TCE	1,700	1,000	160
Toluene	<8.8	<5.8	25
PCE	4,800	3,400	710
Ethyl Benzene	<10	<6.7	19
Xylenes(m,p and o)	<20	<13.4	80

SGP-8 (11/11/10)			
	14.25'	11'	6'
1,1-DCA	210	79	4.4
Cis-1,2-DCE	120	33	<4.4
1,1,1-TCA	290	210	82
Benzene	6.0J	4.9J	1.1J
TCE	3,600	1,600	260
Toluene	<17B	<12B	1.2J
PCE	11,000	5,800	1,600

LEGEND

3413 ADDRESS NUMBER

S RESIDENTIAL FOUNDATION STRUCTURE ON SLAB

C RESIDENTIAL FOUNDATION STRUCTURE WITH CRAWL SPACE

B RESIDENTIAL FOUNDATION STRUCTURE WITH BASEMENT

SECONDARY STRUCTURE

NON-RESIDENTIAL STRUCTURE

PARCEL OUTLINE

NOTE: INFORMATION FOR FOUNDATION STRUCTURE BASED ON DATA FROM MONTGOMERY COUNTY AUDITOR WEB SITE (www.mcauditor.org); INFORMATION WILL BE VERIFIED DURING RECONNAISSANCE.

SOIL-GAS SAMPLING POINT LOCATION

(21) GROUNDWATER TABLE PCE CONCENTRATION IN ug/L

SOIL-GAS CONCENTRATIONS

SGP-11 (11/11/10)	SAMPLE IDENTIFICATION (DATE)
11'	DEPTH IN FEET
cis-1,2-DCE	cis-1,2-DICHLOROETHENE
trans-1,2-DCE	trans-1,2-DICHLOROETHENE
1,1-DCA	1,1-DICHLOROETHANE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
TCE	TRICHLOROETHENE
PCE	TETRACHLOROETHENE
J	BELOW LABORATORY DETECTION LIMIT; ESTIMATED VALUE
B	METHOD BLANK DETECTION

ALL SOIL-GAS CONCENTRATIONS IN MICROGRAMS PER CUBIC METER AND PRESENTED IN TABLE 3

PCE GROUNDWATER TABLE CONCENTRATIONS

>100 ug/L TETRACHLOROETHENE

50 TO 100 ug/L TETRACHLOROETHENE

5 TO 50 ug/L TETRACHLOROETHENE

ALL GROUNDWATER TABLE CONCENTRATIONS IN MICROGRAMS PER LITER (ug/L) AND PRESENTED IN TABLE 2

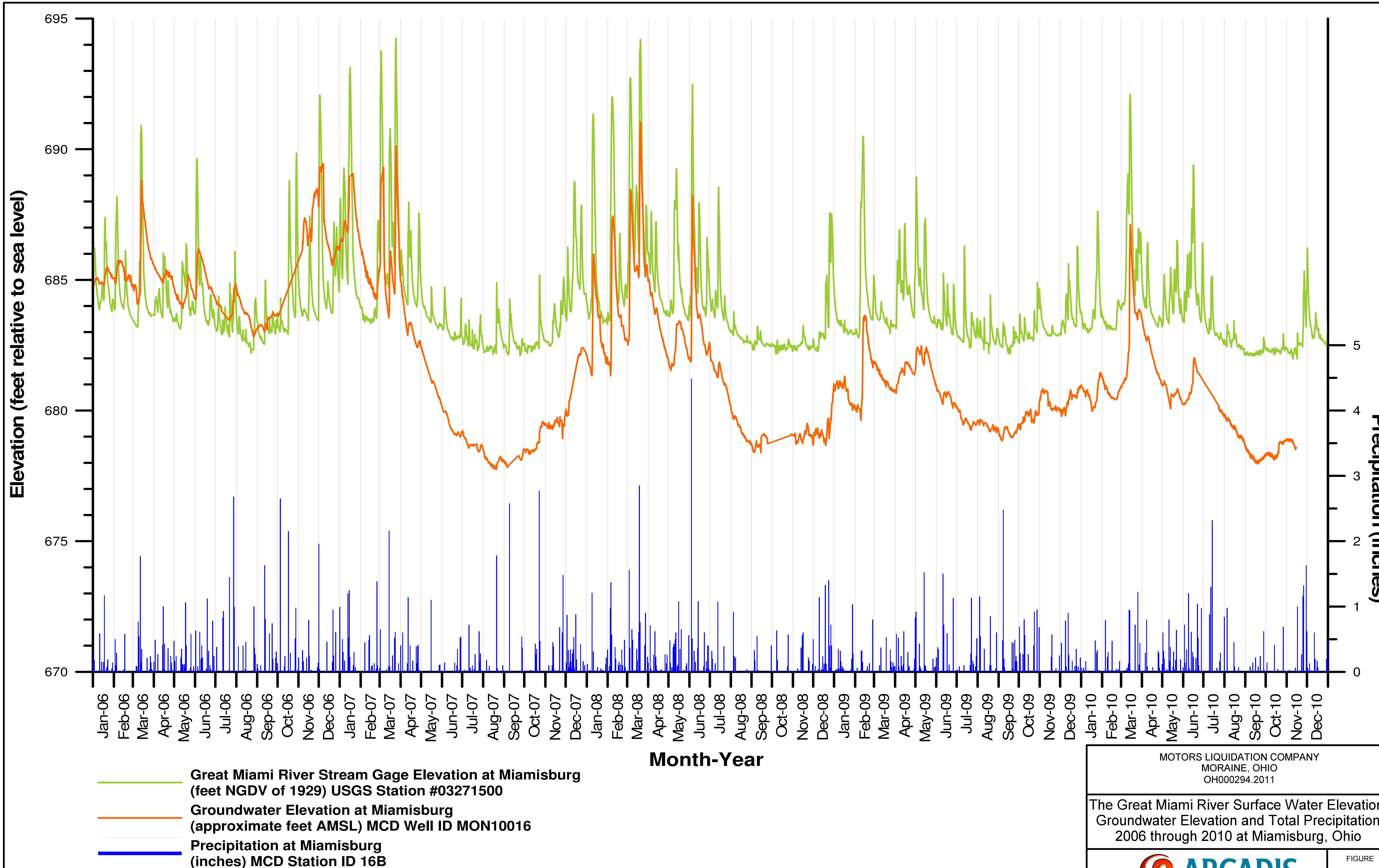
MOTORS LIQUIDATION COMPANY
MORAINE, OHIO

OH000294.2011

SOIL-GAS SAMPLE RESULTS AND PCE GROUNDWATER TABLE PLUME IN NEIGHBORHOOD SOUTHWEST OF SITE (OCTOBER-NOVEMBER 2010)

ARCADIS

FIGURE 6

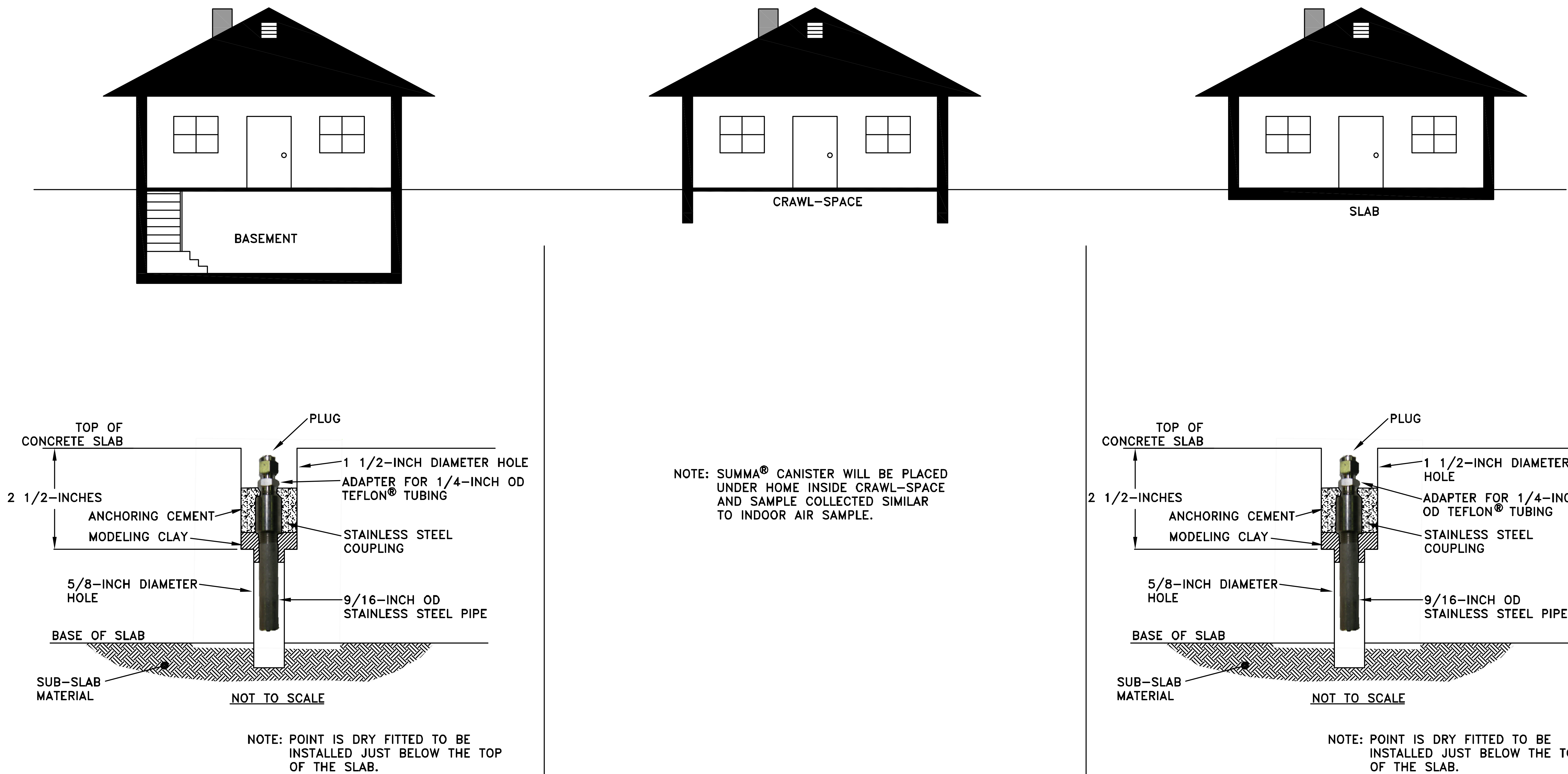


MOTORS LIQUIDATION COMPANY
MORAINE, OHIO
OH000294.2011

The Great Miami River Surface Water Elevation, Groundwater Elevation and Total Precipitation 2006 through 2010 at Miamisburg, Ohio

ARCADIS

FIGURE
7



MOTORS LIQUIDATION COMPANY
MORAINE, OHIO

OH000294.2011

RESIDENTIAL STRUCTURE AND SUB-SLAB SAMPLE POINT DETAIL

ARCADIS

FIGURE
8

CITY:(DUBLIN) DIV/GROUP:(SER2) DB:(RSMITH) LD:(Opt) PIC:(Opt) PM:(N. GILLOTTI) TM:(J. MANZO) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Columbus-OH\ACT\OH000294-MOTORS LIQUIDATION COMPANY\2010\OH29410-41.dwg LAYOUT: FIG 1 PARCEL MAP SAVED: 2/14/2011 10:49 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ACAD.CTB PLOTTED: 3/4/2011 8:37 AM BY: SMITH, BOB
XREFS: PROJECTNAME: ----

Appendix A

Access Agreement

Motors Liquidation Company
MLC
Access Agreement

Name (please print): ____________________________________

Address of property ____________________________________
to be sampled

Home Phone # ____________________________________

Cell Phone # ____________________________________

E-Mail address ____________________________________

I consent to employees, contractors, and authorized representatives of the Motors Liquidation Company (MLC) and U.S. Environmental Protection Agency (EPA) entering and having continued access to this property for the following purpose:

Conducting air monitoring and air sampling activities;

I realize that these actions taken by MLC are undertaken pursuant to its response and enforcement responsibilities under the Resource Conservation Recovery Act (RCRA) at Sections 3001 to 3019f, and 7003, 42 U.S. C. §§ 6921 to 6939f, and under the direction of the EPA.

This written permission is given by me voluntarily, on behalf of myself and all other co-owners of this property, with knowledge of my right to refuse and without threats or promises of any kind.

Date _______________ Signature _________________________________

Sample Location Questions:
1. Are you the Owner __or the Tenant __of the home or building? If you are the owner, go to #3.

2. If you are the Tenant, please write in the owner's name: ________________________ Go to #3 and write in owner's address and phone number.

3. If you are the owner but live at a different address, write your address below (this is the address where the sample results will be mailed to, otherwise, the results will be mailed to the address at the top of the page):

Owner's Address:__________________________________

____
Home Phone #

____
Cell Phone #

____
E-Mail Address

4. Does the home or building have a basement? Yes__ No___ (If no, you are done)
5. If yes, does the basement have a concrete slab? Yes___ No ____
6. If no, does the basement have a dirt floor? Yes ___ No ___ Partial ___

I DO NOT authorize access by MLC at the above-referenced property.

____

Print Name Signature Date

ARCADIS

Appendix B

Instructions for Occupants during Indoor Air Sampling Events

Instructions for Occupants During Indoor Air Sampling Events

Representatives of ARCADIS will be collecting one or more indoor air samples from your building in the near future. In order to collect an indoor air sample in your structure that is both representative of indoor conditions and avoids the common sources of background air contamination associated with household activities and consumer products, ARCADIS requests your assistance.

Please follow the instructions below starting at least 48 hours prior to and during the indoor air sampling event:

- Operate your furnace and whole house air conditioner as appropriate for the current weather conditions
- Do not use wood stoves, fireplaces or auxiliary heating equipment
- Do not open windows or keep doors open.
- Avoid using window air conditioners, fans or vents
- Do not smoke in the building
- Do not use air fresheners or odor eliminators
- Do not use paints or varnishes (up to a week in advance, if possible)
- Do not use cleaning products (e.g., bathroom cleaners, furniture polish, appliance cleaners, all purpose cleaners, floor cleaners)
- Do not use cosmetics, including hair spray, nail polish remover, perfume, etc.
- Avoid bringing freshly dry cleaned clothes into the building
- Do not partake in hobbies indoors that use solvents
- Do not apply pesticides
- Do not store containers of gasoline, oil or petroleum based or other solvents within the building or attached garages (except for fuel oil tanks)
- Do not operate or store automobiles in an attached garage
- Do not operate gasoline powered equipment within the building, attached garage or around the immediate perimeter of the building

You will be asked a series of questions about the structure, consumer products you store in your building, and household activities typically occurring in the building. These questions are designed to identify "background" sources of indoor air contamination. While this investigation is looking for a select number of chemicals related to the subsurface contamination, the laboratory will be analyzing the indoor air samples for a wide variety of chemicals. Thus, tetrachloroethene used in dry cleaning or acetone found in nail polish remover might be found in your sample results. Your cooperation is greatly appreciated.

Form modified from New Jersey Department of Environmental Protection Vapor Intrusion Guidance.

ARCADIS

Appendix C

Standard Operating Procedures

SOP 20 – Sub-Slab Soil-Gas Point Installation and Sampling

SOP 21 – Administering Helium Tracer Gas for Leak Checks of Soil-Gas or Sub-Slab Sampling Points

SOP 22 – Indoor Air and Ambient Air Sampling

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

SOP 20

Sub-Slab Soil-Gas Point Installation and Sampling

Motors Liquidation Company

Moraine, Ohio

Rev. #: 1.2

Rev Date: February 10, 2011

ARCADIS

Approval Signatures

Prepared by: ______________ Date: July 7, 2010
Mitch Wacksman

Approved by: ______________ Date: July 7, 2010
Christopher Lutes

Modified by: ______________ Date: Revised, February 10, 2011
Mitch Wacksman

Modified by: ______________ Date: Revised, December 3, 2010
Joseph Rumschlag

I. Scope and Application

This document describes the procedures for installing permanent sub-slab sampling points and collecting soil-gas samples using permanent points. Samples from the points are collected in an evacuated 1-liter SUMMA®-type canister, (evacuated to approximately <28 inches of mercury [Hg]) which provides a recoverable whole-gas sample when allowed to fill to a vacuum of 2-8 inches of Hg. The whole-air sample is analyzed for volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GC/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv) or lower.

The following sections list the necessary equipment and provide detailed instructions for the installation of permanent sub-slab soil-gas points and the collection of sub-slab soil-gas samples for VOC analysis.

Site specific requirements and/or field conditions may require modifications to some of the procedures outlined in this standard operating procedure (SOP). Alterations to the SOP may be completed per approval of the Project Manager.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading sub-slab soil-gas sample collection activities must have previous sub-slab soil-gas sampling experience.

III. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific installation. For sub-slab soil-gas point installation, drilling with an electric concrete impact drill should be completed only by personnel with prior experience using such a piece of equipment and with the appropriate health and safety measures in place as presented in the JLA. It is possible to encounter high concentrations of VOCs in sub-slab soil-gas, so the amount of time the borehole remains open should be minimized. For the same reason, when installing sub-slab points in spaces with minimal dilution potential, such as closets, it may be necessary to provide local ventilation. Finally, sub-slab point installation should be completed after any indoor air sampling to avoid cross contamination of the indoor air samples.

IV. Equipment List

The equipment required to install a permanent sub-slab soil-gas point is presented below:

- Appropriate personal protective equipment (PPE; as required by the site specific HASP and the JLA)
- Electric hammer drill (e.g., Bosch®, Hilti®, etc.);
- 5/8-inch and 1 1/2-inch diameter concrete drill bits for impact drill (drill bit length contingent on slab thickness);
- Decontaminated soil-gas point (typically 3-inch stainless steel pipe 9/16-inch OD [1/4-inch NPT threads on one end], 1/4-inch NPT female coupling, stainless steel Swagelok® fitting (or similar) bored through male connector [1/4-inch tube OD x 1/4 inch male NPT]), and stainless steel Swagelok® (or similar) plug for 1/4-inch tube fitting;
- Extra 1/4-inch Swagelok® front and back compression sleeves;
- Tubing cutter with heavy-duty cutting wheel;
- Hand tools, including open-end wrench (typically 9/16-inch), pliers, Channel Lock® pliers, etc.;
- Teflon® tape;
- Quick-setting non-shrink grout powder;
- Modeling clay (VOC free and non-drying);
- Potable water for mixing grout;

- Disposable cups and spoons for mixing grout;
- Spray bottle with potable water;
- Broom and dust pan;
- Paper towels;
- Nitrile gloves;
- Work gloves;
- Knee pads;
- Bottle brush;
- Ground fault circuit interrupter (GFCI);
- Extension cords capable of amperage required for hammer drill;
- Plastic sheeting; and
- Shop vacuum with clean fine-particle filter

The equipment required for sub-slab soil-gas sample collection is presented below:

- 1-liter stainless steel SUMMA® canisters (order at least one extra, if feasible);
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g.,30 minutes) or flow rate (e.g., 50 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible);
- 1/4-inch OD Teflon® tubing;
- 1/4-inch Swagelok® by 1/8-inch NPT male stainless steel coupling;
- Extra 1/4-inch Swagelok® front and back compression sleeves;

- Decontaminated stainless steel Swagelok® or comparable “T” fitting and needle valve for isolation of purge pump;
- Stainless steel duplicate “T” fitting provided by the laboratory (if collecting duplicate [i.e., split] samples);
- Portable vacuum pump capable of producing very low-flow rates (e.g., 50 to 200 mL/min);
- Electric flow sensor (Bios DryCal® or equivalent);
- Tracer gas testing supplies (refer to “Administering Tracer Gas” SOP #21);
- Appropriate-sized open-end wrench (typically 9/16-inch and 1/2-inch);
- Tedlar® bag to collect purge air or length of tubing sufficient to vent it outside the structure;
- Compound pressure/vacuum gauge;
- Portable weather meter, if appropriate;
- Chain-of-custody (COC) form;
- Sample collection log (attached);
- Nitrile gloves;
- Work gloves;
- Field notebook.

V. Procedure

Permanent Sub-Slab Soil-Gas Point Installation

Permanent sub-slab soil-gas points are installed using an electric drill and manual placement of the sub-slab point. After a dry fit, the sub-slab point is inserted into the hole and grouted with a quick-setting, non-shrink grout powder. The soil-gas point is equipped with a plug. The plug is removed and a compression fitting nut and ferrules are used to allow collection of a sub-slab soil-gas sample through Teflon® tubing. The sub-slab point and tubing will be purged with a portable sampling pump prior to collecting the sub-slab soil-gas sample. Detailed installation methods are as follows:

1. Complete utility clearance in accordance with ARCADIS Utility Locate SOP with assistance from Ohio Utility Protection Service (OUPS) prior to drilling activities.

2. Assemble the sub-slab sample point assembly. Teflon® tape should never be used with Swagelok® connections; it should be used on normal NPT threads.

3. Remove, only to the extent necessary any covering on top of the slab (e.g., carpet).

4. Lay down plastic sheeting to keep the work area clean. Check to make sure shop vacuum is working properly and fine concrete particles will not pass through filter.

5. Advance the 1 1/2-inch drill bit approximately 2 1/2 inches into the slab. This hole is drilled deep enough to permit the top of the sampling point to be set flush with the slab when the 1/4-inch tubing (9/16-inch OD) is inserted into the 5/8-inch hole drilled under Step 6, below. Clean up cuttings with shop vacuum, bottle brush, and dust pan.

6. Drill a 5/8-inch-diameter hole into the concrete slab using the electric drill. Do not fully penetrate the slab at this time. Stop drilling approximately 1 inch short of penetrating the slab. To gage this, a typical concrete slab is 4-6 inches thick. Therefore, stop drilling at 3 inches.

7. Use the shop vacuum, bottle brush and dust broom to clean up the work area and material that may have fallen into and around the drill hole.

8. Advance the 5/8-inch drill bit the remaining thickness of the slab and approximately 3 inches into the sub-slab material to create an open cavity.

   Note (if possible) from the drill cuttings any evidence for the types of materials in the immediate sub-slab – i.e. moisture barriers, sand, gravel, etc.

9. Use the bottle brush, whisk broom, and dust pan to quickly clean material around and within the hole. The hole should not be left open for any extended length of time to ensure that VOCs below the slab do not migrate into indoor air (plug with clay during clean up). Do not use the shop vacuum to clean up the drill hole after the full thickness of the slab has been penetrated.

10. Using an assembled sub-slab point, test fit the components so that the proper length of 1/4-inch tubing and depth of the 2 1/2-inch hole provides enough space for the coupling. Adjust so that the sample port plug will lie flush with the slab surface and does not create a tripping hazard.

11. If necessary, re-drill the 5/8-inch hole to ensure it remains clear. This can also be accomplished using a piece of steel rod, sample tubing, or even a piece of heavy wire (e.g., coat hanger).

12. Wrap the sample point assembly with Teflon® tape or VOC free modeling clay, to the extent necessary, for a snug fit of the assembly into the 5/8-inch diameter hole and also to prevent migration of cement to the sub-slab. Ensure that Teflon® tape or modeling clay do not interfere with the cement that will be used to permanently fix and seal the sample point.

13. Prepare a mixture of VOC-free non-shrink quick-setting cement and water according to the manufactures directions in a disposable cup using a plastic spoon for mixing.

14. Before cementing in the sub-slab point, moisten the 1 1/2-inch drill hole with the spray bottle to provide better adhesion.

15. Cement in the sub-slab point using the plastic spoon to apply the cement into the annular space between the coupling and the 1 1/2-inch drill hole.

16. Replace the surface covering (e.g., carpet) if warranted. Sample collection location should be returned to pre-sampling conditions to the extent feasible given the presence of a permanent point.

17. Proceed to sub-slab soil-gas sample collection after waiting a minimum of 24 hours for equilibration following sub-slab point installation.

Sub-Slab Soil-Gas Sample Collection

Once the permanent sub-slab point is installed, the following procedures should be used to collect the sample in a SUMMA® canister:

1. Record the following weather information from inside the building being sampled in the field notebook:

   a. wind speed and direction (if capable with in-field measuring device);

   b. ambient temperature;

   c. barometric pressure; and

   d. relative humidity.

2. Before sampling, remove the sample point plug and attach a compound pressure/vacuum gauge to the end of the sample point to record the pressure gradient occurring between indoors and sub-slab. Record the positive or negative pressure reading in the field notebook. Cap the sample point once the reading is collected.

3. Check all SUMMA®-type canisters for correct vacuum. The vacuum gauges provided by the analytical laboratory as part of the sample train (i.e., canister and flow controller) are used to record the initial and final vacuums in the air sampling canister. Pre-sampling vacuum in the canister should be between -30 inches of mercury (in Hg) and -25 in Hg. In the event a canister is not within this initial range, it will be rejected and a new canister, flow controller and vacuum will be similarly checked.

4. Remove the brass plug from the SUMMA® canister and connect the flow controller with in-line particulate filter and vacuum gauge to the SUMMA® canister. Do not open the valve on the SUMMA® canister. Record in the field

notebook and COC form the flow controller number with the appropriate SUMMA® canister number.

5. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, couple two SUMMA® canisters using stainless steel Swagelok® duplicate sample T-fitting supplied by the laboratory. Attach flow controller with in-line particulate filter and vacuum gauge to duplicate sample T-fitting provided by the laboratory.

6. Complete a "shut in" or "leak down" test prior to sampling each sub-slab soil-gas sample point to test the integrity of all above ground sampling equipment supplied by the laboratory (i.e., SUMMA® canister, flow controller, vacuum gauge, and associated fittings). All above ground sampling equipment will be assembled and the cap from the SUMMA® canister will be placed on the end of the sample train, effectively producing a closed system. The SUMMA® canister valve will then be briefly opened then closed; the vacuum applied by the canister is then effectively "shut-in" to the sample train. The vacuum gauge will be observed for at least one minute, and if there is any appreciable loss in vacuum, fittings should be adjusted to remedy the situation and create a leak-free environment. In the event a leak cannot be remedied, field staff should reject the sampling apparatus and choose another unit.

7. Connect a Swagelok® (or comparable) T-fitting to the end of the sample tubing. On one end of the T-fitting connect a short length of Teflon® tubing to the assembled sample train (flow control with in-line particulate filter and vacuum gauge and SUMMA® canister). On the other end of the T-fitting connect a Swagelok® (or similar) two-way valve using a short length of 1/4-inch OD Teflon® tubing.

8. Connect the two-way valve and the properly calibrated portable vacuum pump using a length of tubing. Affix a Tedlar® bag to the purge pump to capture all purged air. The purged air should be evacuated outside the building.

9. Purge 3 volumes of air from the sub-slab soil-gas point and sampling line using a portable pump at a rate of approximately 50 mL/min. Calculate three-times the volume of the inside of the sample tubing and sample point using the calculation:

$$V_1 + V_2 = V_t$$

where:

$V_1 = \pi r^2 h$ = open space volume of sample tubing

$V_2 = \pi r^2 h$ = open space volume of sample point
V_t = total volume

r = inner radius of sample point or sample tubing

h = height of sample point or length of tubing

10. A tracer-gas leak test should be conducted to ensure that ambient leakage is either not occurring or is within acceptable limits. Check the seal established around all sub-slab soil-gas points and connections by using a tracer gas (e.g., helium) or other method established in the state guidance documents. [Note: Refer to SOP 21 "Administering Tracer Gas," for procedures on tracer gas use.] If unacceptable leaks are detected ($\geq$ 5% of the source concentration), take corrective action to seal all potential sources of leak in the sampling train. If the problem cannot be corrected, a replacement sub-slab point should be installed and sampled. Measure organic vapor and tracer gas levels within the Tedlar® bag, as appropriate

11. Close the two-way valve to isolate the purge pump.

12. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

13. On a floor plan or sketch of the area being sampled, include the following information:

    - Sample location;
    - Locations of heating, ventilation, and air conditioning equipment;
    - Chemical storage areas;
    - Any attached garages or utility areas;
    - Doorways and stairways;

- Any sumps, drains, or other utility perforations;
- Separate footings sections or buildings constructions; and
- The nearest street and the direction of north.

14. Take a photograph of the SUMMA® canister and surrounding area unless prohibited by the building owner.

15. Check the SUMMA® canister approximately half way through the sample duration and note progress on sample logs.

Termination of Sample Collection

1. Due to the short duration of sampling, field staff should stay with the SUMMA® canister throughout sampling.

2. Stop collecting the sample when the canister vacuum reaches approximately 5 inches of Hg (leaving some vacuum in the canister provides a way to verify if the canister leaks before it reaches the laboratory) or when the desired sample time has elapsed.

3. Record the final vacuum. Stop collecting the sample by closing the SUMMA® canister valve. Record the date, local time (24-hour time notation) of valve closing on the sample collection log, and COC form.

4. Disconnect sample tubing from the sample point and replace flush-mount cap.

5. Remove the particulate filters and flow controllers from the SUMMA® canisters, re-install the brass plugs on the canister fittings, and tighten with the appropriate wrench.

6. Package the canisters and flow controllers in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canisters should not be preserved with ice or refrigeration during shipment.

7. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).

8. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via carrier (e.g., Federal Express) for analysis.

9. Replace the surface covering (e.g., carpet) if warranted. Sample collection location should be returned to pre-sampling conditions to the extent feasible given the presence of a permanent sample point. Document with photographs.

Decommissioning of Permanent Sub-Slab Soil-Gas Points

1. Remove, only to the extent necessary any covering on top of the permanent sample point (e.g., carpet).

2. Lay down plastic sheeting to keep the work area clean. Check to make sure shop vacuum is working properly and fine concrete particles will not pass through filter.

3. Using a hammer, carefully strike the sample point on the top of the plug to dislodge the permanent point from the slab. Repeat until the sample point becomes loose inside the borehole.

4. Remove the sample point from the slab.

5. Use the shop vacuum, bottle brush and dust broom to clean up the work area and material that may have fallen into and around the drill hole.

6. Prepare a mixture of VOC-free, non-shrink, quick-setting cement and water according to the manufactures directions in a disposable cup using a plastic spoon for mixing.

7. Place cement in 11/2-inch borehole using the plastic spoon until the hole is filled and wait until the cement sets.

8. Replace the surface covering (e.g., carpet) if warranted.

9. Document with photos.

VI. Cautions

The following cautions and field tips should be reviewed and considered prior to installing or collecting a sub-slab soil gas sample.

- When drilling sample collection holes, utilities may be in the area. Always complete utility location, identification and marking before installing sub-slab sample points as required by the ARCADIS Utility Location Policy and Procedure. Be aware that public utility locator organizations frequently do not provide location information within buildings so alternative lines of evidence must be used.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

- Care should be taken to ensure that the flow controller is pre-calibrated to the proper sample collection time (confirm with laboratory prior to sampling event, and confirm on packaging list). Sample integrity is maintained if the sampling event is shorter than the target duration, but sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure. Excessive vacuum remaining in the canister can also result in elevated reporting limits.

- If low-flow conditions are encountered (when air flow rates are less-than 10 mL/min or when vacuum is greater than 10 inches of Hg) and preclude the collection of representative sub-slab soil-gas samples, due to high moisture conditions and/or tight soils, a replacement sub-slab point should be installed, for up to three attempts.

- Field personnel will properly seal the sub-slab point at the slab surface to prevent leaks of atmosphere into the sub-slab point during purging and sampling.

- Quick-setting non-shrink grout and modeling clay or other materials used to seal the hole should only be obtained from an approved ARCADIS source and should not be purchased off the shelf from an unapproved retail source. Data indicate that some modeling clays may contain VOCs that can affect sample results.

- It is important to record the canister pressure, start and stop times and sample identification on a proper field sampling form. Often SUMMA® canisters are collected over a 24 hour period. The time/pressure should be recorded at the start of sampling, and then again one or two hours later. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn't stuck. If the canister is running correctly for a 24 hour period then the vacuum will have decreased slightly after an hour or two (for example from 29 inches to 27 inches of Hg). Consult your project manager (PM), risk assessor or air sampling expert by phone if the SUMMA® canister does not appear to be working properly.

- Ensure that there is still measureable vacuum in the SUMMA® after sampling. Sometimes the gauges sent from the lab have offset errors, or they stick.

- When sampling carefully consider elevation. If your site is over 2,000 feet above sea level or the difference in elevation between your site and your lab is more than 2,000 feet then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in the http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped two to three days before the scheduled start of the sampling event so that all materials can be checked. Order replacements if needed.

- Requesting extra canisters from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- Check the seal around the soil-gas sampling point by using a tracer gas (e.g., helium) or other method established in the appropriate guidance document.

- A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

VII. Waste Management

The waste materials generated by these activities should be minimal. Personal protective equipment, such as gloves and other disposable equipment (i.e., tubing) should be collected by field personnel for proper disposal.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook and/or sample log (attached) at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, flow rate, initial vacuum reading, and final vacuum reading. Field sampling logs and COC records will be transmitted to the Project Manager.

IX. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Duplicate samples will be collected at a rate of 1 per 10 air samples (10%).

Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs prior to any dilution). Duplicate sub-slab soil-gas samples should be collected via a split sample train, allowing the primary and duplicate sample to be collected from the sub-slab soil-gas point simultaneously.

Trip blank samples will not be used during sub-slab soil-gas sampling. SUMMA® canisters are self-sealed containers which do not permit any contamination to enter during shipment or storage. Furthermore all parts of the SUMMA® canister are metal and non-porous, therefore there is no potential for any contamination to be absorbed. The batch certified clean SUMMA® canisters will be provided by the laboratory. The only potential contamination would come from a possible leak in the SUMMA® canister. The integrity of each SUMMA® canister will be confirmed prior to sampling by measuring the vacuum within the canister, with follow up measurements after the canister is filled in the field, and upon arrival at the laboratory.

X. References

CEPA. 2010. Advisory – Active Soil Investigation. California Environmental Protection Agency. March.

OEPA. 2010. Sample Collection and Evaluation of Vapor Intrusion to Indoor Air. Guidance Document for Remedial Response and Voluntary Action Program. Division of Emergency and Remedial Response. May.

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Sub-slab/Soil-Gas Sample Collection Log

		Sample ID:	
Client:		**Boring Equipment:**	
Project:		**Sealant:**	
Location:		**Tubing Information:**	
Project #:		**Miscellaneous Equipment:**	
Samplers:		**Subcontractor:**	
`		**Equipment:**	
Sampling Depth:		**Moisture Content of Sampling Zone):**	
Time and Date of Installation:		**Approximate Purge Volume:**	

Instrument Readings:

Date	Time	Canister Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PID (ppb)

(a) Record canister information at a minimum at the beginning and end of sampling

SUMMA® Canister Information:

Size (circle one):	**1 L** **6 L**
Canister ID:	
Flow Controller ID:	
Notes:	

Tracer Test Information (if applicable):

Initial Helium Shroud:	
Final Helium Shroud:	
Tracer Test Passed:	**Yes** **No**
Notes:	

General Observations/Notes:

Approximating One-Well Volume (for purging):

$V_1 + V_2 = V_t$ where: $V_1 = \pi r^2 h$ = open space volume of sample tubing; $V_2 = \pi r^2 h$ = open space volume of sample point; V_t = total volume; r = inner radius of sample point, or sample tubing; h = height of sample point or length of tubing.

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SOP 21

Administering Helium Tracer Gas for Leak Checks of Soil-Gas or Sub-Slab Sampling Points

Motors Liquidation Company

Moraine, Ohio

Rev. #: 2.1

Rev Date: December 3, 2010

ARCADIS

SOP 21
Administering Helium Tracer Gas
Rev. #: 2.1 | Rev Date: December 3, 2010

Approval Signatures

Prepared by: ____________________ Date: May 20, 2008
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Modified by: ____________________ Date: Revised, August 20, 2010
Trey Fortner

Modified by: ____________________ Date: Revised, December 3, 2010
Joseph Rumschlag

I. Scope and Application

When collecting sub-slab soil-gas samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control device to verify the integrity of the soil-gas point seal. Without the use of a tracer, verification that a sub-slab soil-gas sample has not been diluted by ambient or indoor air is difficult.

This standard operating procedure (SOP) focuses on using helium as a tracer gas. However, depending on the nature of the contaminants of concern, other compounds can be used as a tracer including sulfur hexafluoride (SF6), butane and propane (or other gases). In all cases, the protocol for using a tracer gas is consistent and includes the following basic steps: (1) enrich the atmosphere in the immediate vicinity where the port or sample tubing intersects the surface with the tracer gas; and (2) measure a vapor sample from the sample tubing for the presence of high concentrations (>5%) of the tracer. A pail, bucket, garbage can or even a plastic bag can serve to keep the tracer gas in contact with the port during the testing.

There are two basic approaches to testing for the tracer gas:

1. Include the tracer gas in the list of target analytes reported by the laboratory; or

2. Use a portable monitoring device to analyze a sample of soil-gas for the tracer prior to sampling for the compounds of concern. (Note that tracer gas samples can be collected via syringe, Tedlar® bag, etc. They need not be collected in SUMMA® canisters or minicans.)

This SOP focuses on monitoring helium using a portable sampling device, although helium can also be analyzed by the laboratory along with other volatile organic compounds (VOCs). Real-time tracer sampling is generally preferred as the results can be used to confirm the integrity of the port seals prior to formal sample collection.

During the initial stages of a sub-slab soil-gas sampling program, tracer gas samples should be collected at each of the sampling points. If the results of the initial samples indicate that the port seals are adequate, the Project Manager can consider reducing the number of locations at which tracer gas samples are used. At a minimum, at least 10% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil-gas points as part of a long-term monitoring program, the port should be tested prior to the first sampling event. Tracer gas testing of subsequent sampling events is not necessary unless conditions have changed at the site.

Site specific requirements and/or field conditions may require modifications to some of the procedures outlined in this SOP. Alterations to the SOP may be completed per approval of the Project Manager.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading the tracer gas testing must have previous experience conducting similar tests.

III. Equipment List

The equipment required to conduct a helium tracer gas test are presented below:

- Appropriate PPE for site (as required by the Health and Safety Plan).
- Helium (laboratory grade).
- Regulator for helium tank.
- Shroud (plastic bucket, garbage can, etc).
    - The size of the shroud should be sufficient to fit over the sub-slab soil-gas point. It is worth noting that using a smaller shroud obviously uses less helium as well; this may be important when projects require a number of helium tracer tests.
    - The shroud will need to have three small holes in it. These holes will include one on the top (to accommodate the sample tubing), and two on the side (one for the helium detector probe, and one for the helium line).
    - The shroud ideally encloses the entire sampling train.

- Helium detector capable of measuring from 1 - 100% (Dielectric MGD-2002, Mark Model 9522, or equivalent).

- Tedlar® bags.

- Seal material for shroud (rubber gasket, modeling clay, bentonite, etc). Although the sealing material is not in direct contact with the sample if no leak occurs, sealing materials with high levels of VOC emissions should be avoided, since they could easily contaminate a sample from a point in which a trace leak occurs.

- Field notebook.

IV. Procedure

The procedure used to conduct the helium tracer test should be specific to the shroud being used and the methods of soil-gas point installation. The helium tracer test can be conducted when using temporary or permanent sample point installs and from inside or outside a facility. However, when using the tracer gas within an indoor area you must provide adequate ventilation because helium is an asphyxiant.

1. Attach Teflon® sample tubing to the sample point. This can be accomplished utilizing a number of different methods depending on the sample install (i.e., barbed fitting, Swagelok® fitting, ball valve, etc.).

2. Place the shroud over the sample point and tubing.

3. Pull the tubing through hole in top of shroud. Seal opening with modeling clay.

4. Place weight on top of shroud to help maintain a good seal with the ground.

5. Insert helium tubing into hole in side of shroud, seal with modeling clay to prevent leaks.

6. Fill shroud with helium. While filling shroud allow atmospheric air to escape either by leaving a crack with the surface or by providing a release value on the side of the shroud.

7. Use the helium detector to test level of helium gas from the bottom of the shroud

(where the sample tubing intersects the ground). Helium should be added until the environment inside the shroud has > 60% helium.

8. Purge the sample point through the sample tubing into a Tedlar bag using a hand held sampling pump. The sample pump should be operating at a rate of 50 mL/minute (the purge rate should not exceed the sample collection rate).Use a stand-alone flow sensor to monitor purge flow-rate during purge (Bios DryCal or equivalent). Test the air in the Tedlar® bag for helium using portable helium detector. If the sample point has been installed properly there should be zero helium in purge air.

9. If > 5% helium is noted in purge air, add more clay or other material to the seal the sample port at the surface and repeat the testing procedure. If the seal cannot be fixed, re-install sample point.

10. Monitor and record helium level in shroud before, during and after tracer test.

11. Monitor and record helium level in purge exhaust at the end of purging.

12. At successful completion of tracer test and sample point purging, the soil-gas sample can be collected (if the helium shroud must be removed prior to sample collection be mindful not disturb the sample tubing and any established seals).

V. Cautions

Helium is an asphyxiant! Be cautious with its use indoors!

Care should be taken not to pressurize shroud while introducing helium. If the shroud is completely air tight and the helium is introduced quickly, the shroud can be over-pressurized and helium can be pushed into the ground.

Because minor leakage around the port seal should not materially affect the usability of the soil-gas sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (>5%) of tracer gas are observed in a sample, the port seal should be enhanced to reduce the infiltration of ambient air and the tracer test readministered. If the problem cannot be rectified, a new sample point should be installed.

VI. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location, and the helium concentrations in both the shroud and the purge air before, during, and after tracer testing. Any problems encountered should also be recorded in the field notes.

APPENDIX: Compressed Gases—Use and Storage

In general, a compressed gas is any material contained under pressure that is dissolved or liquefied by compression or refrigeration. Compressed gas cylinders should be handled as high-energy sources and therefore as potential explosives and projectiles. Prudent safety practices should be followed when handling compressed gases since they expose workers to both chemical and physical hazards.

Handling

- Safety glasses with side shields (or safety goggles) and other appropriate personal protective equipment should be worn when working with compressed gases.
- Cylinders should be marked with a label that clearly identifies the contents.
- All cylinders should be checked for damage prior to use. Do not repair damaged cylinders or valves. Damaged or defective cylinders, valves, etc., should be taken out of use immediately and returned to the manufacturer/distributor for repair.
- All gas cylinders (full or empty) should be rigidly secured to a substantial structure at 2/3 height. Only two cylinders per restraint are allowed in the laboratory and only soldered link chains or belts with buckles are acceptable. Cylinder stands are also acceptable but not preferred.
- Handcarts shall be used when moving gas cylinders. Cylinders must be chained to the carts.
- All cylinders must be fitted with safety valve covers before they are moved.
- Only three-wheeled or four-wheeled carts should be used to move cylinders.
- A pressure-regulating device shall be used at all times to control the flow of gas from the cylinder.
- The main cylinder valve shall be the only means by which gas flow is to be shut off. The correct position for the main valve is all the way on or all the way off.
- Cylinder valves should never be lubricated, modified, forced, or tampered with.
- After connecting a cylinder, check for leaks at connections. Periodically check for leaks while the cylinder is in use.
- Regulators and valves should be tightened firmly with the proper size wrench. Do not use adjustable wrenches or pliers because they may damage the nuts.
- Cylinders should not be placed near heat or where they can become part of an electrical circuit.
- Cylinders should not be exposed to temperatures above 50 °C (122 °F). Some rupture devices on cylinders will release at about 65 °C (149 °F). Some small cylinders, such as lecture bottles, are not fitted with rupture devices and may explode if exposed to high temperatures.
- Rapid release of a compressed gas should be avoided because it will cause an unsecured gas hose to whip dangerously and also may build up enough static charge to ignite a flammable gas.

- Appropriate regulators should be used on each gas cylinder. Threads and the configuration of valve outlets are different for each family of gases to avoid improper use. Adaptors and homemade modifications are prohibited.
- Cylinders should never be bled completely empty. Leave a slight pressure to keep contaminants out.

Storage

- When not in use, cylinders should be stored with their main valve closed and the valve safety cap in place.
- Cylinders must be stored upright and not on their side. All cylinders should be secured.
- Cylinders awaiting use should be stored according to their hazard classes.
- Cylinders should not be located where objects may strike or fall on them.
- Cylinders should not be stored in damp areas or near salt, corrosive chemicals, chemical vapors, heat, or direct sunlight. Cylinders stored outside should be protected from the weather.

Special Precautions

Flammable Gases

- No more than two cylinders should be manifolded together; however several instruments or outlets are permitted for a single cylinder.
- Valves on flammable gas cylinders should be shut off when the laboratory is unattended and no experimental process is in progress.
- Flames involving a highly flammable gas should not be extinguished until the source of the gas has been safely shut off; otherwise it can reignite causing an explosion.

Acetylene Gas Cylinders

- Acetylene cylinders must always be stored upright. They contain acetone, which can discharge instead of or along with acetylene. Do not use an acetylene cylinder that has been stored or handled in a nonupright position until it has remained in an upright position for at least 30 minutes.
- A flame arrestor must protect the outlet line of an acetylene cylinder.
- Compatible tubing should be used to transport gaseous acetylene. Some tubing like copper forms explosive acetylides.

Lecture Bottles

- All lecture bottles should be marked with a label that clearly identifies the contents.
- Lecture bottles should be stored according to their hazard classes.
- Lecture bottles that contain toxic gases should be stored in a ventilated cabinet.
- Lecture bottles should be stored in a secure place to eliminate them from rolling or falling.

- Lecture bottles should not be stored near corrosives, heat, direct sunlight, or in damp areas.
- To avoid costly disposal fees, lecture bottles should only be purchased from suppliers that will accept returned bottles (full or empty). Contact the supplier before purchasing lecture bottles to ensure that they have a return policy.
- Lecture bottles should be dated upon initial use. It is advised that bottles be sent back to the supplier after one year to avoid accumulation of old bottles.

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SOP 22

Indoor Air and Ambient Air Sampling

Motors Liquidation Company

Moraine, Ohio

Rev. #: 1.2

Rev Date: February 9, 2011

Approval Signatures

Prepared by: Mitch Wacksman Date: July 7, 2010

Approved by: Christopher Lutes Date: July 7, 2010

Modified by: Mitch Wacksman Date: Revised, February 9, 2011

Modified by: Trey Fortner Date: Revised, December 3, 2010

I. Scope and Application

This document describes the procedures to collect indoor air and ambient air samples. Samples are collected in an evacuated 6-liter SUMMA®-type canister, (evacuated to <28 inches of mercury [Hg]) which provides a recoverable whole-gas sample when allowed to fill to a vacuum of 2-8 inches of Hg. The whole-air sample is analyzed for volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GC/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv) or lower.

The following sections list the necessary equipment and provide detailed instructions for placing the sampling device and collecting indoor air or ambient air samples for VOC analysis.

Site specific requirements and/or field conditions may require modifications to some of the procedures outlined in this standard operating procedure (SOP). Alterations to the SOP may be completed per approval of the Project Manager.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading indoor air or ambient air sample collection activities must have previous indoor air or ambient air sampling experience.

III. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. The following are examples of hazards that are often encountered in conducting indoor air or ambient air sampling:

- In crawl spaces, hazards often include low head room, limited light, poisonous insects, venomous snakes, insulation, electrical and plumbing lines, and sharp debris.

- In residential buildings and neighborhoods unfamiliar pets can pose a hazard. Even though proper permission for sampling may have been secured, it is still possible to encounter persons suspicious of or hostile to the sampling team. Two sampling personnel are required at all times due to these hazards.

- In occupied industrial buildings be aware of the physical hazards of ongoing industrial processes. Examples include moving forklifts and equipment pits.

IV. Equipment List

The equipment required for indoor air or ambient air sample collection is presented below:

- Appropriate PPE (as required by the Health and Safety Plan);

- 6-liter, stainless steel SUMMA® canisters (order at least one extra, if feasible);

- Flow controllers with in-line particulate filters and vacuum gauges (flow controllers are pre-calibrated by the laboratory to a specified sample duration [e.g., 24-hour]). Confirm with lab that flow controller is equipped with an in-line particulate filter and pressure gauge (order an extra set for each extra SUMMA® canister, if feasible);

- Appropriate-sized open-end wrenches (typically 9/16-inch);

- Chain-of-custody (COC) form;

- Building survey and product inventory form (example attached);

- Portable photoionization detector (PID) (for use identifying potential background sources during building survey described below);

- Sample collection log (attached);

- Field notebook;

- Camera if photography is permitted at sampling locations;

- Portable weather meter capable of collecting barometric pressure, relative humidity, and temperature, if appropriate;

- Box, chair, tripod, or similar to hold canister above the ground surface; and

- Teflon sample tubing may be used to sample abnormal situations (i.e., sumps, where canisters must be hidden, etc.). In these situations ¼-inch Swagelok fittings or other methods may be appropriate to affix tubing to canister. Staff should check this before heading out into field.

V. Procedure

Initial Building Survey for Indoor Air Samples (if applicable to project)

1. Complete the appropriate building survey form and product inventory form (attached) as necessary in advance of sample collection. The product inventory should include ingredients of products as well as quantities. A copy of this completed form will be provided to the property owner to discuss potential background sources.

2. Confirm with building occupants that Instructions for Occupants During Indoor Air Sampling Events has been followed, and use of products that may provide interference with sample results has been discontinued and specified products removed to a non-attached structure at least 48-hours before sampling.

3. Identify on a site plan all underground utilities, piping, or conduits coming into or out of the building to be sampled.

4. Survey the area for the apparent presence of items or materials (i.e. foundation cracks) that may potentially produce or emit constituents of concern and interfere with analytical laboratory analysis of the collected sample. Record relevant information on survey form and document with photographs.

5. Record date, time, location, and other relevant notes on the sampling form.

6. Items or materials that contain constituents of concern and/or exhibit elevated PID readings shall be considered probable sources of VOCs. Request approval of the owner or occupant to have these items removed to a structure not attached to the target structure at least 48 hours prior to sampling, if possible.

7. Set a date and time with the owner or occupant to return for placement of SUMMA® canisters.

Preparation of SUMMA®-Type Canister and Collection of Indoor Air or Ambient Air Sample

1. Record the following information from wherever the sample is being collected (i.e. inside a building for indoor air samples or outside for ambient air samples) on the sampling form (use a hand-held weather meter, contact the local airport or other suitable information source [e.g., weather.gov] to obtain the following information):

    - ambient temperature;
    - barometric pressure;
    - wind speed; and
    - relative humidity.

2. Choose the sample location in accordance with the sampling plan. If a breathing zone sample is required, place the canister on a ladder, tripod, box, or other similar stand to locate the canister orifice 4 to 5 feet above ground or floor surface. If the canister will not be overseen for the entire sampling period, secure the canisters as appropriate (e.g., lock and chain). Canister may be affixed to wall/ceiling support with nylon rope or placed on a stable surface. In general, areas near windows, doors, air supply vents, and/or other potential sources of "drafts" shall be avoided. Ambient air samples should be placed upwind of the sampling area.

3. Record SUMMA® canister serial number and flow controller number on the sampling log and chain of custody (COC) form. Assign sample identification on canister ID tag, and record on the sample collection log (attached), and COC form.

4. Remove the cap from the SUMMA® canister. Attach the flow controller with in-line particulate filter and vacuum gauge to the SUMMA® canister with the appropriate-sized wrench. Tighten by hand first, then gently with the wrench. Use caution not to over tighten fittings.

5. Open the SUMMA® canister valve to initiate sample collection. Record the date and local time (24-hour time notation) of valve opening on the sample collection log, and COC form. Collection of duplicate samples will include collecting two samples side by side at the same time.

6. On a floor plan or sketch of the area being sampled, include the following information:

   - Sample location;
   - Locations of heating, ventilation, and air conditioning equipment;
   - Chemical storage areas;
   - Any attached garages or utility areas;
   - Doorways and stairways;
   - Any sumps, drains, or other utility perforations;
   - Separate footings sections or buildings constructions; and
   - The nearest street and the direction of north.

7. All SUMMA®-type canisters received from Air Toxics will be checked for correct vacuum. The vacuum gauges provided by the analytical laboratory as part of the sample train (i.e., canister and flow controller) are used to record the initial and final vacuums in the air sampling canister. Pre-sampling vacuum in the canister should be between -30 inches (in) of Hg and -25 in Hg. In the event a canister is not within this initial range, it will be rejected and a new canister, flow controller and vacuum will be similarly checked.

8. Record the initial vacuum pressure in the SUMMA® canister on the sample log and COC form.

9. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, two SUMMA® canisters will be placed side-by-side and allowed to collect a sample during the exact same period of time.

10. Take a photograph of the SUMMA® canister and surrounding area, if possible.

11. The SUMMA® canister should be checked, if possible, at least once during the 24-hour sampling process and the progress noted on the sampling log.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 1-2 hours prior to the end of the sampling interval (e.g., 24-hour), if possible.

2. Stop collecting the sample when the canister vacuum reaches approximately 5 inches of Hg (leaving some vacuum in the canister provides a way to verify if the canister leaks before it reaches the laboratory) or when the desired sample time has elapsed.

3. Record the final vacuum. Stop collecting the sample by closing the SUMMA® canister valve. Record the date, local time (24-hour time notation) of valve closing on the sample collection log, and COC form.

4. Remove the particulate filter and flow controller from the SUMMA® canister, re-install brass cap on canister fitting, and tighten with wrench.

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with string).

7. Complete COC form and place requisite copies in shipping container. Close shipping container and affix custody seal to container closure. Ship to laboratory via overnight carrier (e.g., Federal Express) for analysis.

VI. Cautions

- Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, keep canisters away from heavy pedestrian traffic areas (e.g., main entranceways, walkways) if possible. If the canisters are not to be overseen for the entire sample duration, precautions should be taken to maintain the security of the sample (e.g., do not place in areas regularly accessed by the public, fasten the sampling device to a secure object using lock and chain, label the canister to indicate it is part of a scientific project, notify local authorities, place the canister in secure housing that does not disrupt the integrity/validity of the sampling event). Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes before and/or during the sampling event.

- If a sub-slab soil-gas sample is collected from a permanent point at the same residence then wait a minimum of 24 hours after the installation of the point before sampling indoor air to minimize cross-contamination from sub-slab soil-gas that may have entered the indoor air during the installation of the point.

- Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 2 to 5–inches Hg) remains in the canister when sample collection is terminated.

- It is important to record the canister pressure, start and stop times and sample identification on a proper field sampling form. Often SUMMA® canisters are collected over a 24 hour period. The time/pressure should be recorded at the start of sampling, and then again one or two hours later. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn't stuck. If the canister is running correctly for a 24 hour period then the vacuum will have decreased slightly after an hour or two (for example from 29 to 27 inches Hg). Consult your project manager (PM), risk assessor or air sampling expert if the SUMMA® canister does not appear to be working properly.

- When sampling carefully consider elevation. If your site is over 2,000 feet above sea level or the difference in elevation between your site and your lab is more than 2,000 feet then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum remaining http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped two to three days before the scheduled start of the sampling event so that all materials can be checked. Order replacements if needed.

- Requesting extra canisters from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- A Shipping Determination must be completed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

- When collecting ambient air samples it is advisable to contact the local police department to inform them of the sampling and the equipment (i.e. SUMMA®) to be used. This will inhibit any false alarms from concerned citizens.

VII. Waste Management

No specific waste management procedures are required.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook and/or sample log (attached) at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, flow rate, initial vacuum reading, and final vacuum reading. Field sampling logs and COC records will be transmitted to the Project Manager. A building survey form and product inventory form (Attachment A) may also be completed for each building within the facility being sampled during each sampling event as applicable.

IX. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Duplicate samples will be collected at a rate of 1 per 10 air samples (10%).

Indoor air sample analysis will be according to USEPA Method TO-15. This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. The GC/MS system requires a 1-liter gas sample (which can easily be recovered from a 6-liter canister) to provide a 0.5 ppbv detection limit. The 6-liter canister also provides several additional 1-liter samples in case subsequent re-analyses or dilutions are required. This system also offers the advantage of the GC/MS detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

Trip blank samples will not be used during indoor air or ambient air sampling. SUMMA® canisters are self-sealed containers which do not permit any contamination to enter during shipment or storage. Furthermore all parts of the SUMMA® canister are metal and non-porous, therefore there is no potential for any contamination to be absorbed. The batch certified clean SUMMA® canisters will be provided by the laboratory. The only potential contamination would come from a possible leak in the SUMMA® canister. The integrity of each SUMMA® canister will be confirmed prior to sampling by measuring the vacuum within the canister, with follow up measurements after the canister is filled in the field, and upon arrival at the laboratory.

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Building Survey and Product Inventory Form

Directions: This form must be completed for each residence or area involved in indoor air testing.

Preparer's Name: ___________________________________

Date/Time Prepared: ________________________________

Preparer's Affiliation: _______________________________

Phone No.: ____

Purpose of Investigation: ____

1. OCCUPANT:

Interviewed: Y / N

Last Name: _________________________ First Name: _________________________

Address: ____

County: ___________________________________

Home Phone: _______________________ Office Phone: ________________________

Number of Occupants/Persons at this Location: _________________

Age of Occupants: ______________________

2. OWNER OR LANDLORD: (Check if Same as Occupant ___)

Interviewed: Y / N

Last Name: _________________________ First Name: _________________________

Address: ____

County: _________________________________

Home Phone: ____________________ Office Phone: ____________________

3. BUILDING CHARACTERISTICS:

Type of Building: (circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: ________________

If the Property is Residential, Type? (circle appropriate response)

Ranch		2-Family 3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Log Home	Other:______________

If Multiple Units, How Many? __________

If the Property is Commercial, Type?

Business Type(s) __________________________________

Does it include residences (i.e., multi-use)? Y / N   If yes, how many? ________

Other Characteristics:

Number of Floors______   Building Age______

Is the Building Insulated? Y / N   How Air-Tight?   Tight / Average / Not Tight

4. AIRFLOW:

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow Between Floors

____

____

____

Airflow Near Source

___

___

Outdoor Air Infiltration

___

Infiltration Into Air Ducts

___

___

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS: (circle all that apply)

a.	**Above grade construction:**	wood frame	concrete	stone brick
b.	**Basement type:**	full	crawlspace	slab other ________
c.	**Basement floor:**	concrete	dirt	stone other ________
d.	**Basement floor:**	uncovered	covered	covered with ____________
e.	**Concrete floor:**	unsealed	sealed	sealed with ____________
f.	**Foundation walls:**	poured	block stone	other ________________
g.	**Foundation walls:**	unsealed	sealed	sealed with ____________
h.	**The basement is:**	wet	damp	dry moldy
i.	**The basement is:**	finished	unfinished	partially finished

j. Sump present? Y / N

k. Water in sump? Y / N / NA

Basement/lowest level depth below grade: ________(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

Potential Vapor Point Entry	Field Screening Results (ppm)	Comments

Are the basement walls or floor sealed with waterproof paint or epoxy coatings? Y / N

6. HEATING, VENTILATING, AND AIR CONDITIONING: (circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation   Heat pump   Hot water baseboard

Space heaters   Stream radiation   Radiant floor

Electric baseboard   Wood stove   Outdoor wood boiler

Other __________

The primary type of fuel used is:

Natural gas   Fuel oil   Kerosene

Electric   Propane   Solar

Wood coal

Domestic hot water tank fueled by: ______________________________

Boiler/furnace located in: Basement   Outdoors   Main Floor   Other____________

Air conditioning: Central Air   Window Units   Open Windows   None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

7. OCCUPANCY:

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage):

Basement ____

1st Floor ____

2nd Floor ____

3rd Floor ____

4th Floor ____

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY:

a. Is there an attached garage? Y / N

b. Does the garage have a separate heating unit? Y / N / NA

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car)?

Y / N / NA Please specify: ____

d. Has the building ever had a fire? Y / N When? ________________________

e. Is a kerosene or unvented gas space heater present? Y / N Where? ________________

f. Is there a workshop or hobby/craft area? Y / N Where & Type? ______________

g. Is there smoking in the building? Y / N How frequently? ______________________

h. Have cleaning products been used recently? Y / N When & Type? ______________

i. Have cosmetic products been used recently? Y / N When & Type? ______________

j. Has painting/staining been done in the last 6 months? Y / N Where & When? __________

k. **Is there new carpet, drapes or other textiles?** Y / N Where & When? ________________

l. **Have air fresheners been used recently?** Y / N When & Type? ________________________

m. **Is there a kitchen exhaust fan?** Y / N If yes, where __________________________

n. **Is there a bathroom exhaust fan?** Y / N If yes, where vented?_________________________

o. **Is there a clothes dryer?** Y / N If yes, is it vented outside? Y / N

p. **Has there been a pesticide application?** Y / N When & Type?_______________________

q. **Are there odors in the building?** Y / N

If yes, please describe: ____

Do any of the building occupants use solvents (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist) at work? Y / N

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No

Yes, use dry-cleaning infrequently (monthly or less) Unknown

Yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y / N

Date of Installation: _______________________

Is the system active or passive? Active/Passive

Are there any Outside Contaminant Sources? (circle appropriate responses)

Contaminated site with 1000-foot radius? Y / N Specify _________________________________

Other stationary sources nearby (e.g., gas stations, emission stacks, etc.): ____________________

____

Heavy vehicle traffic nearby (or other mobile sources): ___________________________________

9. WATER AND SEWAGE:

Water Supply: Public Water Drilled Well Driven Well Dug Well Other: _______

Sewage Disposal: Public Sewer Septic Tank Leach Field Dry Well Other: _______

10. RELOCATION INFORMATION: (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: ___________________________________

____

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided and explained to residents? Y / N

11. FLOOR PLANS:

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

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First Floor:

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12. OUTDOOR PLOT:

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

13. PRODUCT INVENTORY FORM:

Make and Model of field instrument used: ____

List specific products found in the residence or area that have the potential to affect indoor air quality (e.g., gasoline or kerosene storage cans, glues, paints, cleaning solvents/products, polishes/waxes, new furniture/ carpet, nail polish/hairspray/cologne).

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo** Y/N

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Indoor Air or Ambient Air Sample Collection Log

		Sample ID:	
Client:		Outdoor/Indoor:	
Project:		Sample Intake Height:	
Location:		Tubing Information:	
Project #:		Miscellaneous Equipment:	
Samplers:		Time On/Off:	
Sample Point Location:		Subcontractor:	

Instrument Readings:

Date	Time	Canister Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PID (ppb)

(a) Record canister information at a minimum at the beginning and end of sampling

SUMMA Canister Information:

Size (circle one):	1 L 6 L
Canister ID:	
Flow Controller ID:	
Notes:	

General Observations/Notes:

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Appendix D

Laboratory QA/QC

Table D-1. Sample Container, Preservation, Shipping, Packaging Requirements, and QC, Motors Liquidation Company, Moraine, Ohio.

Air Toxics Limited, Folsom, California

Target Parameters	Analytical Method	Containers, Preservatives, Holding Times - Air	Field QC Samples	Laboratory SOP Reference
1,1-Dichloroethane 1,1-Dichloroethene trans-1,2-Dichloroethlene 1,1,1-Trichlorethane cis-1,2-Dichloroethene Trichloroethene Tetrachloroethene Vinyl chloride	U.S. EPA TO-15[a]	Evacuated stainless steel canister - SUMMA® No Preservative Hold Time = 30-days prior and 30-days after sampling	1 duplicate sample per 10 samples	Air Toxics QA/QC methods are presented in the Laboratory Quality Assurance Program[b] (NELAP Quality Manual, Rev. 21.2 date 8/09) and TO 14/TO-15 - Volatile Organic Compounds Methods Manual Section 7 (Rev. 17.1, date 12/09)

VOCs - Volatile organic compounds.
U.S. EPA - United States Environmental Protection Agency.
SOP - Standard operating procedure.
QC - Quality Control.
(a) Instruments with different calibration ranges are utilized for sub-slab and Indoor air samples under U.S. EPA method TO-15 allowing for standard and lower level detection limits (Table B-2).
(b) Presented in Appendix B of the Revised Vapor Intrusion Verification Work Plan (September 16, 2010).

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Table D-2. Standard and Lower Level Reporting Limits, Motors Liquidation Company, Moraine, Ohio.

Air Toxics Limited, Folsom, California

Compound	Standard Detection Limit (µg/m^3)	Lower Level Detection Limit (µg/m^3)
Trichloroethene	2.7	0.55
Tetrachloroethene	3.4	0.69
1,1,1-Trichloroethane	2.8	0.55
1,1- Dichloroethane	2.0	0.41
1,1-Dichloroethene	2.0	0.40
cis-1,2-Dichloroethene	2.0	0.40
trans-1,2-Dichloroethene	2.0	0.39
Vinyl Chloride	1.3	0.26

Standard Detection Limit - sub-slab soil-gas sample.
Lower Level Detection Limit - indoor air and crawl space sample.
µg/m^3 - micrograms per cubic meter.