

Former Emerson Street Landfill Sub-Slab Ventilation Guidance Document Update 2007

Prepared for:

City of Rochester Division of Environmental Quality
30 Church Street
Room 300B
Rochester, New York 14614

LaBella Project No. 207392

November 2007

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1.0 INTRODUCTION AND BACKGROUND

In recent years, vapor intrusion has come to the attention of government agencies concerned with public health. Sub-slab vapor intrusion occurs when volatile hazardous chemicals accumulate beneath the building slab and migrate into the building due to a pressure difference between the building and the sub-slab. This pressure difference is most commonly present during the heating season. For landfill sites where landfill gas, which typically includes methane gas, is being actively produced through decomposition of waste, vapor intrusion is more likely throughout the year. The constituents of landfill gas, causes the threat of accumulation of explosive levels of methane, in addition to the health risks of long term exposure to lower levels. Other volatile organic chemicals, which can be found in landfills and other industrial and commercial sites, have the potential to migrate into buildings, chlorinated volatile organic compounds (Chlorinated-VOCs) are of particular concern due to the toxicity associated with chlorine functional groups in organic molecules.

This guidance document was developed by LaBella Associates, P.C. (LaBella), on behalf of the City of Rochester's Division of Environmental Quality (DEQ), as an update of the document titled "Former Emerson Street Landfill Sub-Slab Ventilation Guidance Document" dated May 2000 by Haley and Aldrich of New York for the City of Rochester (hereafter referred to as "The 2000 Guidance Document"). Background and historical information that is quoted from the 2000 Guidance Document appears in italics. The 2000 Guidance Document and this 2007 Updated Guidance Document were developed *to assist the City of Rochester with design guidance of sub-slab ventilation (or landfill gas abatement) systems in buildings constructed over solid waste and/or ash contained within the former Emerson Street Landfill (FESL). This document was produced in response to the Monroe County Department of Health (MCDOH) concerns regarding the possibility of landfill gases seeping into the sub-slab portions of such buildings.* This updated document also addresses the need to provide guidance for paved surfaces within the landfill footprint.

It should be noted that the City of Rochester has applied an Environmental Institutional Control (EIC) to parcels located within the FESL. The EIC system requires DEQ approval as part of the City Permit process for any construction activity on a parcel flagged by the system. The City of Rochester coordinates with the New York State Department of Environmental Conservation (NYSDEC), New York State Department of Health (NYSDOH) and/or Monroe County Department of Health (MCDOH) as needed.

The existing 2000 Guidance Document has become outdated due to the promulgation of new guidelines by the NYSDOH and the NYSDEC in October 2006. The NYSDOH document is titled "Guidance for Evaluating Soil Vapor Intrusion in the State of New York", and the NYSDEC companion document is titled "DER-13 / Strategy for Evaluating Soil Vapor Intrusion at Remedial Sites in New York". The NYSDEC document describes the State's criteria for evaluating new and existing sites in order to determine whether these sites have the potential for exposures related to soil vapor intrusion. The FESL

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appears on the "List of Inactive Hazardous Waste Sites with Pre-2003 Remedial Decisions where Disposal of Chlorinated Hydrocarbons Occurred", however, the priority rankings of these sites have not yet been published. The new NYSDOH guidance includes recommendations for active depressurization systems, (as opposed to the passive systems described in the 2000 Guidance Document), as well as recommendations for testing and reporting. This updated document takes into account these recommendations.

Previous FESL investigations have correlated historical information regarding the variable composition of the landfill and analytical data at specific locations. Historic aerial photographs have been reviewed to determine the date of filling of different portions of the landfill. This information was useful because it is known that during the final years of the landfill's operational life (the early 1970s); the site incinerator was no longer functioning properly, resulting in inadequately incinerated waste, and a high percentage of un-incinerated, putrescible waste. Putrescible waste poses multiple difficulties for future redevelopment. First, its decomposition results in differential settling, requiring more comprehensive building structures. Second, the decomposition of the waste produces methane and other landfill gasses, which pose the threat of accumulation in buildings resulting in potential explosion or chronic toxicity. In addition, analytical data indicating the presence of Chlorinated-VOCs suggests the likelihood that non-permitted disposal of industrial chemicals and/or miscellaneous disposal of household waste containing chemicals may have taken place at the FESL. The portions of the landfill where possible non-permitted disposal took place are listed as a NYSDEC Inactive Hazardous Waste Disposal Site (IHWDS). Landfill disposal by year and the limits of the IHWDS are shown on Figure 1.

Available analytical data types relevant to soil vapor migration include the following:

- ground surface landfill gas flux measurements throughout the landfill;
- soil gas measurements for methane, vinyl chloride (a Chlorinated-VOC), and the VOCs: benzene, toluene, ethylbenzene, and xylenes (BTEX) across a limited area (the state-listed IHWDS portion of the landfill, see Figure 1);
- PID measurements taken in utility vaults and sewers along roadways surrounding the landfill;
- soil samples for select Chlorinated-VOCs from borings across the landfill; and
- groundwater samples for select Chlorinated-VOCs from wells installed across the landfill.

In this document, a methodology for selecting an appropriate ventilation system is described that is dependent on landfill gas and Chlorinated-VOC measurements in the geographic location of the proposed buildings or parking lot (with respect to the footprint of the FESL), and the type of foundation required for a building. In general, a more robust ventilation system is recommended in areas of either higher historical contamination measurements, or where high putrescible-waste content requires caisson foundation styles. Parking lot venting systems are recommended in areas with high historical methane measurements.

2.0 EXISTING SITE SOIL-GAS CONTAMINATION INFORMATION

The report "Former Emerson Street Landfill, Modified Remedial Investigation", H&A of New York, January 1994, contains applicable landfill gas flux information. During this investigation, landfill gas measurements were obtained across the landfill area with specially-designed gas flux chambers. As summarized in the report, landfill gas is typically composed of 58% methane, 42% carbon dioxide, and trace amounts of hydrogen sulfide and other organic compounds. Methane emission rates varied in the FESL samples from a minimum of 7.8 to a maximum of 1200 $\mu\text{g}/\text{m}^2$ -minute. Results are summarized on Figure 2. The H&A report also contains analytical information for Chlorinated-VOCs in soil, groundwater, and utility vault water samples, and PID readings for utility vaults and manholes. Analytical results indicated the presence of Chlorinated-VOCs at various locations throughout the landfill, but concentrated in the IHWDS portion. Results are summarized on Figure 3.

The report "Former Emerson Street Landfill Remedial Investigation Report for Parcels 4, 10, and 11", LaBella Associates P.C., and Geomatrix Consultants, Inc., March 2001, describes sampling completed in the IHWDS portion of the landfill. Sampling was completed in soil, groundwater, sewers, and extensive soil gas points. For the purpose of this guidance document, sewer samples were not reviewed as they did not add additional areas to problem areas identified by the sampling in other media. Analytical results confirmed and further delineated the presence of Chlorinated-VOCs in the IHWDS portion of the landfill. The soil gas results for the specific constituents detected in this summary are briefly summarized below:

- Vinyl chloride concentrations ranged from 0.02 milligrams per cubic meter (mg/m^3) to 9 mg/m^3 ;
- Benzene concentrations ranged from 0.02 mg/m^3 to 0.6 mg/m^3 ;
- Total BTEX concentrations ranged from 0.48 mg/m^3 to 499 mg/m^3 ;
- Chlorobenzene concentrations ranged from 0.02 mg/m^3 to 1.6 mg/m^3 ; and,
- Methane concentrations ranged from 380 ppm to 790,000 ppm.

The cumulative results are summarized on Figure 3.

The FESL can be separated into four general geographic regions (FESL Quadrants) based on the landfill waste composition and historic analytical data. The composition of the landfill will likely impact the type of building design that will be developed. In other words, buildings constructed over areas of high non-ash, potential putrescible solid waste will more likely have pier or caisson-style foundations to provide structural stability, and this type of foundation does not allow easy implementation of a plastic sheeting type liner as a vapor barrier. For caisson or pier type foundations, cold-spray applied membrane liners are recommended. Conversely, a standard concrete footing with slab on grade foundation type is more amenable to implementation of a system utilizing a plastic sheeting type vapor barrier.

The characteristics of the FESL Areas are summarized on Figure 4 and below:

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Quadrants A and B (North of Emerson Street):

Portions of Quadrants A and B were filled during the 1970's, the last years of the landfill's operational life (Figure 1). At this time the incinerator was no longer operating properly, resulting in unincinerated putrescible waste being deposited in the landfill during that period. These portions of the landfill are characterized by thicker fill, higher percentage of potentially putrescible solid waste and less incinerated ash, and higher landfill gas flux at the surface relative to other FESL areas sampled. These areas are characterized by landfill gas flux measurements between 100 and 1200 $\mu\text{g}/\text{m}^2\text{-minute}$, and/or soil gas methane concentrations above 5,000 ppm. In addition, these quadrants have also been characterized with Chlorinated-VOC contamination in soil gas, soil, and groundwater. Quadrant A is distinguishable from Quadrant B by a larger area of documented Chlorinated-VOC contamination present in Quadrant A. The listed IHWDS portions of the landfill are located within Quadrant A.

Quadrant C (South of Emerson Street, East of Colfax Street):

Quadrant C is characterized by thinner fill, lower percentage of potentially putrescible solid waste and more incinerated ash, and intermediate landfill gas flux at the surface relative to other FESL areas sampled. This area is characterized by landfill gas flux measurements between 50 and 200 $\mu\text{g}/\text{m}^2\text{-minute}$. It has been hypothesized that this may be related to the presence of organic rich marsh-derived soils at depth in this area, as opposed to landfill related gas. There is also an area of Chlorinated-VOC contamination in this quadrant.

Quadrant D (South of Emerson Street, West of Colfax Street):

Quadrant D is characterized by thinner fill, lower percentage of potentially putrescible solid waste and ash that was more efficiently and completely incinerated, and lower landfill gas flux at surface relative to other FESL areas sampled. This area is characterized by landfill gas flux measurements below 50 $\mu\text{g}/\text{m}^2\text{-minute}$. In addition, there are several small areas of Chlorinated-VOC contamination in this quadrant, which may be the result of post-landfill industrial activity as opposed to landfill operations.

3.0 RECOMMENDED ADDITIONAL SAMPLING

This section describes the recommended additional sampling prior to redevelopment of FESL parcels.

3.1 Sampling Methods & Procedures

Site specific soil gas sampling is recommended, though not required, prior to redevelopment. Predevelopment sampling would be particularly useful in Quadrants C and D where less comprehensive data is available. Recent information would be of great value in customization of the design of sub-slab depressurization systems and parking lot vent systems. In the case of parking lots, quantitative sampling could demonstrate that there is no need for a vent system.

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If sampling is performed, it is recommended that data be collected from soil gas points advanced approximately 4-feet below ground surface, or at a depth that corresponds to the depth of the building slab. Soil gas samples can be analyzed either qualitatively or quantitatively. Qualitative analysis can be done using a PID for total VOCs and a portable gas analyzer for methane. Quantitative analysis can be done with a portable gas chromatograph, or sample collection and laboratory analysis for methane, Chlorinated-VOCs, and petroleum related VOCs. Recent NYSDOH guidance indicates sampling using low flow rates (less than 0.2 liters per minute) using Summa Canisters that are pre-cleaned by the laboratory. The typical analytical method for VOCs is the United States Environmental Protection Agency (USEPA) Method TO-15. Detailed guidance on soil gas sampling is provided in the NYSDOH "Guidance for Evaluating Vapor Intrusion in the State of New York", portions of which are reproduced as Appendix 2 of this document.

3.2 Interpreting Sampling Results

A useful resource for understanding the significance of measured concentrations of different soil gas contaminants is the USEPA document entitled "OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)", November 2002. Lookup tables are included in the USEPA guidance, and attached in Appendix 4, that provide target concentrations for a wide range of chemicals that pose vapor migration concerns. This guidance was used to develop the Chlorinated-VOC contamination areas shown in Figure 3. [Note: NYSDOH may be developing additional lookup tables or matrices, as such; NYSDOH should also be consulted once sample results are available.]

4.0 DESCRIPTION OF VENTILATION SYSTEMS

Buildings:

Due to the potential presence of methane and/or Chlorinated-VOCs, engineering controls are recommended at all new buildings constructed within the footprint of the landfilling at the FESL, as indicated on Figure 1. Areas that are within the site boundary but outside landfill areas may be demonstrated to not require ventilation systems based on sampling and analysis. It should be noted that for VOCs, soil gas testing in the absence of a slab and the associated pressure differential may not be a good predictor of the absence of a soil vapor migration problem. Following building construction, additional testing would be required, per the NYSDOH guidance, and if vapor migration were found to be occurring, a 'retrofit' system would need to be designed and built. It is more cost effective, easier and more effective to build a system prior to building construction than afterwards. With that in mind, the basic system recommended for buildings is an active sub-slab depressurization system. For all Quadrants, it is recommended that the system consists of the following components:

- an impermeable vapor barrier that inhibits migration of landfill gases through the sub-slab and into the building (see below for specifics);
- sub-slab vent pipes that provide a conduit for landfill gas to the exterior of the building;

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- fans attached to the vent pipes that result in active depressurization of the sub-slab;
- an alarm system demonstrating that the system is operating, which should be located conspicuously in an area frequented by a person responsible for monitoring the system's status (an informational sheet with emergency contact information and that briefly describes the operation of the system should be available in the alarm area);
- crushed stone placed in vent-pipe trenches and a layer of crushed stone or sand (depending on the structural needs of the slab) beneath the entire slab to act as a high permeability zone for gas migration and pressure field extension; and
- permanent gauge points to evaluate the effectiveness of the system.

Based on the geographic location described above, LaBella recommends the impermeable vapor barrier liner for the system be one of the two following types:

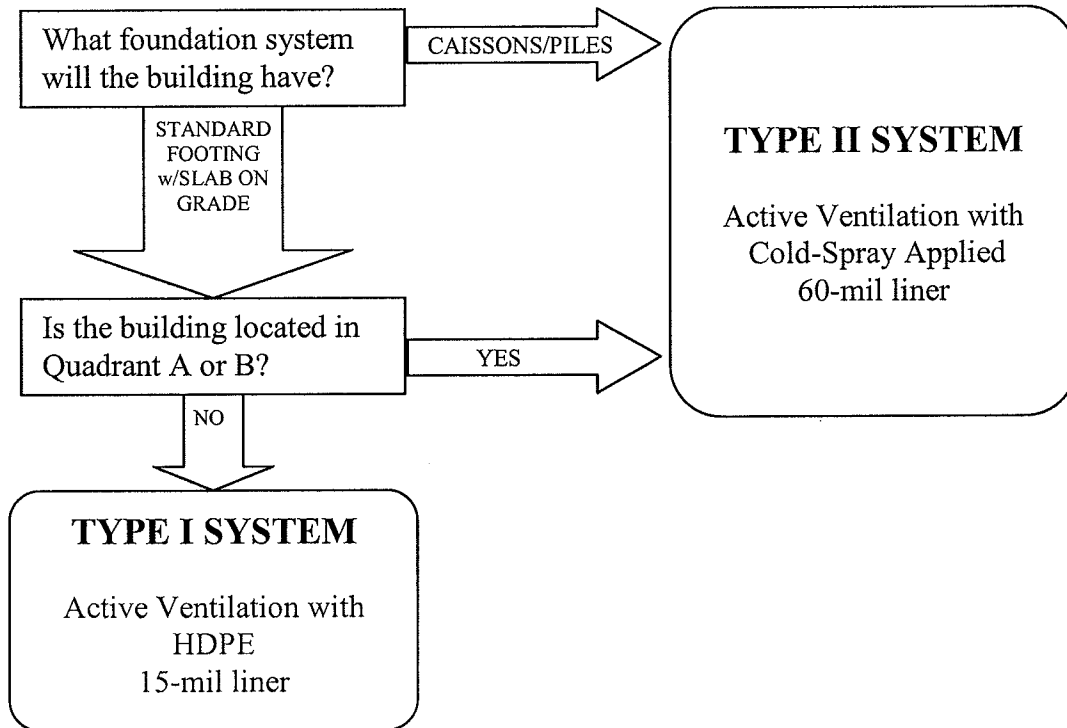
- Type I: 15 mil reinforced polyethylene sheeting; or,
- Type II: 60 mil spray-applied membrane

The Type I liner is appropriate for buildings constructed south of Emerson Street (Quadrants C and D) if the foundation is a standard concrete footing with slab on grade type. The Type II liner is appropriate for buildings constructed north of Emerson Street (Quadrants A and B), regardless of foundation type, and for buildings constructed south of Emerson Street (Quadrants C and D) with caisson or pile type foundations.

Example building layouts and construction details are provided in Figures 5 and 6. Example specifications are provided in Attachment 1.

A conceptual decision matrix for determining the recommended sub-slab ventilation system type is presented below:

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Parking Lots/Paved Areas:

When landfills that contain actively decomposing materials are capped, there are concerns that methane gas may accumulate to levels that could cause the threat of explosion. It is therefore recommended that when parking lots or other paved areas are planned within the FESL footprint, a vent system be designed to prevent methane accumulation. Areas not identified as methane areas on Figure 2 may not require vent systems if soil gas test results do not show methane gas evolution above $40 \mu\text{g}/\text{m}^2\text{-minute}$, or 100 ppm soil gas methane. While no definitive standards exist for methane gas levels, the $40 \mu\text{g}/\text{m}^2\text{-minute}$ value is based on being elevated with respect to a background sample of approximately $30 \mu\text{g}/\text{m}^2\text{-minute}$; and the 100 ppm value is based on elevation above natural background levels of 0 to 50 ppm. The evacuation action level is 5,000 ppm, or 10 % of the lower explosive limit (LEL) for methane, as determined by the U.S. National Fire Code.

As a rule of thumb, vents should be placed every 200 feet. Venting systems can be constructed either as well points (simpler and less expensive), or with horizontal piping lengths similar to the building sub-slab depressurization systems. Well points or horizontal piping should be screened/placed in the upper five feet of fill. All vents should be equipped with a stack that extends at least as high as the rooftops of nearby buildings, or 35 feet, whichever is greater. Stacks can be affixed to lighting systems as structural support when feasible. The stack may terminate in a water intrusion prevention device, a wind-driven

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exhaust turbine, or a flare, depending on the methane concentrations. Flares are only appropriate when a horizontal system is used, or the area to be paved is small enough (4000 sq ft) to be served by a single vent. Systems utilizing flares may be subsidized by the State when built in cooperation with the City. Flares are beneficial to the environment because they combust the methane to carbon dioxide (a less active greenhouse gas than methane) and water vapor. They are also helpful in preventing odor problems.

Example layouts and construction details are provided in Figures 5 and 6.

Air Emission Permitting/Registration Status:

According to the provisions of Title III 201-3.3.c of the New York State Air Pollution Regulations, emissions of methane, and trace constituents that are less than 1 percent by weight for any regulated air pollutant, or 0.1 percent by weight for any carcinogen, are classified as 'trivial' and are exempt from registration and permitting provisions of subparts 201-4 and 201-5. Benzene and vinyl chloride are the only carcinogens known to be present in soil vapor at the FESL. The highest known concentrations of benzene and vinyl chloride in soil gas at the site (measured by Geomatrix in 2001) are 0.000048 and 0.00072 percent, respectively. Concentrations of Chlorinated-VOCs in other media do not approach the 1 percent level, nor the 0.1 percent level, making it unlikely that higher concentrations would exist in the air in the vicinity of the contaminate media. Nonetheless, site specific soil gas data should be collected to confirm the registration exemption status prior to construction of a system.

5.0 RECOMMENDATIONS FOR INSTALLATION AND MAINTENANCE

The following recommendations are for general guidance purposes only, and are not to be used as construction specifications. Construction specifications should be developed by a qualified professional on a site-specific basis. Similarly, specific requirements for system maintenance and reporting should be coordinated with the appropriate regulatory agency or agencies (e.g. NYSDEC, MCDOH, NYSDOH, etc.)

General Building Sub-Slab Depressurization System Installation Recommendations:

- Design the layout of the piping so that the spacing between each piping length is approximately 15 feet.
- Limit the initial length of pipe running on one fan to 150 to 200 ft. Following initial radius of influence testing, pipe runs can be consolidated to run on as few fans as testing demonstrates can achieve adequate pressure fields. Radius of influence testing can only be done once the slab/asphalt surface course is in place.
- Include piping routed to separate fans around the perimeter of the building, as this is a common 'short-circuit' area. This will protect the rest of the system from pressure 'short-circuiting'.
- It is recommended that the installation of the system be overseen and/or inspected by a qualified professional. Regulatory agencies (e.g. NYSDEC, MCDOH, NYSDOH, etc.) may require submission of a report that documents the installation of the system.

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- Explosivity testing should be conducted on the vented air in each leg of the system before and during initial operation. It is recommended that the explosivity testing be performed prior to the purchase of exhaust fans. If the explosivity testing indicates significant levels of landfill gases (>5,000 ppm methane or 10% LEL), intrinsically safe fans are required.
- The degree to which the system can be refined for maximum efficiency (smallest number of fans) depends on the number of test points installed, since fans can only be eliminated when it is demonstrated that sufficient coverage is provided by fewer fans.
- *Avoid sharp items (e.g. larger stones, rebar) that could damage the integrity of the vapor barrier or piping, as appropriate.*

General Building Sub-Slab Depressurization System:

- Upon system completion, perform a positive-pressure smoke test of the vapor barrier and the system to detect any leaks around concrete cracks, floor joints, and at the suction point. Any leaks identified should be resealed until the smoke test passes (i.e., no smoke observed).
- Test buildings with natural draft combustion appliances for backdrafting and correct as necessary.
- Conduct a Pressure Field Extension test using the installed test points per the 2006 NYSDOH Guidance Document. The test can be performed by attaching a magnahelic micro pressure gauge to the gauge end, or by observing smoke being drawn in to the gauge end. This test must demonstrate that a vacuum is being created beneath the entire slab. [*Note: This test is included in the 2006 NYSDOH Guidance. See Appendix 2.*]
- When possible, route gauge points for pressure test points outside the building through the foundation rather than through the building floor, as slab penetrations provide potential contamination paths for future chemical spills.
- Air sampling is indicated if there is any indication of possible impediments to comprehensive sub-slab communication of the depressurization system (i.e., locations with wet or dense sub-slab soils, multiple foundations and footings, minimal pressure differentials between the interior and sub-slab). In buildings with basements, post-mitigation indoor air sampling from the basement alone (i.e., without a concurrent indoor air sample from the first floor) is recommended in most circumstances. See the NYSDOH Guidance Document, Section 3, for sampling protocols.
- Typically, post-mitigation sampling should be conducted no sooner than 30 days after installing a depressurization system. If the system is installed outside of the heating season or at the end of a season, post-mitigation air sampling may be postponed until the heating season, per the DOH.

System maintenance recommendations:

- Inspect external portions of the systems, including fans, piping, alarms, labeling, etc., biannually to evaluate system integrity. Repair or replace components as necessary.

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- Inspect fans monthly to ensure they are operating properly and are securely mounted. Repair or replace components as necessary.
- Inspect exhaust points monthly to ensure they haven't become plugged or blocked. Inspect more frequently in cold weather to ensure the exhaust points are not clogged by snow or ice.
- It is recommended that system inspections and maintenance be performed on a regular basis and that documentation of these activities be generated and retained. Regulatory agencies (e.g. NYSDEC, MCDOH, NYSDOH, etc.) may require that copies of such documentation be submitted.
- *Perform other maintenance activities as specified by manufacturer of installed equipment.*

6.0 CONTACT INFORMATION

The individuals, agencies, and organizations listed below may be contacted for additional information:

Joseph Biondolillo
City of Rochester, Department of Environmental
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(585) 428-6649

Avon, NY 14414
(585) 226-2466

Mark Gregor
City of Rochester, Department of Environmental
Services
Division of Environmental Quality
30 Church Street, Room 300B
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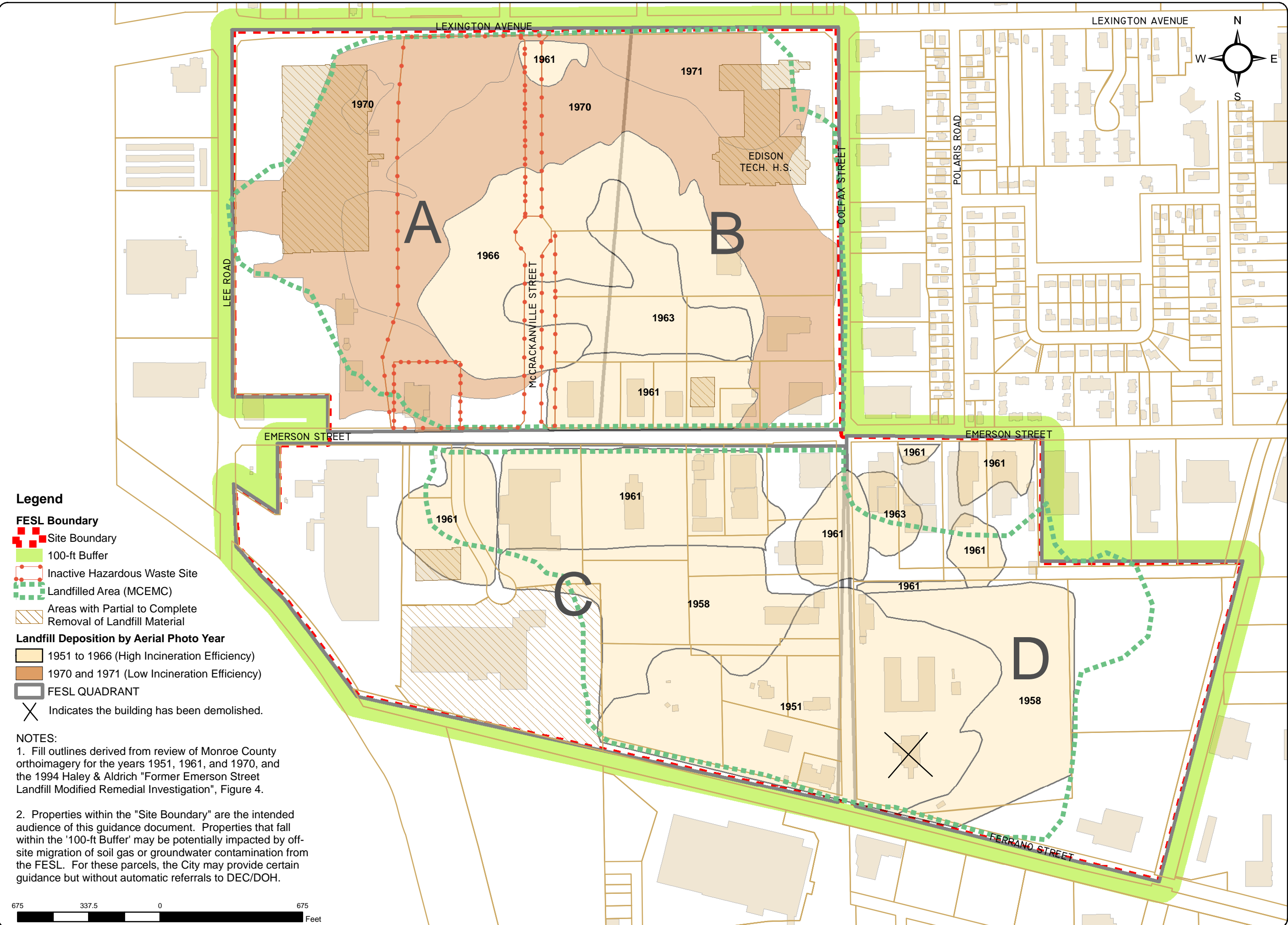
Todd Caffoe
NYSDEC Region 8
Div. of Hazardous Waste Remediation
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Figures

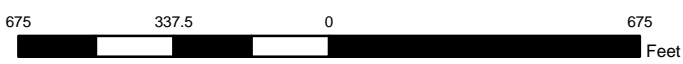


Legend

- FESL Boundary**
- Site Boundary
 - 100-ft Buffer
 - Inactive Hazardous Waste Site
 - Landfilled Area (MCEMC)
 - Areas with Partial to Complete Removal of Landfill Material
- Landfill Deposition by Aerial Photo Year**
- 1951 to 1966 (High Incineration Efficiency)
 - 1970 and 1971 (Low Incineration Efficiency)
- FESL QUADRANT
- Indicates the building has been demolished.

NOTES:

- Fill outlines derived from review of Monroe County orthoimagery for the years 1951, 1961, and 1970, and the 1994 Haley & Aldrich "Former Emerson Street Landfill Modified Remedial Investigation", Figure 4.
- Properties within the "Site Boundary" are the intended audience of this guidance document. Properties that fall within the '100-ft Buffer' may be potentially impacted by off-site migration of soil gas or groundwater contamination from the FESL. For these parcels, the City may provide certain guidance but without automatic referrals to DEC/DOH.



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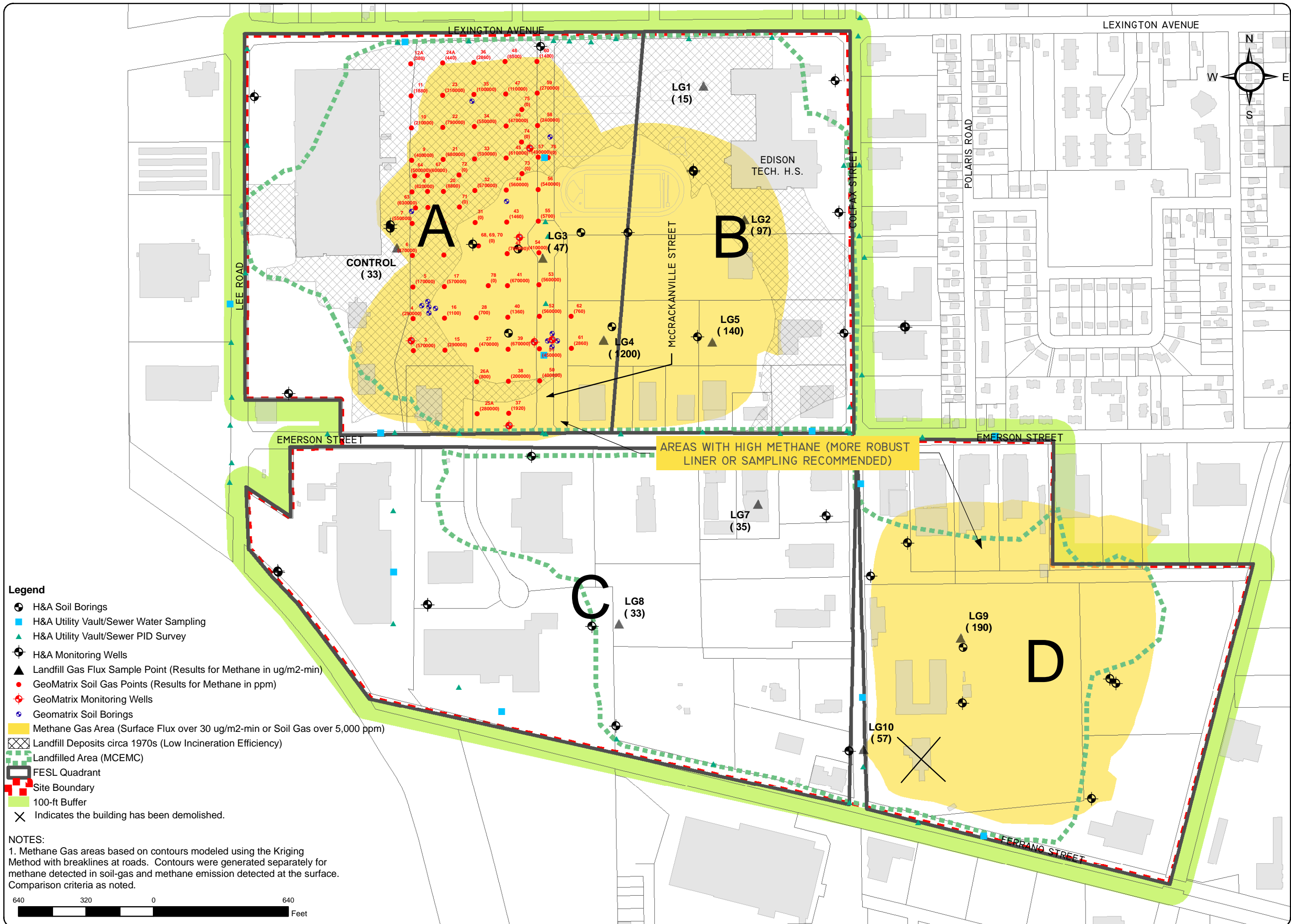
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 CITY OF ROCHESTER
 FORMER EMERSON STREET LANDFILL
 ROCHESTER, NEW YORK

DRAWING TITLE
 LANDFILL DEPOSITION YEAR

ISSUED FOR:	DESIGNED BY:	RCN
FINAL	DRAWN BY:	RCN
DATE:	REVIEWED BY:	DP
JULY 2007		

FILEPATH: S:\GIS\PROJECTS\FESL\Landfill Deposition\Draw.mxd

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 FIGURE 1



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PROJECT CLIENT
 CITY OF ROCHESTER
 FORMER EMERSON STREET LANDFILL
 ROCHESTER, NEW YORK

DRAWING TITLE
 HIGH METHANE
 EVOLUTION AREAS

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DATE: MAY 2007	REVIEWED BY	DPN

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 FIGURE 2



Legend

- H&A Soil Borings (Total Cl-VOC Results in ug/kg)
- Geomatrix Soil Borings (Total Cl-VOC Results in ug/kg)
- H&A Monitoring Wells (Total Cl-VOC Results in ug/L)
- Geomatrix Monitoring Wells (Total Cl-VOC Results in ug/L)
- ▲ H&A Utility Vault/Sewer PID Survey (VOCs in ppm)
- H&A Utility Vault/Sewer Water Sampling (Total Cl-VOC Results in ug/L)
- ▲ H&A Landfill Gas Flux Points
- Geomatrix Soil Gas Points (Results for Vinyl Chloride in mg/m3)
- Chlorinated VOC in Any Media (Criteria vary)
- ▨ Landfill Deposits circa 1970s (Low Incineration Efficiency)
- ▨ Landfilled Area (MCEMC)
- FESL Quadrant
- Site Boundary
- 100-ft Buffer
- ✕ Indicates the building has been demolished.

NOTES:

1. Chlorinated VOC areas were based on contours modeled using the Kriging Method with breaklines at roads. Contours were generated separately for detected Cl-VOCs in soil-gas and groundwater, and total Cl-VOCs in soil samples. Detected Cl-VOCs in soil-gas and groundwater were compared to USEPA criteria for soil vapor migration from shallow groundwater.

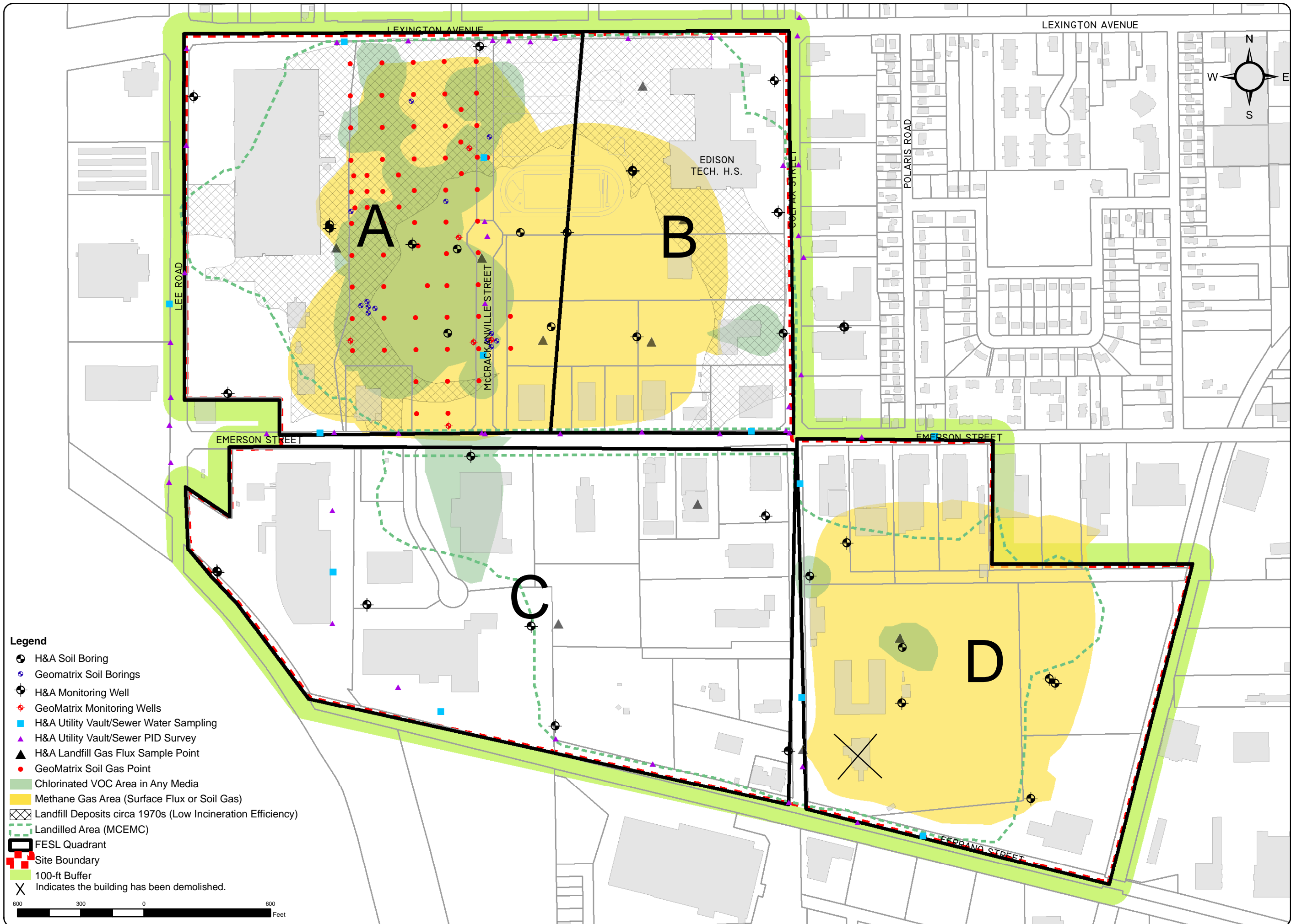
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 DRAWN BY: RCN
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PROJECT/DRAWING NUMBER
 207392
 FIGURE 3



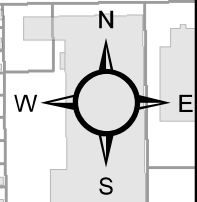
Legend

- H&A Soil Boring
- Geomatrix Soil Borings
- H&A Monitoring Well
- GeoMatrix Monitoring Wells
- H&A Utility Vault/Sewer Water Sampling
- H&A Utility Vault/Sewer PID Survey
- H&A Landfill Gas Flux Sample Point
- GeoMatrix Soil Gas Point
- Chlorinated VOC Area in Any Media
- Methane Gas Area (Surface Flux or Soil Gas)
- Landfill Deposits circa 1970s (Low Incineration Efficiency)
- Landfilled Area (MCEMC)
- FESL Quadrant
- Site Boundary
- 100-ft Buffer
- Indicates the building has been demolished.



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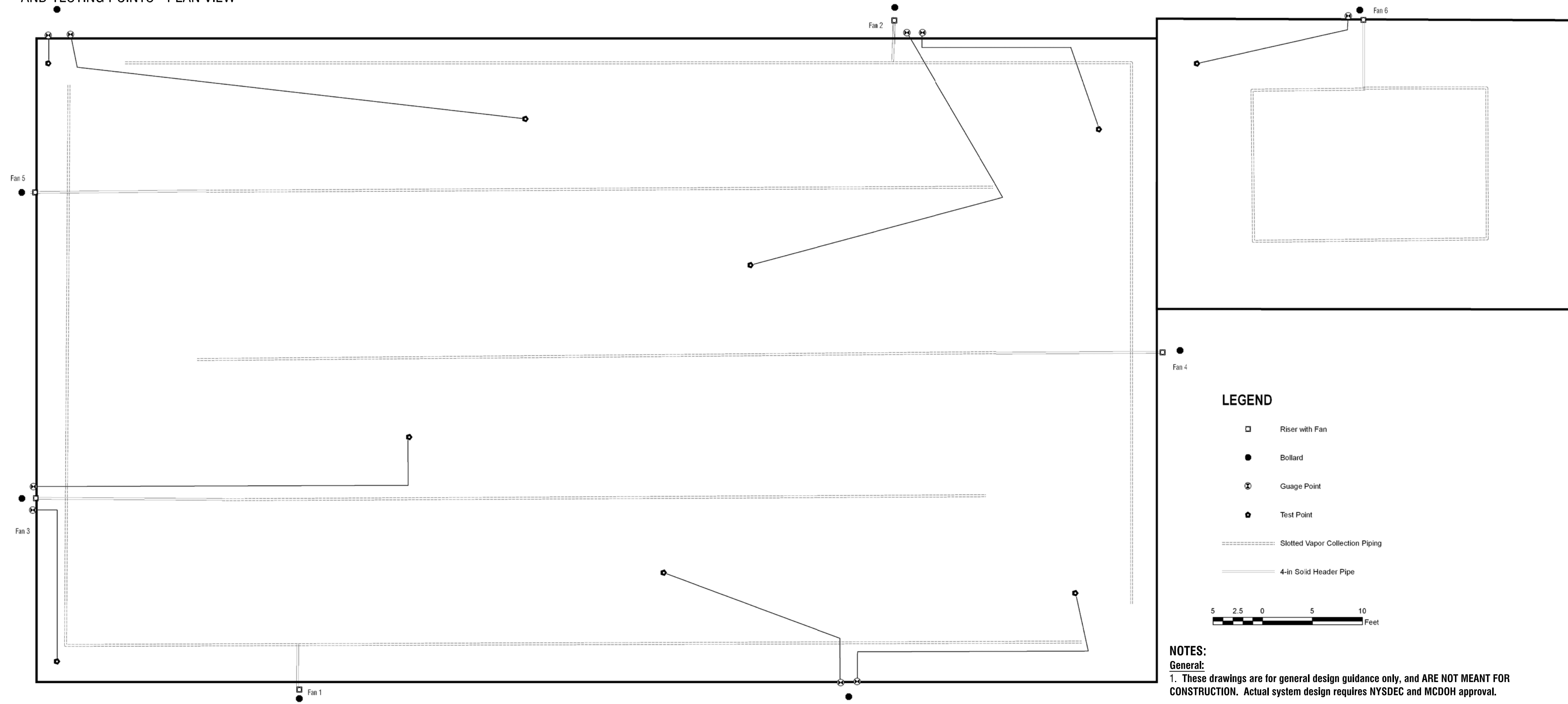
PROJECT/TITLE
 CITY OF ROCHESTER
 FORMER EMERSON STREET LANDFILL
 ROCHESTER, NEW YORK

ISSUED FOR: FINAL
 DATE: MAY 2007
 FILEPATH: S:\GIS\PROJECTS\FESL\land

DESIGNED BY:	RCN
DRAWN BY:	RCN
REVIEWED BY:	DPN

PROJECT/DRAWING NUMBER
 207392
 FIGURE 4

EXAMPLE BUILDING SUB-SLAB
DEPRESSURIZATION SYSTEM LAYOUT
AND TESTING POINTS - PLAN VIEW



LEGEND

- Riser with Fan
- Bollard
- ⊙ Gauge Point
- Test Point
- Slotted Vapor Collection Piping
- 4-in Solid Header Pipe



NOTES:

- General:**
1. These drawings are for general design guidance only, and ARE NOT MEANT FOR CONSTRUCTION. Actual system design requires NYSDEC and MCDOH approval.
 2. Install perforated cap at each vapor collection pipe termination.
 3. Slope header pipe up 1/4-inch per foot from connection with vapor collection piping.
 4. Piping layouts may be adjusted as necessary, as long as the spacing between lengths is maintained at ~15-ft.
 5. The distance from the header pipe to the end of the pipe length should not exceed 175-ft.
 6. Spacing between lengths and length of pipes may be greater if geotechnical testing indicates high permeability in the upper soil horizon.
 7. Areas where the slab is isolated by sub-surface foundation walls should have separate systems (see Fan 6).
 8. Test points should be placed in 'worst-case' areas based on an assumed 15-ft radius of influence of each pipe.
 9. Structure shown is for representation purposes only. Actual building layout and dimensions will vary.

Geovent System:

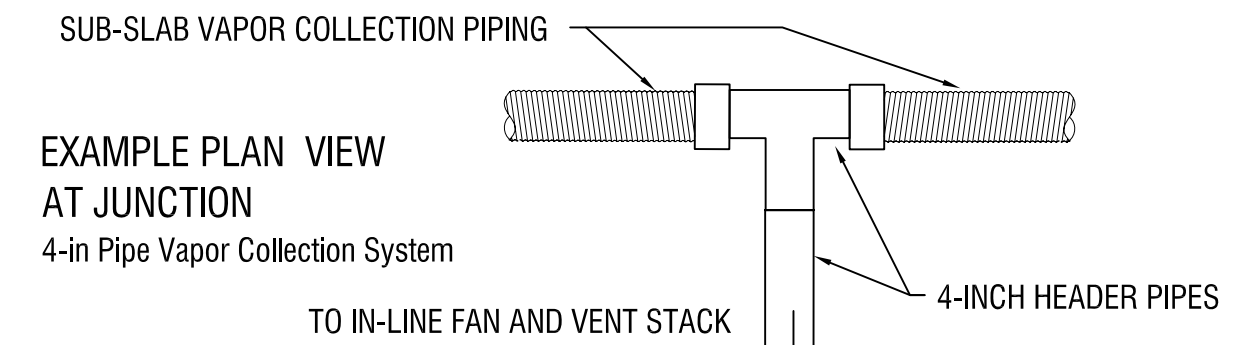
1. Install per manufacturer instructions.

4-in Pipe System:

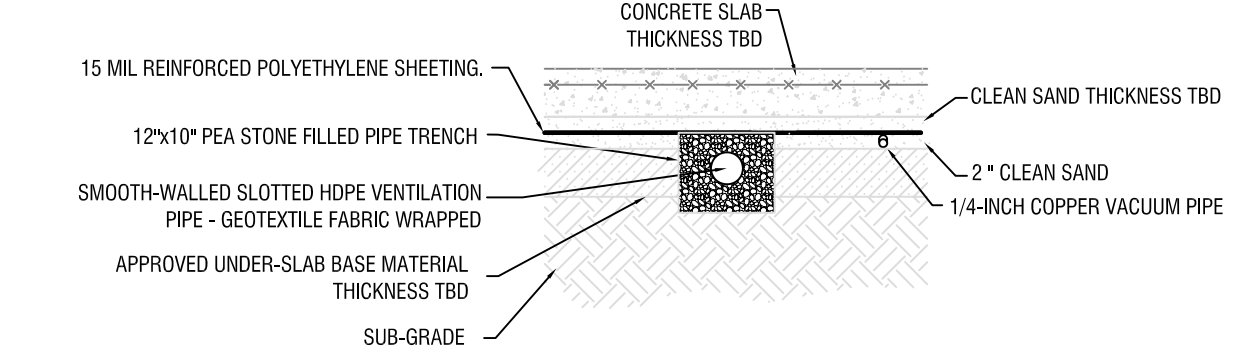
1. All sub-slab vapor collection piping is geotextile-wrapped 4-inch perforated dual-walled corrugated exterior smooth interior HDPE.
2. Header piping shown is 4-inch schedule 40 PVC. Actual Piping may vary.

Detail Notes:

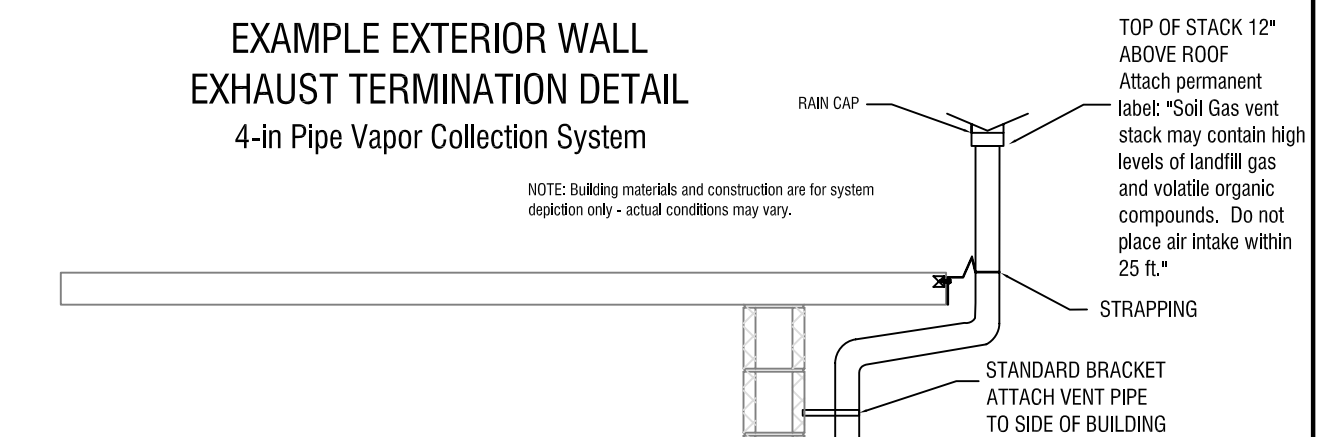
1. Profile sequence may change based on materials specified by the slab designer. Any alterations to the depicted profile that reduces the layer of permeable material shall be made in coordination with NYSDEC & MCDOH.
2. CLEAN SAND shall be bedding/cushion sand as specified in NYS DOT Section 703-06.
3. PEA STONE shall consist of material that will pass through a 2-inch sieve and be retained by a 1/4-inch sieve.
4. To protect the vapor barrier, all penetrations made after pouring of the slab, such as joints, etc, shall be cut in a manner to avoid penetrating the protective sand layer above the vapor barrier.
5. Seal all penetrations and gaps with an elastomeric joint sealant.
6. Type II liners need not be paired with 'Geovent' ventilation systems as shown. 4-in pipe or Geovent may be used interchangeably with either liner type.



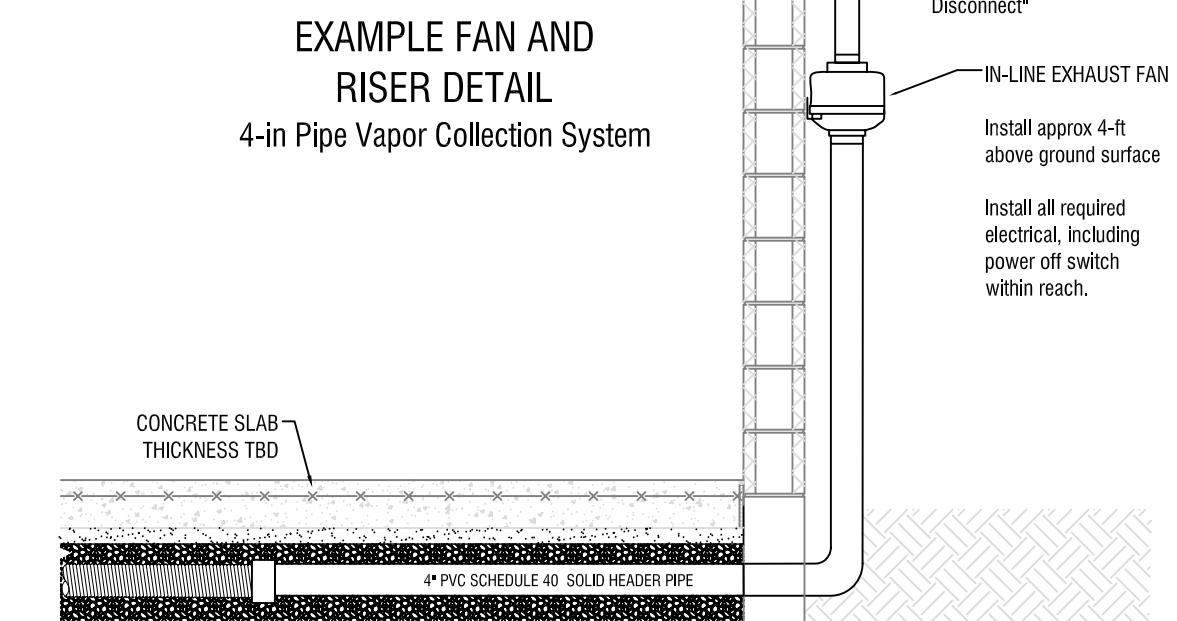
EXAMPLE CROSS-SECTIONAL
DETAIL AT TRENCH AND TEST PIPE
Type I Liner and
4-in Pipe Vapor Collection System



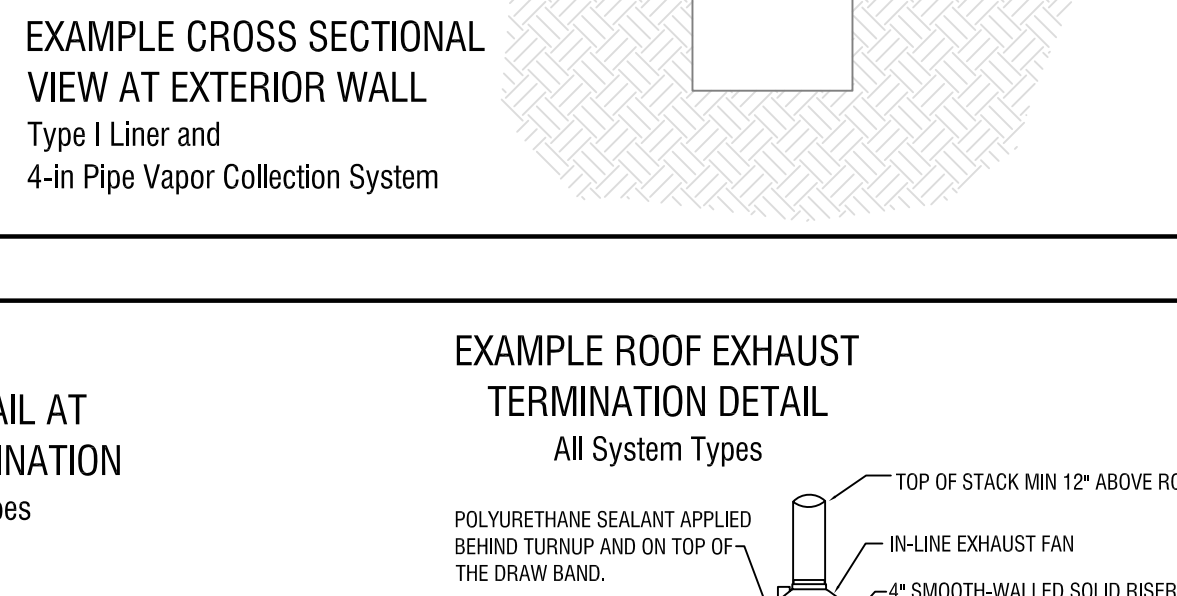
EXAMPLE EXTERIOR WALL
EXHAUST TERMINATION DETAIL
4-in Pipe Vapor Collection System



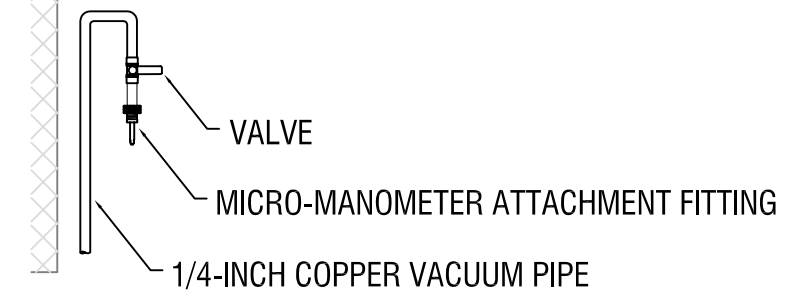
EXAMPLE FAN AND
RISER DETAIL
4-in Pipe Vapor Collection System



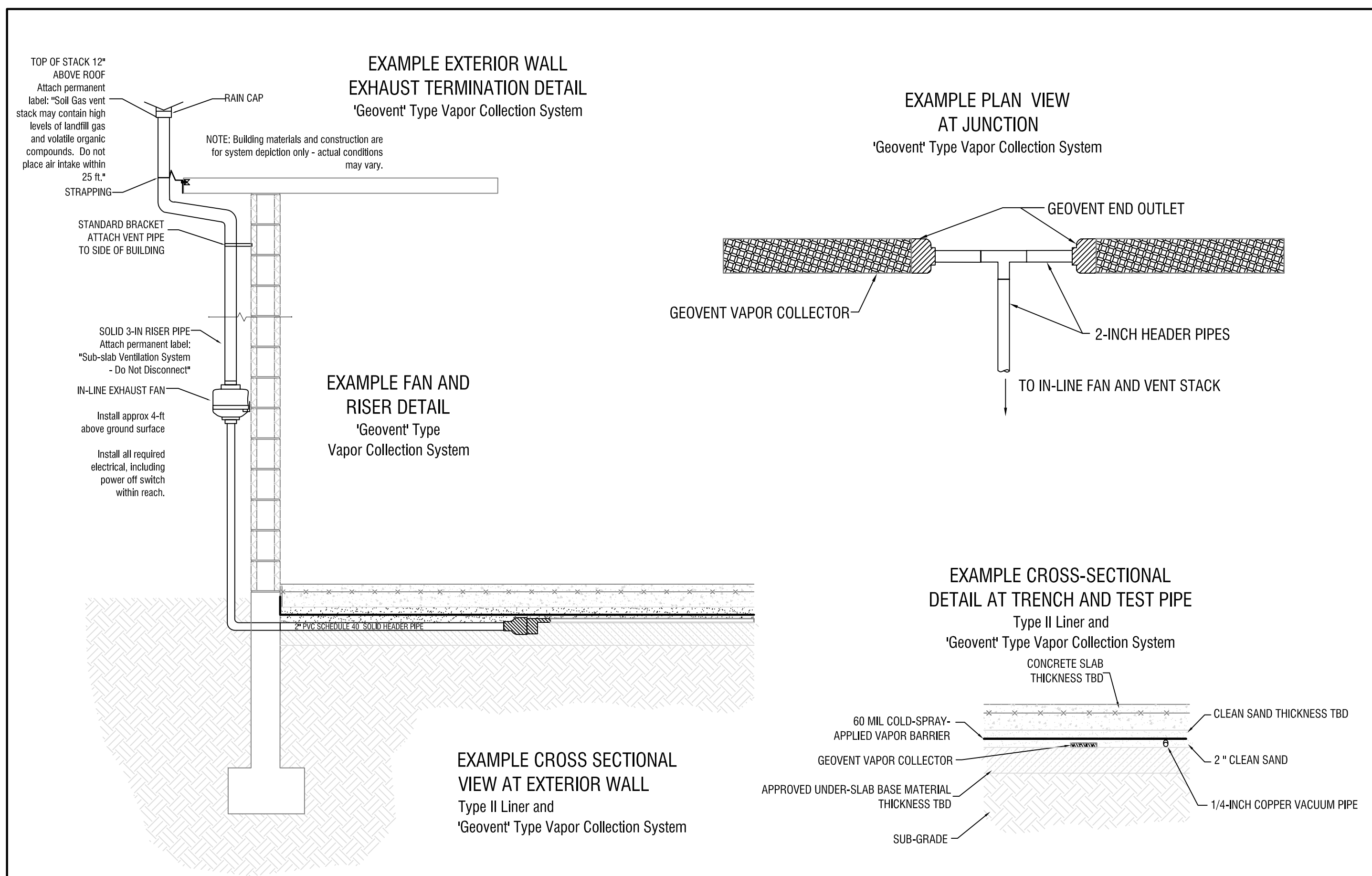
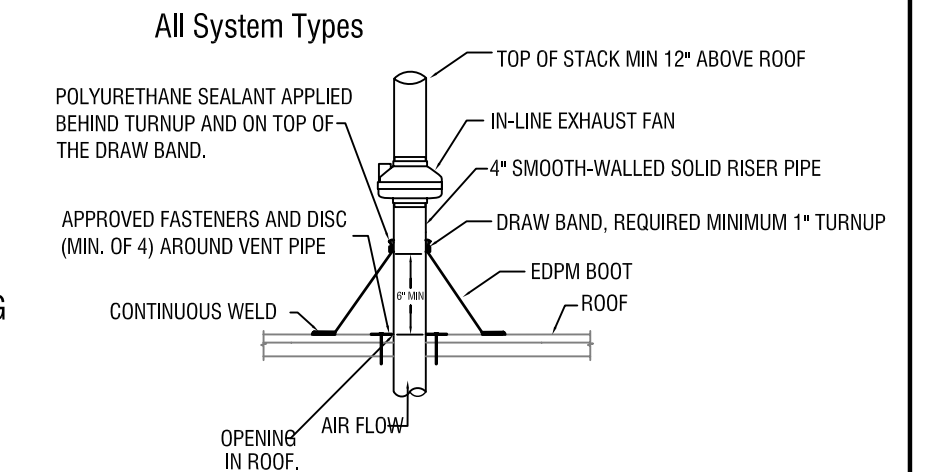
EXAMPLE CROSS SECTIONAL
VIEW AT EXTERIOR WALL
Type I Liner and
4-in Pipe Vapor Collection System



EXAMPLE DETAIL AT
TEST PIPE TERMINATION
All System Types



EXAMPLE ROOF EXHAUST
TERMINATION DETAIL
All System Types



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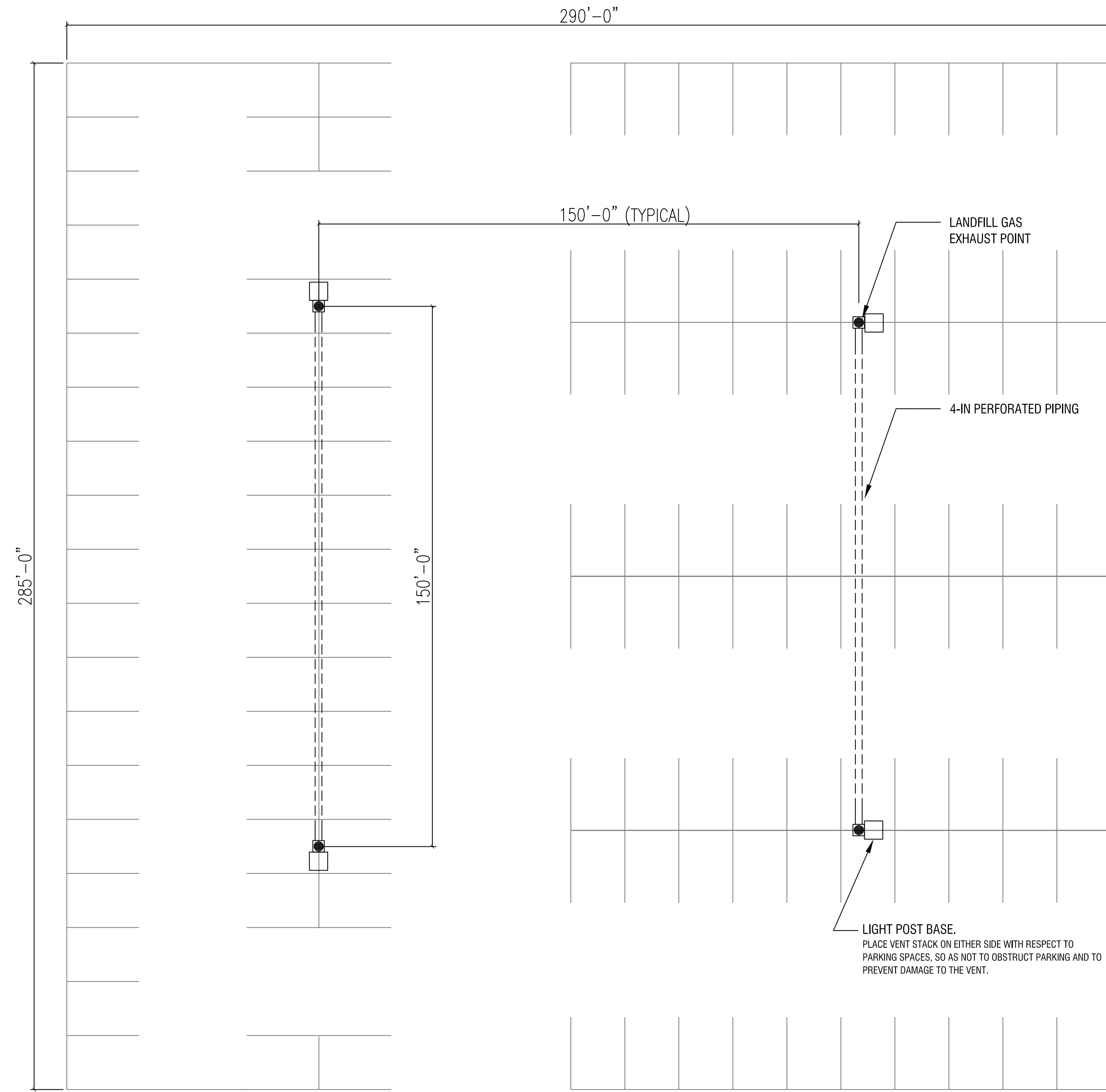
PROJECT CLIENT
CITY OF ROCHESTER
FORMER EMERSON STREET LANDFILL
ROCHESTER, NEW YORK

DRAWING TITLE
GUIDANCE FOR SUB-SLAB
VENTILATION SYSTEM & DETAILS

ISSUED FOR: FINAL
DESIGNED BY: RCM
DRAWN BY: RCM
REVIEWED BY: DEP
DATE: JUNE 2007

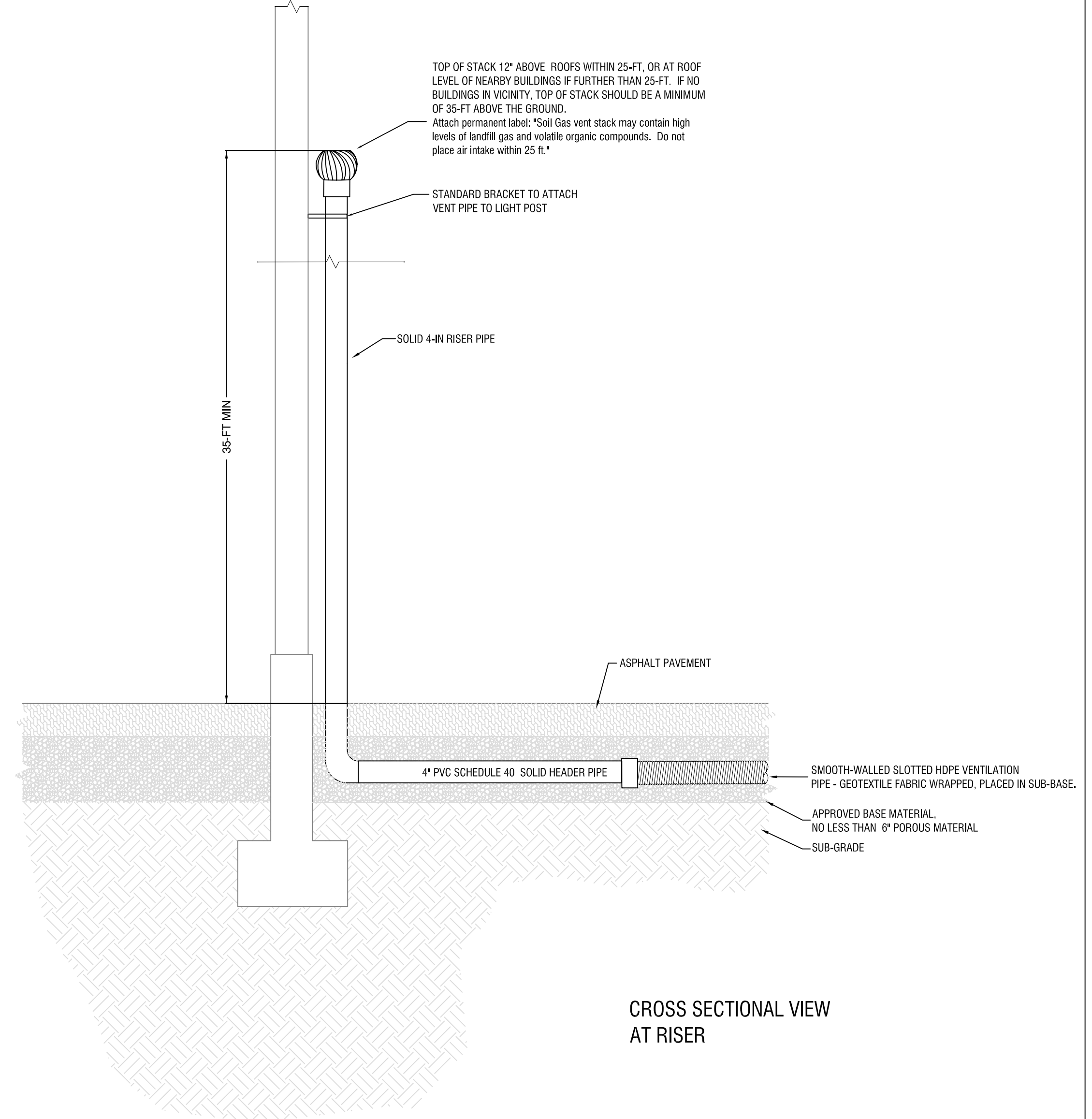
PROJECT/DRAWING NUMBER
207292
FIGURE 5

EXAMPLE PARKING LOT VENT SYSTEM
PLAN VIEW



- NOTES:
- Profile sequence may change based on materials specified by the designer. Any alterations to the depicted profile that reduces the layer of permeable material shall be made in coordination with NYSDEC & NYSDOH.
 - PEA STONE shall consist of material that will pass through a 2-inch sieve and be retained by a 1/4-inch sieve.

PARKING LOT VENT SYSTEM
EXHAUST TERMINATION DETAIL



CROSS SECTIONAL VIEW
AT RISER

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Appendix 1

SUB SLAB VAPOR SYSTEM

A. Vapor Barrier

1. TYPE I BARRIER

- i. A minimum 15-mil polyethylene or approved equivalent flexible sheeting material shall be placed prior to pouring the slab or placing the floor assembly to serve as a soil-gas-barrier by bridging any cracks that develop in the slab or floor assembly. The sheeting should cover the entire floor area, and separate sections of sheeting should be overlapped at least 12 inches. The sheeting shall be sealed around any pipe, wire or other penetrations of the material, per the manufacturer's instructions. All punctures or tears in the material repaired according to the manufacturer's instructions. The sheeting shall meet the following requirements (Stego Wrap 15-mil Class A Vapor Barrier or approved equivalent)

Property and Test

Underslab Vapor Retarders, ASTM E 1745 Class A
Water Vapor Permeance, ASTM E 96 & ASTM F 1249
Tensile Strength, ASTM D 882
Puncture Resistance, ASTM D 1709
Chemical Resistance, ASTM E 154
Life Expectancy, ASTM E 154

Performance Standard

Meet or Exceed
0.012 perms (0.006 water vapor transmission rate)
76.6 lbf./in.
2445 grams
Unaffected
Indefinite

- ii. Seams in the vapor barrier shall be sealed with a product designed to be compatible with the vapor barrier (i.e. Stego Tape for Stego Wrap products).
- iii. Follow all manufacturer's instructions (attached for Stego products, Appendix A).

2. TYPE II BARRIER

- i. A minimum 60-mil spray-applied impermeable barrier material (Liquid-Boot or approved equivalent) shall be placed prior to pouring the slab or placing the floor assembly to serve as a soil-gas-barrier by bridging any cracks that develop in the slab or floor assembly, in accordance with manufacturer's instructions. The barrier should cover the entire slab area. The barrier shall be sealed around any pipe, wire or other penetrations of the material, per the manufacturer's instructions. All punctures or tears in the material repaired according to the manufacturer's instructions.

B. Prevention of Soil-Gas Entry

1. All concrete floor slabs shall be designed, mixed, placed, reinforced, consolidated, finished, and cured to minimize the formation of cracks in accordance with standards set forth in the Model Building Codes.
2. Large openings through concrete slabs, wood, and other floor assemblies in contact with the soil, such as spaces around sanitary sewer piping, internal roof drains, shower, or toilet drains, shall be filled or closed with materials that provide a permanent airtight seal such as non-shrink mortar, grouts, expanding foam, or similar materials designed for such application.
3. Smaller gaps around all pipe, wire, or other objects that penetrate concrete slabs or other floor assemblies shall be made air tight with an elastomeric joint sealant, as defined in ASTM C920-87, and applied in accordance with the manufacturer's recommendations.

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4. All control joints, isolation joints, construction joints, and any other joints in concrete slabs or between slabs and foundation walls shall be sealed. A continuous formed gap (for example, a "tooled edge") which allows the application of a sealant that will provide a continuous, airtight seal shall be created along all joints. When the slab has cured, the gap shall be cleared of loose material and filled with an elastomeric joint sealant, as defined in ASTM C920-97, and applied in accordance with the manufacturer's recommendations.
5. Joints, cracks, or other openings around all penetrations of both exterior and interior surfaces of masonry block or wood foundation walls below the ground surface shall be sealed with an elastomeric sealant that provides an air-tight seal. Penetrations of poured concrete walls should also be sealed on the exterior surface. This includes sealing of wall tie penetrations.
6. Completion is subject to owner/environmental consultant approval. The owner and environmental consultant shall be provided 24-hour notice to inspect the system.

C. Gas Collection and Vent System

1. 4-inch Pipe Type System

- i. Lengths of sub-slab vapor collection piping shall be installed beneath the vapor barrier as depicted in Figures 5 and 6. Sub-slab vapor collection piping is geotextile-wrapped 4-inch perforated dual-walled corrugated exterior smooth interior HDPE.
- ii. Vapor collection piping shall be installed in 10x12-in pipe trenches as depicted on Figure 6. Pipe trenches shall be backfilled with PEA STONE, which shall consist of material that will pass through a 2-inch sieve and be retained by a 1/4-inch sieve.
- iii. Install perforated cap at each vapor collection pipe termination, and slope header pipe up 1/4-inch per foot from connection with vapor collection piping.
- iv. The collection piping shall be connected via the appropriate fittings to 4" schedule 40 pvc header pipe. The header pipes shall penetrate the building envelope through the foundation walls, as depicted on Figure 6.

2. "Geovent" Type System

- i. Lengths of filter-fabric wrapped 3-dimensional vent core (Liquid-Boot GEOVENT or approved equivalent) should be installed beneath the sub-base as depicted in Figures 5 and 6. The vent system shall be installed in accordance with the manufacturer's instructions.
- ii. The vent shall be connected via the appropriate fittings to 2" schedule 80 pvc header pipe. The header pipes shall penetrate the building envelope through the foundation walls, as depicted on Figure 6.

3. General Requirements for Either System

- i. The header pipes shall terminate at a vertical standpipe installed attached to the exterior wall, as depicted on Figure 6. The standpipe shall terminate at least 12 inches above the surface of the roof; in a location at least 25 feet from any air intakes, at least 10 feet away from any window, air intakes, or other opening into the conditioned spaces of the building that is less than 2 feet below the exhaust point, and 10 feet from any adjoining or adjacent buildings.

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- ii. All exposed and visible interior and exterior vent pipes shall be identified with at least one every 15-feet. The label shall read: "Landfill Gas Reduction System."
- iii. Vent pipes shall be installed in a configuration and supported in a manner that ensures that any rain water or condensation accumulating within the pipes drains downward into the ground beneath the vapor barrier.
- iv. Completion is subject to owner/environmental consultant approval. The owner and environmental consultant shall be provided 24-hour notice to inspect the system.
- v. It should be noted that while either gas collection type may be used with either membrane type, in the case of Liquid Boot products, the manufacturer will not sell Geovent independently of a liner.

D. Fans

- 1. Activation of the sub-slab depressurization system shall be completed by adding exhaust fans in the vertical stand pipes, as shown on Figures 5 and 6.
- 2. The fans shall meet the following requirements (in-line exhaust fans of type RadonAway GP-501 or approved equivalent):

Watts	Max Pres. "wc	Typical flow (ft3/min {cfm}) vs. static pressure (water column inches {"wc})								
		0.0" wc	0.5" wc	1.0" wc	1.5" wc	2.0" wc	2.5" wc	3.0" wc	3.5" wc	4.0" wc
60-140	4.2	-- cfm	-- cfm	95 cfm	87 cfm	80 cfm	70 cfm	57 cfm	30 cfm	10 cfm

- 3. Connection of the fans shall be coordinated with the Environmental Consultant to allow for performance testing, and explosivity testing of the vented air in each leg of the system before and during initial operation. No fans shall be activated prior to testing for explosivity.

Note: It is recommended that the explosivity testing be performed prior to the purchase of all of the designed exhaust fans. Based on the results of performance testing, the actual number of exhaust fans required to operate the system may be reduced. In addition, if the explosivity testing indicates significant levels of landfill gases, the proposed fans may not be appropriate and intrinsically safe fans may be required.

- 4. The fans in the vent pipes and all positively pressurized portions of the vent pipes shall be located outside the habitable space of the building.
- 5. The fans in the vent pipes shall be installed in vertical runs of the vent pipes, at approximately 4-feet from the ground, to facilitate maintenance and repair.

E. Warning Systems

- 1. Each vertical standpipe shall be equipped with a manometer (Vacu-Ray Vacuometer U-tube type manometer or approved equivalent) below the fan, to demonstrate that pressure within the pipe is below atmospheric pressure.

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2. Each fan shall be equipped with a prominently positioned visible or audible warning system (WVM-93C vacuum monitor alarm or approved equivalent) to alert the building occupant if there is loss of pressure or air flow in the vent pipe, or if the fan ceases operation. Location of the warning system shall be subject to owner/environmental consultant approval.
 3. Test points consisting of an open length of copper vacuum tubing shall be installed beneath the slab as depicted on Figure 5. The vacuum tubing shall be fabric-wrapped at its sub-slab termination. The vacuum tubing shall be routed to the exterior through foundation walls, and terminate in a barbed fitting suitable for use with a magnahelic micro pressure gauge (such as the Infiltec DM-1 Digital Micro-Manometer or approved equivalent). The exterior terminations shall be mounted approximately 3-feet above the ground on the side of the building, fitted with a stop valve beneath the barbed fitting, and protected with a weather proof housing, as depicted in Figure 6.
 4. Each gauge point shall be protected by a bollard.
 5. Completion is subject to owner/environmental consultant approval. The owner and environmental consultant shall be provided 24-hour notice to inspect the system.
- F. HVAC systems shall be designed and installed to avoid depressurization of the building relative to underlying and surrounding soil. Specifically, joints in air ducts and plenums passing through unconditioned spaces shall be sealed.
- G. Completion is subject to owner/environmental consultant approval. The owner and environmental consultant shall be provided 24-hour notice to inspect the system.

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Appendix 2

FINAL

**Guidance for Evaluating Soil Vapor Intrusion
in the State of New York**

October 2006

Prepared by:



NEW YORK STATE DEPARTMENT OF HEALTH
Center for Environmental Health
Bureau of Environmental Exposure Investigation

Soil Vapor Intrusion Guidance Release History

October 2006 — Current version

February 2005 — Public comment draft

Contact Information

Comments and questions on the guidance may be sent to the following:

New York State Department of Health
Bureau of Environmental Exposure Investigation
Flanigan Square, Room 300
547 River Street
Troy, New York 12180-2216

Email: BEEI@health.state.ny.us
Telephone: 1-800-458-1158, extension 27850

New York State Departments of Health and Environmental Conservation — Web Sites on Soil Vapor Intrusion

This guidance, policy documents, training documents, fact sheets, etc. are available to the public on the following web sites:

New York State Department of Health
http://www.health.state.ny.us/environmental/indoors/vapor_intrusion

New York State Department of Environmental Conservation
<http://www.dec.state.ny.us/website/der/guidance/vapor/index.html>

As new information becomes available (e.g., revisions or amendments to the guidance, new fact sheets, etc.), these web sites will be updated accordingly.

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Table 1.1 Environmental factors that may affect soil vapor intrusion

Environmental Factor	Description
Soil conditions	Generally, dry, coarse-grained soils facilitate the migration of subsurface vapors and wet, fine-grained or highly organic soils retard migration.
Volatile chemical concentrations	The potential for vapor intrusion generally increases with increasing concentrations of volatile chemicals in groundwater or subsurface soils, as well as with the presence of NAPL.
Source location	The potential for vapor intrusion generally decreases with increasing distance between the subsurface source of vapor contamination and overlying buildings. For example, the potential for vapor intrusion associated with contaminated groundwater decreases with increasing depth to groundwater.
Groundwater conditions	<p>Volatile chemicals dissolved in groundwater may off-gas to the vadose zone from the surface of the water table. If contaminated groundwater is overlain by clean water (upper versus lower aquifer systems or significant downward groundwater gradients), then vapor phase migration or partitioning of the volatile chemicals is unlikely.</p> <p>Additionally, fluctuations in the groundwater table may result in contaminant smear zones. The "smear zone" is the area of subsurface soil contamination within the range of depths where the water table fluctuates. Chemicals floating on top of the water table, such as petroleum components, can sorb onto soils within this zone as the water table fluctuates. Sorption of chemicals can influence their gaseous and aqueous phase diffusion in the subsurface, and ultimately the rate at which they migrate.</p>
Surface confining layer	A surface confining layer (e.g., frost layer, pavement or buildings) may temporarily or permanently retard the migration of subsurface vapors to outdoor air. Confining layers can also prevent rainfall from reaching subsurface soils, creating relatively dry soils that further increase the potential for soil vapor migration.
Fractures in bedrock and/or tight clay soils	Fractures in bedrock and desiccation fractures in clay can increase the potential for vapor intrusion beyond that expected for the bulk, unfractured bedrock or clay matrix by facilitating vapor migration (in horizontal and vertical directions) and movement of contaminated groundwater along spaces between fractures.
Underground conduits	Underground conduits (e.g., sewer and utility lines, drains or tree roots, septic systems) with highly permeable bedding materials relative to native materials can serve as preferential pathways for vapor migration due to relatively low resistance to flow.
Weather conditions	Wind and barometric pressure changes and thermal differences between air and surrounding soils may induce pressure gradients that affect soil vapor intrusion.
Biodegradation processes	Depending upon environmental conditions (e.g., soil moisture, oxygen levels, pH, mineral nutrients, organic compounds, and temperature), the presence of appropriate microbial populations, and the degradability of the volatile chemical of concern, biodegradation in the subsurface may reduce the potential for vapor intrusion. For example, readily biodegradable chemicals in soil vapor may not migrate a significant distance from a source area while less degradable chemicals may travel farther.

Table 1.2 Building factors that may affect vapor intrusion

Building Factor	Description
Operation of HVAC systems, fireplaces, and mechanical equipment (e.g., clothes dryers or exhaust fans/vents)	Operation may create a pressure differential between the building or indoor air and the surrounding soil that induces or retards the migration of vapor-phase contaminants toward and into the building. Vapor intrusion can be enhanced as the air vented outside is replaced.
Heated building	When buildings are closed up and heated, a difference in temperature between the inside and outdoor air induces a stack effect, venting warm air from higher floors to the outside. Vapor intrusion can be enhanced as the air is replaced in the lower parts of the building.
Air exchange rates	The rate at which outdoor air replenishes indoor air may affect vapor migration into a building as well the indoor air quality. For example, newer construction is typically designed to limit the exchange of air with the outside environment. This may result in the accumulation of vapors within a building.
Foundation type	Earthen floors and fieldstone walls may serve as preferential pathways for vapor intrusion.
Foundation integrity	Expansion joints or cold joints, wall cracks, or block wall cavities may serve as preferential pathways for vapor intrusion.
Subsurface features that penetrate the building's foundation	Foundation perforations for subsurface features (e.g., electrical, gas, sewer or water utility pipes, sumps, and drains) may serve as a preferential pathway for vapor intrusion.

1.4 Factors affecting indoor air quality

Chemicals are a part of our everyday life. They are found in the household products we use and in items we bring into our homes. As such, chemicals are found in indoor air of homes not affected by intrusion of contaminated soil vapor. Examples of alternate sources of volatile chemicals in indoor air are given in Table 1.3. Similarly, volatile chemicals can be in the outdoor air that enters a home or place of business. Certain commercial and industrial facilities, such as gasoline stations and dry cleaners, and vehicle exhaust are examples of possible sources of volatile chemicals in outdoor air.

Commonly found concentrations of these chemicals in indoor and outdoor air are referred to as "background levels." These levels are generally determined from the results of samples collected in homes, offices and outdoor areas not known to be affected by external sources of volatile chemicals (for example, a home not known to be near a chemical spill, a hazardous waste site, a dry-cleaner, or a factory). Background sources of volatile chemicals are considered when conducting an investigation of the soil vapor intrusion pathway [Section 2] and when evaluating the results [Section 3].

Table 1.3 Alternate sources of volatile chemicals in indoor air

Source	Description
Outdoor air	Outdoor sources of pollution can affect indoor air quality due to the exchange of outdoor and indoor air in buildings through natural ventilation, mechanical ventilation or infiltration. Outdoor sources of volatile compounds include automobiles, lawn mowers, oil storage tanks, dry cleaners, gasoline stations, industrial facilities, etc.
Attached or underground garages	Volatile chemicals from sources stored in the garage (e.g., automobiles, lawn mowers, oil storage tanks, gasoline containers, etc.) can affect indoor air quality due to the exchange of air between the garage and indoor space.
Off-gassing	Volatile chemicals may off-gas from building materials (e.g., adhesives or caulk), furnishings (e.g., new carpets or furniture), recently dry-cleaned clothing, or areas (such as floors or walls) contaminated by historical use of volatile chemicals in a building. Volatile chemicals may also off-gas from contaminated groundwater that infiltrates into the basement (e.g., at a sump) or during the use of contaminated domestic well water (e.g., at a tap or in a shower).
Household products	Household products include, but are not limited to, cleaners, mothballs, cigarette smoke, paints, paint strippers and thinners, air fresheners, lubricants, glues, solvents, pesticides, fuel oil storage, and gasoline storage.
Occupant activities	For example, in non-residential settings, the use of volatile chemicals in industrial or commercial processes or in products used for building maintenance. In residential settings, the use of products containing volatile chemicals for hobbies (e.g., glues, paints, etc.) or home businesses. People working at industrial or commercial facilities where volatile chemicals are used may bring the chemicals into their home on their clothing.
Indoor emissions	These include, but are not limited to, combustion products from gas, oil and wood heating systems that are vented outside improperly, as well as emissions from industrial process equipment and operations.

1.5 General approach to evaluating soil vapor intrusion

Since no two sites are exactly alike, the approach to evaluating soil vapor intrusion is dependent upon site-specific conditions. A thorough understanding of the site, including its history of use, characteristics (e.g., geology, geography, identified environmental contamination, etc.) and potentially exposed populations, is used to develop an investigation plan. Existing information is reviewed to determine what data are available and what additional data should be collected (i.e., to guide the investigation). In addition, factors affecting soil vapor migration and intrusion [Section 1.3] and indoor air quality [Section 1.4] are also considered when both conducting an investigation [Section 2] and evaluating the results [Section 3].

1.7 Applicability of guidance

This guidance should be considered anywhere soil vapor intrusion is evaluated in the State of New York, whether the evaluation is being undertaken voluntarily by a corporation, a municipality, or private citizen, or under one of the state's environmental remediation programs.

1.7.1 Residential and non-residential settings

The guidance should be followed in residential and non-residential settings where people may be exposed involuntarily to chemicals from soil vapor intrusion.

1.7.2 Chlorinated and non-chlorinated volatile chemical sites

The guidance should be used when evaluating soil vapor intrusion at chlorinated and non-chlorinated volatile chemical sites, including petroleum hydrocarbon sites and manufactured gas plant sites. While the likelihood for exposures related to soil vapor intrusion may differ between sites due to site-specific conditions and chemical-specific properties, the extent of volatile chemical contamination and the nature of the contamination, these factors should be considered when developing the conceptual site model and implementing an investigation plan (as discussed in Sections 1.5 and 1.6). For example, if the conceptual site model suggests that soil vapor intrusion is not a concern at a petroleum hydrocarbon site due to biodegradation, the work plan might include the measurement of select bioparameters (e.g., oxygen, carbon dioxide, methane, etc.), along with the petroleum hydrocarbons, at varying depths to demonstrate bioattenuation in the vadose. The work plan might include sub-slab vapor sampling as well to demonstrate that conditions beneath nearby buildings are also resulting in bioattenuation of the petroleum hydrocarbons.

1.7.3 Current, new and past remedial sites

As discussed in the NYSDEC's Program Policy *DER-13: Strategy for Prioritizing Vapor Intrusion Evaluations at Remedial Sites in New York* (NYSDEC 2006), the soil vapor intrusion pathway will be evaluated at all completed, current and future remedial sites New York State. This soil vapor intrusion guidance document complements the NYSDEC's policy by providing recommendations on how to evaluate soil vapor intrusion. The combined goal of the policy and guidance documents is to conduct soil vapor intrusion evaluations as efficiently and effectively as possible at all remedial sites in New York.

1.8 Updates to the guidance

The investigation, evaluation, mitigation and remediation of soil vapor are evolving disciplines and this guidance document will be updated periodically, as appropriate. The history of the document's release is provided on the inside of the cover page. In addition, changes to the document are noted in Appendix A. The current version of the document supercedes previous versions. The current version of the guidance is available on the NYSDOH's web site (http://www.health.state.ny.us/environmental/indoors/vapor_intrusion/) or by contacting the NYSDOH's Bureau of Environmental Exposure Investigation [see Contact Information on the inside of the cover page]. Revisions or amendments to the guidance will be posted on the NYSDOH's web site.

Section 2: Investigation of the Soil Vapor Intrusion Pathway

Soil vapor is an environmental medium, like groundwater and soil, that should be characterized during the investigation of a site. This section provides guidance on collecting appropriate and relevant data that can be used to identify current or potential human exposures to contaminated subsurface vapors associated with a site. As discussed in Section 1.5, no two sites are exactly alike. Site-specific and/or building-specific conditions may warrant modifying the recommendations herein. Therefore, guidance provided in this section is presented in terms of general steps and strategies that should be applied when approaching an investigation of soil vapor intrusion.

2.1 Sites at which an investigation is appropriate

Data collected to date do not support the use of pre-determined concentrations of volatile chemicals (i.e., screening criteria) in either groundwater or soil to trigger a soil vapor intrusion investigation. Therefore, although the level of investigation may vary, the pathway should be investigated at any site with the following:

- a. an existing subsurface source (e.g., on the basis of preliminary environmental sampling) or likely subsurface source (e.g., on the basis of known previous land uses) of volatile chemicals [Section 1.1]; and
- b. existing buildings or the possibility that buildings may be constructed near a subsurface source of volatile chemicals.

2.2 Types of samples

The following are types of samples that are collected to investigate the soil vapor intrusion pathway:

- a. subsurface vapor samples:
 1. *soil vapor* samples (i.e., soil vapor samples not beneath the foundation or slab of a building) and
 2. *sub-slab vapor* samples (i.e., soil vapor samples immediately beneath the foundation or slab of a building);
- b. crawl space air samples;
- c. indoor air samples; and
- d. outdoor air samples.

The types of samples that should be collected depend upon the specific objective(s) of the sampling, as described below.

2.2.1 Soil vapor

Soil vapor samples are collected to determine whether this environmental medium is contaminated, characterize the nature and extent of contamination, and identify possible sources of the contamination. Our experience to date indicates soil vapor results alone typically cannot be relied upon to rule out sampling at nearby buildings. For example, concentrations of volatile chemicals in sub-slab vapor samples have been substantially higher (e.g., by a factor of 100 or more) than concentrations found in nearby soil vapor

samples (e.g., collected at 8 feet below grade near the building). This may be due to differences in factors such as soil moisture content and pressure gradients. Therefore, exposures are evaluated primarily based on sub-slab vapor, indoor air and outdoor air sampling results and soil vapor results are primarily used as a tool to guide these investigations.

Soil vapor sampling results are also used when evaluating the effectiveness of direct or indirect measures to remediate contaminated subsurface vapors. (Soil vapor extraction is an example of a direct remedial measure, and groundwater pumping and treating an indirect measure.)

2.2.2 Sub-slab vapor

Sub-slab vapor samples are collected to characterize the nature and extent of soil vapor contamination immediately beneath a building with a basement foundation and/or a slab-on-grade. Sub-slab vapor sampling results are used in conjunction with indoor air and outdoor air sampling results when evaluating the following:

- a. *current* human exposures;
- b. the potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes); and
- c. site-specific attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations).

Sub-slab vapor samples are often collected after soil vapor characterization and/or other environmental sampling (e.g., soil and groundwater characterization) indicate they are warranted. Sub-slab samples are typically collected concurrently with indoor and outdoor air samples. However, outside of the heating season, sub-slab vapor samples may be collected independently depending on the sampling objective (e.g., to characterize the extent of subsurface vapor contamination outside of the heating season to develop a more comprehensive, focused investigation plan for the heating season).

2.2.3 Crawl space air

Similar to sub-slab vapor samples, crawl space air samples are collected to characterize the nature and extent of contamination immediately beneath a building with a crawl space foundation. Crawl space air sampling results are used in conjunction with indoor air and outdoor air sampling results when evaluating the following:

- a. *current* human exposures; and
- b. the potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes).

2.2.4 Indoor air

Indoor air samples are collected to characterize exposures to air within a building, including those with earthen floors. Indoor air sampling results are used when evaluating the following:

- a. *current* human exposures;
- b. the potential for *future* exposures (e.g., if a currently vacant building should become occupied); and
- c. site-specific attenuation factors (e.g., the ratio of indoor air to sub-slab vapor concentrations).

Indoor air samples are often collected after subsurface vapor characterization and other environmental sampling (e.g., soil and groundwater characterization) indicate they are warranted. When indoor air samples are collected, concurrent sub-slab vapor, crawl space air (if applicable) and outdoor air samples are collected to evaluate the indoor air results appropriately. However, indoor air and outdoor air samples, without sub-slab vapor samples, may be collected when confirming the effectiveness of a mitigation system [Section 4].

In addition, site-specific situations may warrant collecting indoor air samples prior to characterizing subsurface vapors and/or without concurrent sub-slab vapor sampling to examine immediate inhalation hazards. Examples of such situations may include, but are not limited to, the following:

- a. in response to a spill event to qualitatively and/or quantitatively characterize the contamination;
- b. if high readings are obtained in a building when screening with field equipment (e.g., a photoionization detector (PID), an organic vapor analyzer, or an explosimeter) and the source is unknown;
- c. if significant odors are present and the source needs to be characterized; or
- d. if groundwater beneath the building is contaminated, the building is prone to groundwater intrusion or flooding (e.g., sump pit overflows), and subsurface vapor sampling is not feasible. In these situations, the collection of water samples from the sump may also be appropriate.

2.2.5 Outdoor air

Outdoor air samples are collected to characterize site-specific background outdoor air conditions. Outdoor air samples should be collected simultaneously with indoor air samples to evaluate the potential influence, if any, of outdoor air on the indoor air sampled. Outdoor air samples may also be collected concurrently with soil vapor samples to identify potential outdoor air interferences associated with infiltration of outdoor air into the sampling apparatus while the soil vapor was collected.

2.3 Phase of a site investigation in which to sample

There is no single phase (e.g., preliminary site characterization or remedial investigation) of a site investigation during which sampling to evaluate the soil vapor intrusion pathway is appropriate. Initiation of investigation activities for this specific purpose should be determined on a site-by-site basis. However, if exposures due to soil vapor intrusion appear likely at any point during the investigation, evaluation of this exposure pathway should not be delayed.

If the locations of likely source areas are reasonably known, sampling earlier during the investigation of a site rather than later is recommended because of the iterative nature of the sampling process [Section 2.5]. However, if current site conditions are not well-defined, then sampling after contamination in other environmental media (e.g., groundwater and soil) has been characterized may be considered. In the latter scenario, groundwater, soil and other site information may be used to guide an investigation of the soil vapor intrusion pathway, such as selecting locations for subsurface vapor samples based on likely migration pathways and source areas [Sections 2.6.1 and 2.6.2]. At a minimum, depth to groundwater and soil stratigraphy should be identified prior to collecting soil vapor samples.

Sampling may be delayed at parcels that are undeveloped or contain unoccupied buildings provided

- a. characterization of the parcel is not needed to
 1. address exposures in the surrounding area;
 2. design remedial measures for subsurface vapor contamination; or
 3. monitor or confirm the effectiveness of remedial measures; and
- b. measures are in place that assure that the parcel will not be developed, or buildings occupied, without addressing exposure concerns [Section 3.6].

If exposures due to soil vapor intrusion appear likely, and a delay of sampling is contemplated, the State (i.e., the NYSDEC and NYSDOH) should be informed of the contemplated delay and the rationale for the delay. Furthermore, the party contemplating the delay should consider any comments the State may have on the information provided.

2.4 Time of year in which to sample

2.4.1 Soil vapor

Soil vapor samples are collected at any time during the year. Often, sampling is completed during the summer so the results can be used as a tool when selecting buildings to be sampled during the heating season.

2.4.2 Buildings

Sub-slab vapor samples and, unless immediate sampling is appropriate, indoor air samples are typically collected during the heating season because soil vapor intrusion is more likely to occur when a building's heating system is in operation and doors and windows are closed. In New York State, heating systems are generally expected to be operating routinely from November 15th to March 31st. However, these dates are not absolute; the timeframe for sampling may vary depending on factors such as the location of the site (e.g., upstate versus downstate) and the weather conditions for a particular year.

A soil vapor intrusion investigation at a building may be conducted outside of the heating season if the concern for vapor intrusion is greater during another time of year. This may occur at certain industrial buildings, for instance, where HVAC systems are actively managed to control the ratio of recirculated indoor air to make-up air from outside the building. Information about the site and potentially affected structures, including the factors discussed in Section 1.3, should be considered in determining the timing of an investigation.

Samples may be collected at any time of year if exposures due to soil vapor intrusion appear likely. However, samples collected at times when soil vapor intrusion is not expected to have its greatest effect on indoor air quality (typically, samples collected outside of the heating season) should not be used to rule out exposures. For example, results indicating "no further action" or "monitoring required" should be verified when soil vapor intrusion is believed to be most likely to ensure these actions are protective throughout the year.

2.5 Number of sampling rounds

Investigating the soil vapor intrusion pathway usually involves more than one round of subsurface vapor, indoor air and/or outdoor air sampling, for reasons such as the following:

- a. to characterize the nature and extent of subsurface vapor contamination (similar to the delineation of groundwater contamination) and to address corresponding exposure concerns;
- b. to evaluate fluctuations in concentrations due to
 1. different weather conditions (e.g., seasonal effects),
 2. changes in building conditions (e.g., various operating conditions of a building's HVAC system),
 3. changes in source strength, or
 4. vapor migration or contaminant biodegradation processes (particularly when degradation products may be more toxic than the parent compounds); or
- c. to confirm sampling results or the effectiveness of mitigation or remedial systems.

Overall, as discussed in Section 1.5, successive rounds of sampling should be conducted until the following questions can be answered:

- a. Are subsurface vapors contaminated? If so, what are the nature and extent of contamination? What is/are the source(s) of the contamination?
- b. What are the current and potential exposures to contaminated subsurface vapors?
- c. What actions, if any, are appropriate to prevent or mitigate exposures and to remediate subsurface vapor contamination?

Toward this end, multiple rounds of sampling may be appropriate to characterize the nature and extent of subsurface vapor contamination such that

- a. both potential and current exposures are addressed [Section 2.6];
- b. measures can be designed to remediate subsurface vapor contamination, either directly (e.g., SVE system) or indirectly (e.g., soil excavation or groundwater remediation), given that monitoring and mitigation are considered temporary measures implemented to address exposures related to vapor intrusion until contaminated environmental media are remediated [Section 3.4]; and
- c. the effectiveness of remedial measures can be monitored and confirmed (e.g., endpoint sampling) [Section 4.5].

2.6 Sampling locations

The general approach for selecting sampling locations as part of a soil vapor intrusion investigation is similar to the approach for the investigation of other environmental media (e.g., soil and groundwater). Sampling locations should be selected with consideration of the conceptual site model [Section 1.6]. These locations should be selected to meet the stated objectives of the sampling program. Additionally, similar to the investigation of soil and groundwater, it is typical to start at a known or suspected source and work outward. The specific approach, however, will be dependent upon site-specific and building-specific conditions.

2.6.1 Soil vapor

If available, existing environmental data (e.g., groundwater and soil data) and site background information should be used to select locations for sampling soil vapor as part of a vapor intrusion investigation. Locations will vary depending upon surface features (e.g., presence or absence of buildings, areas of pavement, or vacant lot) and subsurface characteristics (e.g., soil stratigraphy, buried structures, utility corridors, or clay lenses), as well as the specific purpose of the sampling. Therefore, a figure illustrating proposed sampling locations (with respect to both areal position and depth), actual locations sampled in the field, and relevant on-site and off-site features should be included in all sampling work plans and reports.

Examples of how locations may vary given the specific purpose of the sampling follow. They include general guidelines that should be followed when selecting soil vapor sampling locations:

- a. to evaluate the **potential for current on-site or off-site exposures**, samples should be collected
 1. in the vicinity of a building's foundation [see special sampling consideration at the end of Section 2.6.1 if sampling around a building with no surrounding surface confining layer], as well as between the building's foundation and the source (if known and not located beneath the building),
 2. along the site's perimeter, and
 3. at a depth comparable to the depth of foundation footings (determined on a building-specific or site-specific basis) or at least 1 foot above the water table in areas where the groundwater table is less than 6 feet below grade;
- b. to evaluate the **potential for future exposures if development** on a known or suspected contaminated area on-site or off-site is possible, representative samples should be collected
 1. in areas with either known or suspected subsurface sources of volatile chemicals, in areas where elevated readings were obtained with field equipment during previous environmental investigations, and in areas of varying concentrations of contamination in the upper groundwater,
 2. in a grid pattern across the area (at an appropriate spacing interval for the size of the area) if information is limited for the area, and
 3. at multiple depths from the suspected subsurface source, or former source, to a depth comparable to the expected depth of foundation footings;

- c. to evaluate the **potential for off-site soil vapor contamination**, samples should be collected
 1. along the site's perimeter,
 2. in areas of potential subsurface sources of vapor contamination (e.g., a groundwater plume that has migrated off-site), and
 3. at a depth comparable to the depth of foundation footings (determined on a site-specific basis) or at least 1 foot above the water table in areas where the groundwater table is less than 6 feet below grade;
- d. to evaluate on-site and off-site **preferential migration pathways** in areas with low permeability soils, samples should be collected
 1. along preferential soil vapor flow paths, such as sewer lines, utility corridors, trenches, pipelines, and other subsurface structures that are likely to be bedded with higher permeability materials, and
 2. at depths corresponding to these subsurface features (will depend on site-specific conditions);
- e. to characterize on-site or off-site **contamination in the vadose zone**, samples should be collected
 1. in areas with either known or suspected sources of volatile chemicals, in areas where elevated readings were obtained with field equipment (e.g., PID) during previous soil and groundwater investigations, and in areas of varying concentrations of contamination in the upper groundwater regime, and
 2. at appropriate depths associated with these areas (will depend on site-specific conditions); and
- f. to investigate the **influence of contaminated groundwater or soil on soil vapor** and to characterize the **vertical profile** of contamination, samples should be collected from clusters of soil vapor probes at varying depths in the vadose zone [Figure 2.2, Section 2.7.1] and preferably in conjunction with the collection of groundwater or soil samples.

Soil vapor samples collected at depths shallower than 5 feet below grade may be prone to negative bias due to infiltration of outdoor air. Therefore, samples from these depths should be collected only if appropriate (based on site-specific conditions), and sampling procedures and results should be reviewed accordingly. The depth of sampling near buildings with slab-on-grade foundations is dependent upon site-specific conditions (e.g., building surrounded by grassy or surface confining layer).

When collecting soil vapor samples around a building with no surrounding surface confining layer (e.g., pavement or sidewalk), samples should be located in native or undisturbed soils away from fill material surrounding the building (approximately 10 feet away from the building) to avoid sampling in an area that may be influenced by the building's operations. For example, operation of HVAC systems, fireplaces, or mechanical equipment (e.g., clothes dryers or exhaust fans/vents) in a building may exacerbate the infiltration of outdoor air into the vadose zone adjacent to the building. As a result, soil vapor samples collected in uncovered areas adjacent to the building may not be representative.

Investigations of soil vapor contamination should proceed outward from known or suspected subsurface sources, as appropriate, on an areal basis until the nature and extent of

subsurface vapor contamination has been characterized and human exposures have been addressed.

2.6.2 Sub-slab vapor

Existing environmental data (e.g., soil vapor, groundwater and soil data), site background information, and building construction details (e.g., basement, slab-on-grade, or multiple types of foundations, HVAC systems, etc.) should be considered when selecting buildings and locations within buildings for sub-slab vapor sampling.

At a minimum, these general guidelines should be followed when selecting buildings to sample for sub-slab vapors:

- a. buildings, including residential dwellings, located above or directly adjacent to known or suspected areas of subsurface volatile chemical contamination should be sampled;
- b. buildings in which screening with field equipment (e.g., PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) suggests a completed migration pathway, such as when readings are above background and from unidentified sources or when readings show increasing gradients, should be sampled; and
- c. buildings within known or suspected areas of subsurface volatile chemical contamination that are used or occupied by sensitive population groups (e.g., daycare facilities, schools, nursing homes, etc.) should be given special consideration for sampling.

Investigations of sub-slab vapor and/or indoor air contamination should proceed outward from known or suspected sources, as appropriate, on an areal basis until the nature and extent of subsurface vapor contamination has been characterized and potential and current human exposures have been addressed. In cases of widespread vapor contamination and depending upon the basis for making decisions (e.g., a "blanket mitigation" approach within a specified area of documented vapor contamination [Section 3.3.1]), a representative number of buildings from an identified study area, rather than each building, may be sampled. Prior to implementation, this type of sampling approach should be approved by State agency personnel.

Within a building, sub-slab vapor samples should be collected

- a. in at least one central location away from foundation footings, and
- b. from the soil or aggregate immediately below the basement slab or slab-on-grade.

The number of sub-slab vapor samples that should be collected in a building depends upon the number of slabs (e.g., multiple slabs-on-grade in a large warehouse) and foundation types (e.g., combined basement and slab-on-grade in a residence). At least one sub-slab vapor sample should be collected from each representative area.

2.6.3 Indoor air

Existing environmental data (e.g., soil vapor, groundwater and soil data), site background information, and building construction details (e.g., basement, slab-on-grade, or multiple types of foundations; number and operation of HVAC systems; elevator shafts; tunnels or other confined-space entry points; etc.) should be considered when selecting buildings and

locations within buildings for indoor air sampling. Indoor air samples are typically collected concurrently with sub-slab vapor and outdoor air samples [Section 2.2.4].

At a minimum, these general guidelines should be followed when selecting buildings to sample for indoor air:

- a. where sub-slab vapor samples were collected without indoor air samples, buildings in which elevated concentrations of contaminants were measured in sub-slab vapor samples should be sampled;
- b. buildings, including residential dwellings, located above or directly adjacent to known or suspected subsurface sources of volatile chemicals or known soil vapor contamination should be sampled;
- c. buildings in which screening with field equipment (e.g., PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) suggests a completed migration pathway, such as when readings are above background and from unidentified sources or when readings show increasing gradients, should be sampled; and
- d. buildings within known or suspected areas of subsurface volatile chemical contamination that are used or occupied by sensitive population groups (e.g., daycare facilities, schools, nursing homes, etc.) should be given special consideration for sampling.

To characterize contaminant concentration trends and potential exposures, indoor air samples should be collected

- a. from the crawl space area,
- b. from the basement (where vapor infiltration is suspected, such as near sump pumps or indoor wells, or in a central location) at a height approximately three feet above the floor to represent a height at which occupants normally are seated and/or sleep,
- c. from the lowest level living space (in centrally-located, high activity use areas) at a height approximately three feet above the floor to represent a height at which occupants normally are seated and/or sleep, and
- d. if in a commercial setting (e.g., a strip mall), from multiple tenant spaces at a height approximately three feet above the floor to represent a height at which occupants normally are seated.

These locations are illustrated in Figure 2.1.

Investigations of indoor air contamination should proceed outward from known or suspected subsurface sources, as appropriate, on an areal basis until potential and current human exposures associated with soil vapor intrusion have been addressed. In cases of widespread vapor contamination and depending upon the basis for making decisions (e.g., a "blanket mitigation" approach within a specified area of documented vapor contamination), a representative number of buildings from an identified study area, rather than each building, may be sampled. Prior to implementation, this type of sampling approach should be approved by State agency personnel.

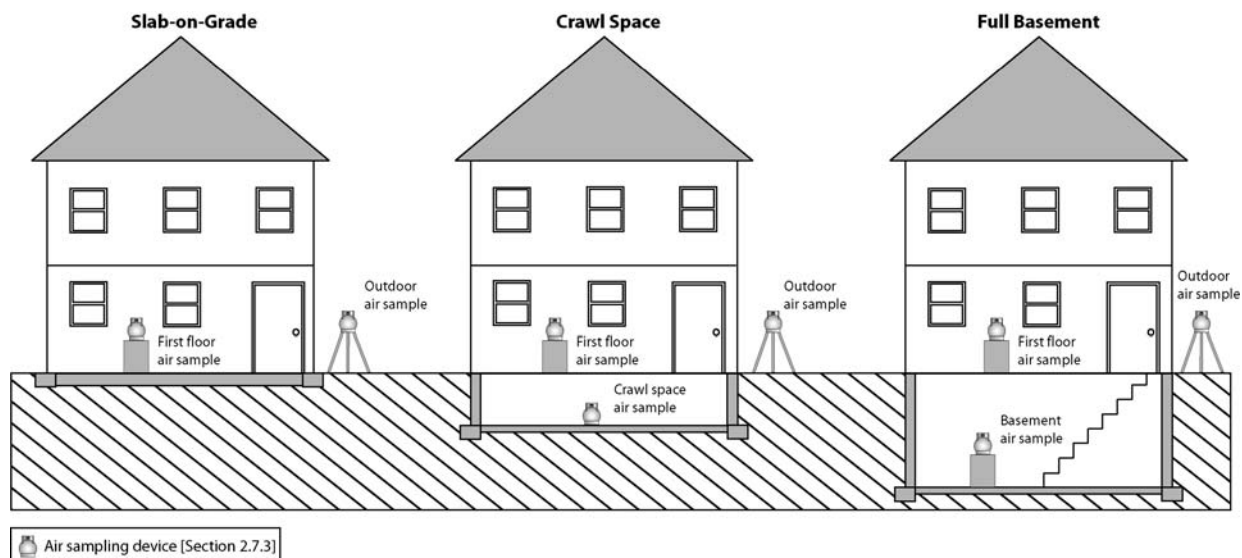


Figure 2.1
Schematic of indoor and outdoor air sampling locations

2.6.4 Outdoor air

Typically, an outdoor air sample is collected outside of each building where an indoor air sample is collected. However, if several buildings are being sampled within a localized area, representative outdoor air samples may be appropriate. For example, one outdoor air sample may be sufficient for three houses being sampled in a cul-de-sac. Outdoor air samples should be collected from a representative upwind location, away from wind obstructions (e.g., trees or bushes), and at a height above the ground to represent breathing zones (3 to 5 feet) [Figure 2.1]. A representative sample is one that is not biased toward obvious sources of volatile chemicals (e.g., automobiles, lawn mowers, oil storage tanks, gasoline stations, industrial facilities, etc.). For buildings with HVAC systems that draw outdoor air into the building, an outdoor air sample collected near the outdoor air intake may be appropriate.

2.7 Sampling protocols

The procedures recommended here may be modified depending on site-specific conditions, the sampling objectives, or emerging technologies and methodologies. Alternative sampling procedures should be described thoroughly and proposed in a work plan submitted for review by the State. The State will review and comment on the proposed procedure and consider the efficacy of the alternative sampling procedure based on the objectives of investigation. In all cases, work plans should thoroughly describe the proposed sampling procedure. Similarly, the procedures that were implemented in the field should be documented and included in the final report of the sampling results.

2.7.1 Soil vapor

Soil vapor probe installations [Figure 2.2] may be permanent, semi-permanent or temporary. In general, permanent or semi-permanent installations are preferred for data consistency reasons and to ensure outdoor air infiltration does not occur. Temporary probes should only be used if measures are taken to ensure that an adequate surface seal is created to prevent outdoor air infiltration and if tracer gas is used at every sampling location. [See Section 2.7.5 for additional information about the use of tracer gas when collecting soil vapor samples.] Soil vapor implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any permanent construction protocol:

- a. implants should be installed using an appropriate method based on site conditions (e.g., direct push, manually driven, auger — if necessary to attain the desired depth or if sidewall smearing is a concern, etc.);
- b. porous, inert backfill material (e.g., glass beads, washed #1 crushed stone, etc.) should be used to create a sampling zone 1 to 2 feet in length;
- c. implants should be fitted with inert tubing (e.g., polyethylene, stainless steel, nylon, Teflon[®], etc.) of the appropriate size (typically 1/8 inch to 1/4 inch diameter) and of laboratory or food grade quality to the surface;
- d. soil vapor probes should be sealed above the sampling zone with a bentonite slurry for a minimum distance of 3 feet to prevent outdoor air infiltration and the remainder of the borehole backfilled with clean material;
- e. for multiple probe depths, the borehole should be grouted with bentonite between probes to create discrete sampling zones or separate nested probes should be installed [Figure 2.2]; and
- f. steps should be taken to minimize infiltration of water or outdoor air and to prevent accidental damage (e.g., setting a protective casing around the top of the probe tubing and grouting in place to the top of bentonite, sloping the ground surface to direct water away from the borehole like a groundwater monitoring well, etc.).

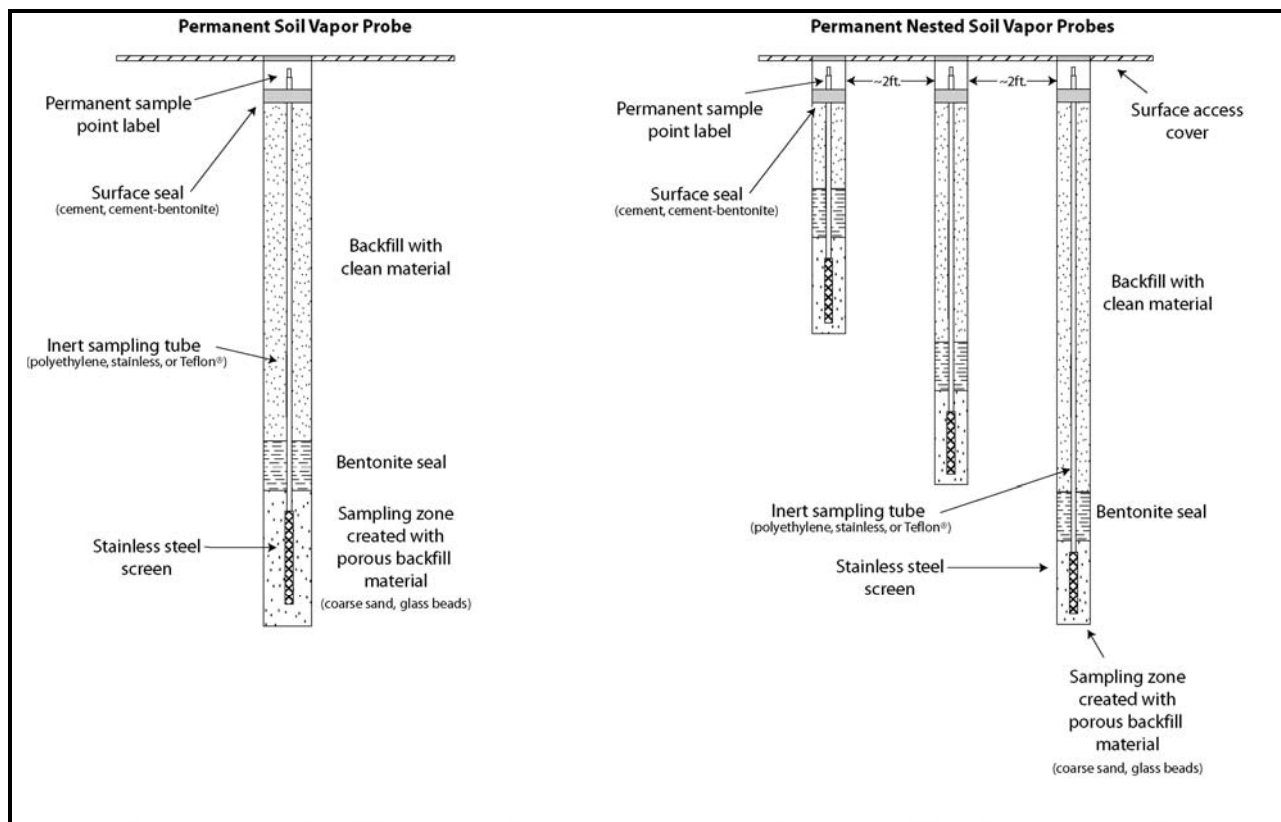


Figure 2.2

Schematics of a generic permanent soil vapor probe and permanent nested soil vapor probes

[Note: Many variations exist and may be proposed in a work plan. Proposed installations should meet the sampling objectives and requirements of the analytical methods.]

To obtain representative samples and to minimize possible discrepancies, soil vapor samples should be collected in the following manner at all locations:

- a. at least 24 hours after the installation of permanent probes and shortly after the installation of temporary probes, one to three implant volumes (i.e., the volume of the sample probe and tube) should be purged prior to collecting the samples;
- b. flow rates for both purging and collecting should not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;
- c. samples should be collected, using conventional sampling methods, in an appropriate container — one which
 - i. meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation),
 - ii. is consistent with the sampling and analytical methods (e.g., low flow rate; Summa[®] canisters if analyzing by using EPA Method TO-15), and
 - iii. is certified clean by the laboratory;

- d. sample size depends upon the volume of that will achieve minimum reporting limits [Section 2.9]; and
- e. a tracer gas (e.g., helium, butane, sulfur hexafluoride, etc.) should be used when collecting soil vapor samples to verify that adequate sampling techniques are being implemented (i.e., to verify infiltration of outdoor air is not occurring) [Section 2.7.5].

In some cases, weather conditions may present certain limitations on soil vapor sampling. For example, condensation in the sample tubing may be encountered during winter sampling due to low outdoor air temperatures. Devices, such as tube warmers, may be used to address these conditions. Anticipated limitations to the sampling should be discussed prior to the sampling event so appropriate measures can be taken to address these difficulties and produce representative and reliable data.

When soil vapor samples are collected, the following actions should be taken to document local conditions during sampling that may influence interpretation of the results:

- a. if sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility should be identified;
- b. outdoor plot sketches should be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor air sampling locations (if applicable), and compass orientation (north);
- c. weather conditions (e.g., precipitation and outdoor temperature) should be noted for the past 24 to 48 hours; and
- d. any pertinent observations should be recorded, such as odors and readings from field instrumentation.

Additional information that could be gathered to assist in the interpretation of the results includes barometric pressure, wind speed and wind direction.

The field sampling team should maintain a sample log sheet summarizing the following:

- a. sample identification,
- b. date and time of sample collection,
- c. sampling depth,
- d. identity of samplers,
- e. sampling methods and devices,
- f. purge volumes,
- g. volume of soil vapor extracted,
- h. if canisters used, the vacuum before and after samples were collected,
- i. apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- j. chain of custody protocols and records used to track samples from sampling point to analysis.

2.7.2 Sub-slab vapor

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. Prior to installation of the sub-slab vapor probe, the building floor should be inspected and any penetrations (cracks, floor drains, utility perforations, sumps, etc.) should be noted and recorded. Probes should be installed at locations where the potential for ambient air infiltration via floor penetrations is minimal.

Sub-slab vapor probe installations [Figure 2.3] may be permanent, semi-permanent or temporary. A vacuum should not be used to remove drilling debris from the sampling port. Sub-slab implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

- a. permanent recessed probes should be constructed with brass or stainless steel tubing and fittings;
- b. temporary probes should be constructed with inert tubing (e.g., polyethylene, stainless steel, nylon, Teflon[®], etc.) of the appropriate size (typically 1/8 inch to 1/4 inch diameter), and of laboratory or food grade quality;
- c. tubing should not extend further than 2 inches into the sub-slab material;
- d. porous, inert backfill material (e.g., glass beads, washed #1 crushed stone, etc.) should be added to cover about 1 inch of the probe tip for permanent installations; and
- e. the implant should be sealed to the surface with non-VOC-containing and non-shrinking products for temporary installations (e.g., permagum grout, melted beeswax, putty, etc.) or cement for permanent installations.

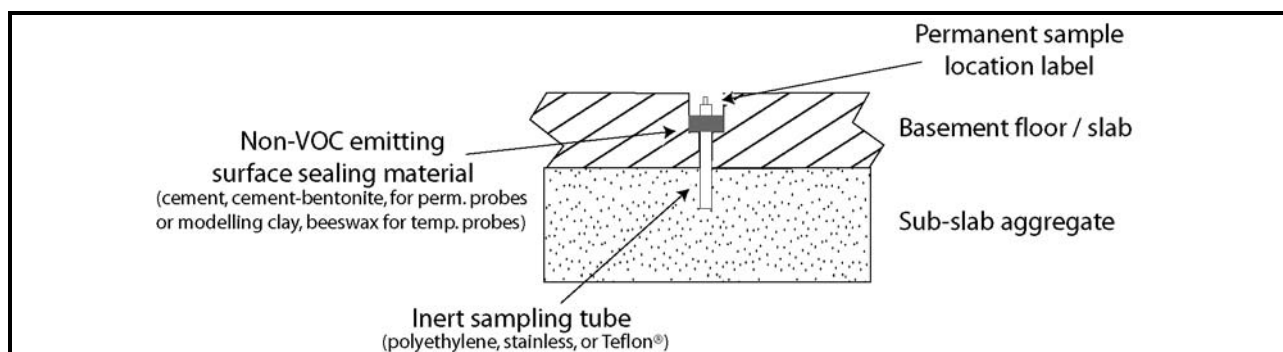


Figure 2.3

Schematic of a generic sub-slab vapor probe

[Note: Many variations exist and may be proposed in a work plan. Proposed installations should meet the sampling objectives and requirements of the analytical methods.]

To obtain representative samples that meet the data quality objectives, sub-slab vapor samples should be collected in the following manner:

- a. after installation of the probes, one to three volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;
- b. flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize ambient air infiltration during sampling; and
- c. samples should be collected, using conventional sampling methods, in an appropriate container — one which
 - i. meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation),
 - ii. is consistent with the sampling and analytical methods (e.g., low flow rate; Summa[®] canisters if analyzing by using EPA Method TO-15), and
 - iii. is certified clean by the laboratory;
- d. sample size depends upon the volume of that will achieve minimum reporting limits [Section 2.9], the flow rate, and the sampling duration; and
- e. ideally, samples should be collected over the same period of time as concurrent indoor and outdoor air samples.

When sub-slab vapor samples are collected, the following actions should be taken to document conditions during sampling and ultimately to aid in the interpretation of the sampling results [Section 3]:

- a. historic and current storage and uses of volatile chemicals should be identified, especially if sampling within a commercial or industrial building (e.g., use of volatile chemicals in commercial or industrial processes and/or during building maintenance);
- b. the use of heating or air conditioning systems during sampling should be noted;
- c. floor plan sketches should be drawn that include the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north), footings that create separate foundation sections, and any other pertinent information should be completed;
- d. outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sampling locations (if applicable), compass orientation (north), and paved areas;
- e. weather conditions (e.g., precipitation and indoor and outdoor temperature) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and
- f. any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

Additional documentation that could be gathered to assist in the interpretation of the results includes information about air flow patterns and pressure relationships obtained by using smoke tubes or other devices (especially between floor levels and between suspected

contaminant sources and other areas), the barometric pressure and photographs to accompany floor plan sketches.

The field sampling team should maintain a sample log sheet summarizing the following:

- a. sample identification,
- b. date and time of sample collection,
- c. sampling depth,
- d. identity of samplers,
- e. sampling methods and devices,
- f. soil vapor purge volumes,
- g. volume of soil vapor extracted,
- h. if canisters used, vacuum of canisters before and after samples collected,
- i. apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- j. chain of custody protocols and records used to track samples from sampling point to analysis.

2.7.3 Indoor air

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. If possible, prior to collecting indoor samples, a pre-sampling inspection [Section 2.11.1] should be performed to evaluate the physical layout and conditions of the building being investigated, to identify conditions that may affect or interfere with the proposed sampling, and to prepare the building for sampling. This process is described in Section 2.11.1.

In general, indoor air samples should be collected in the following manner:

- a. sampling duration should reflect the exposure scenario being evaluated without compromising the detection limit or sample collection flow rate (e.g., an 8 hour sample from a workplace with a single shift versus a 24 hour sample from a workplace with multiple shifts). To ensure that air is representative of the locations sampled and to avoid undue influence from sampling personnel, samples should be collected for at least 1 hour. If the goal of the sampling is to represent average concentrations over longer periods, then longer duration sampling periods may be appropriate. Typically, 24 hour samples are collected from residential settings;
- b. personnel should avoid lingering in the immediate area of the sampling device while samples are being collected;
- c. sample flow rates must conform to the specifications in the sample collection method and, if possible, should be consistent with the flow rates for concurrent outdoor air and sub-slab samples; and
- d. samples must be collected, using conventional sampling methods, in an appropriate container — one which

- i. meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation),
- ii. is consistent with the sampling and analytical methods (e.g., low flow rate; Summa[®] canisters if analyzing by using EPA Method TO-15), and
- iii. is certified clean by the laboratory.

At sites with tetrachloroethene contamination, passive air monitors that are specifically analyzed for tetrachloroethene (i.e., "perc badges") are commonly used to collect indoor and outdoor air samples. If site characterization activities indicate that degradation products of tetrachloroethene also represent a vapor intrusion concern, perc badges may be used to indicate the likelihood of vapor intrusion (i.e., by using tetrachloroethene as a surrogate) followed, as appropriate, by more comprehensive sampling and laboratory analyses to quantify both tetrachloroethene and its degradation products. Perc badge samples ideally should be collected over a twenty-four hour period, but for no less than eight hours.

The following actions should be taken to document conditions during indoor air sampling and ultimately to aid in the interpretation of the sampling results [Section 3]:

- a. historic and current uses and storage of volatile chemicals should be identified, especially if sampling within a commercial or industrial building (e.g., use of volatile chemicals in commercial or industrial processes and/or during building maintenance);
- b. a product inventory survey documenting sources of volatile chemicals present in the building during the indoor air sampling that could potentially influence the sample results should be completed [Section 2.11.2];
- c. the use of heating or air conditioning systems during sampling should be noted;
- d. floor plan sketches should be drawn that include the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system supply and return registers, compass orientation (north), footings that create separate foundation sections, and any other pertinent information should be completed;
- e. outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sampling locations (if applicable), compass orientation (north), and paved areas;
- f. weather conditions (e.g., precipitation and indoor and outdoor temperature) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and
- g. any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

Additional documentation that could be gathered to assist in the interpretation of the results includes information about air flow patterns and pressure relationships obtained by using smoke tubes or other devices (especially between floor levels and between suspected contaminant sources and other areas), the barometric pressure and photographs to accompany floor plan sketches.

The field sampling team should maintain a sample log sheet summarizing the following:

- a. sample identification,
- b. date and time of sample collection,
- c. sampling height,
- d. identity of samplers,
- e. sampling methods and devices,
- f. depending upon the method, volume of air sampled,
- g. if canisters are used, vacuum of canisters before and after samples collected, and
- h. chain of custody protocols and records used to track samples from sampling point to analysis.

2.7.4 Outdoor air

Outdoor air samples should be collected simultaneously with indoor air samples to evaluate the potential influence, if any, of outdoor air on indoor air quality. They may also be collected simultaneously with soil vapor samples to identify potential outdoor air interferences associated with infiltration of outdoor air into the sampling apparatus while the soil vapor was collected. To obtain representative samples that meet the data quality objectives, outdoor air samples should be collected in a manner consistent with that for indoor air samples (described in Section 2.7.3).

The following actions should be taken to document conditions during outdoor air sampling and ultimately to aid in the interpretation of the sampling results [Section 3]:

- a. outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sampling locations, the location of potential interferences (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), and paved areas;
- b. weather conditions (e.g., precipitation and outdoor temperature) should be reported; and
- c. any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

2.7.5 Tracer gas

When collecting soil vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control measure to verify the integrity of the soil vapor probe seal. Without the use of a tracer, there is no way to verify that a soil vapor sample has not been diluted by outdoor air.

Depending on the nature of the contaminants of concern, a number of different compounds can be used as a tracer. Typically, sulfur hexafluoride (SF₆) or helium are used as tracers because they are readily available, have low toxicity, and can be monitored with portable measurement devices. Butane and propane (or other gases) could also be used as a tracer in some situations. Compounds other than those mentioned here may be appropriate, provided they meet project-specific data quality objectives. Where applicable, steps should

be taken to ensure that the gas used by the laboratory to clean the air sampling container is different from the gas used as a tracer during sampling (e.g., helium).

The protocol for using a tracer gas is straightforward: simply enrich the atmosphere in the immediate vicinity of the area where the probe intersects the ground surface with the tracer gas, and measure a vapor sample from the probe for the presence of high concentrations (> 10%) of the tracer. A cardboard box, a plastic pail, or even a garbage bag can serve to keep the tracer gas in contact with the probe during the testing. If there are concerns about infiltration of ambient air through other parts of the sampling train (such as around the fittings, not just at the probe/ground interface), then consideration should be given to ensuring that the tracer gas is in contact with the entire sampling apparatus. In these cases, field personnel may prefer to use a liquid tracer — soaking paper towels with a liquid tracer and placing the towels around the probe/ground interface, around fittings, and/or in the corner of a shroud.

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 vapor for the tracer prior to and after sampling for the compounds of concern. (Note that the tracer gas samples can be collected via syringe, Tedlar[®] bag etc. They need not be collected in Summa[®] canisters or minicans.)

The advantage of the second approach is that the real time tracer sampling results can be used to confirm the integrity of the probe seals prior to formal sample collection.

Figure 2.4 depicts common methods for using tracer gas. In examples a, b and c, the tracer gas is released in the enclosure prior to initially purging the sample point. Care should be taken to avoid excessive purging prior to sample collection. Care should also be taken to prevent pressure build-up in the enclosure during introduction of the tracer gas. Inspection of the installed sample probe, specifically noting the integrity of the surface seal and the porosity of the soil in which the probe is installed, will help to determine the tracer gas setup. Figure 2.4a may be most effective at preventing tracer gas infiltration, however, it may not be appropriate in some situations depending on site-specific conditions. Figures 2.4b and 2.4c may be sufficient for probes installed in tight soils with well-constructed surface seals. Figure 2d provides an example of using a liquid tracer. In all cases, the same tracer gas application should be used for all probes at any given site.

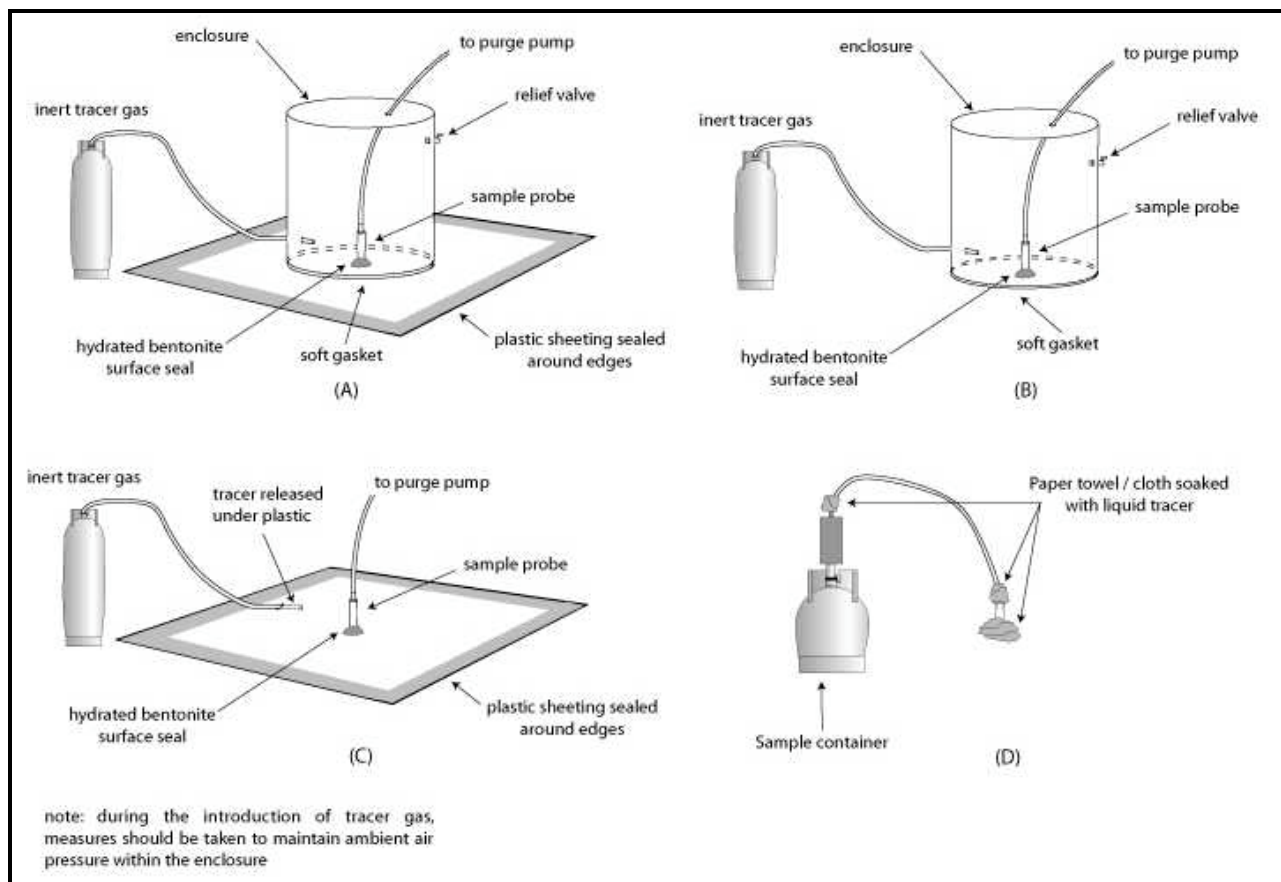


Figure 2.4

Schematics of generic tracer gas applications when collecting soil vapor samples

Because minor leakage around the probe seal should not materially affect the usability of the soil vapor 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 ($> 10\%$) of tracer gas are observed in a sample, the probe seal should be enhanced to reduce the infiltration of outdoor air.

Where permanent or semi-permanent sampling probes are used, tracer gas samples should be collected at each of the sampling probes during the initial stages of a soil vapor sampling program. If the results of the initial samples indicate that the probe seals are adequate, reducing the number of locations at which tracer gas samples are employed may be considered. At a minimum, tracer gas samples should be collected with at least 10% of the soil vapor samples collected in subsequent sampling rounds. When using permanent soil vapor probes as part of a long-term monitoring program, annual testing of the probe integrity is recommended. Where temporary probes are used, tracer gas should be used at every sampling location, every time.

2.8 Quality assurance/quality control (QA/QC)

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

In general, appropriate QA/QC procedures should be followed during all aspects of sample collection and analysis to ensure that sampling error is minimized and high quality data are obtained. Sampling team members should avoid actions (e.g., fueling vehicles, using permanent marking pens, wearing freshly dry-cleaned clothing or personal fragrances, etc.) which can cause sample interference in the field. Portable air monitoring equipment or field instrumentation should be properly maintained, calibrated and tested to ensure validity of measurements. Air sampling equipment should be stored, transported and between samples decontaminated in a manner consistent with the best environmental consulting practices to minimize problems such as field contamination and cross-contamination. Samples should be collected using certified clean sample devices. Where applicable, steps should be taken to ensure that the gas used by the laboratory to clean the sample device is different from the gas used as a tracer during sampling (e.g., helium). Samples should meet sample holding times and temperatures, and should be delivered to the analytical laboratory as soon as possible after collection. In addition, laboratory accession procedures should be followed, including field documentation (sample collection information and locations), chain of custody, field blanks, field sample duplicates and laboratory duplicates, as appropriate.

Some methods call for collecting samples in duplicate (e.g., indoor air sampling using passive sampling devices for tetrachloroethene) to assess errors. Duplicate and/or split samples should be collected in accordance with the sampling and analytical methods being implemented.

For certain regulatory programs, a Data Usability Summary Report (DUSR) or equivalent report may be required to determine whether or not the data, as presented, meets the site or project specific criteria for data quality and data use. This requirement may dictate the level of QC and the category of data deliverable to request from the laboratory. Guidance on preparing these reports is available by contacting the NYSDEC's Division of Environmental Remediation.

New York State Public Health Law requires laboratories analyzing environmental samples collected from within New York State to have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. If ELAP certification is not currently required for an analyte (e.g., trichloroethene), the analysis should be performed by a laboratory that has ELAP certification for similar compounds in air and uses analytical methods with minimum reporting limits similar to background (e.g., tetrachloroethene via EPA Method TO-15). Questions about a laboratory's current certification status should be directed to an ELAP representative at 518-485-5570 or by email at elap@health.state.ny.us.

The work plan should state that all samples that will be used to make decisions on appropriate actions to address exposures and environmental contamination will be analyzed by an ELAP-certified laboratory. The name of the laboratory should also be provided. Similarly, the name of the laboratory that was used should be included in the report of the sampling results. For samples collected and tested in the field for screening purposes by using field testing technology, the qualifications of the field technician should be documented in the work plan.

2.9 Analytical methods

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

Proposed analytical procedures should be identified in work plans. Similarly, the analytical procedures that were used and corresponding reporting limits should be identified when reporting the sampling results. When selecting an appropriate analytical method, the data quality objectives should be considered. As described in Section 3, comparing sampling results for volatile chemicals with background concentrations and with indoor air/sub-slab vapor matrices are critical components of the data evaluation process. Therefore, samples should be analyzed by methods that can achieve minimum reporting limits to allow for comparison of the results with background levels and with the levels presented in the matrices [Section 3.4.2]. If there are additional data quality objectives, they should be considered also. Typically, a minimum reporting limit of 1 microgram per cubic meter (1 mcg/m³) or less is sufficient for most analytes. Examples of commonly used analytical methods include the following:

- a. EPA Method TO-15 for a wide range of VOCs (e.g., samples from evacuated canisters),
- b. NYSDOH Method 311-9 for tetrachloroethene (i.e., samples from perc badges),
- c. EPA Method TO-17 for VOCs (e.g., samples collected with sorbent tubes), and
- d. EPA Method TO-15 for VOCs with selective ion monitoring (SIM) (e.g., to achieve minimum reporting limits lower than those achieved with Method TO-15 alone).

The laboratory should verify that they are capable of detecting the appropriate analytes and can report them at the appropriate reporting limit.

2.9.1 Subsurface vapor

Soil vapor and sub-slab vapor samples should be analyzed for a wide range of volatile chemicals during the first round of sampling (at a minimum) — unless it can be demonstrated that an abbreviated or site-specific analyte list is appropriate. This is analogous to analyzing groundwater samples for a suite of compounds (e.g., EPA's target analyte list/target compound list (TAL/TCL) chemicals) during the initial rounds of site characterization. Based on the initial sampling results, development and application of a site-specific analyte list may be considered for analysis of subsequent soil vapor and sub-slab vapor samples.

If a site-specific analyte list is developed, it should include the following:

- a. volatile chemicals which have been previously detected in environmental media (e.g., soil, groundwater and air) at the site;
- b. volatile chemicals which are known or demonstrated constituents of the contamination in question (e.g., petroleum products or tars from former manufactured gas plants); and
- c. expected degradation products of the chemicals mentioned in a or b.

A site-specific analyte list might also include indicator compounds to assist in identifying and differentiating subsurface sources of volatile chemical contamination. The following are examples of indicator compounds that have been included in site-specific analyte lists given the nature of the contamination or type of site:

- a. gasoline: benzene, toluene, ethylbenzene, xylenes, trimethylbenzene isomers, individual C-4 to C-8 aliphatics (e.g., hexane, cyclohexane, dimethylpentane, 2,2,4-trimethylpentane, etc.), and appropriate oxygenate additives (e.g., methyl-*tert*-butyl ether, ethanol, etc.);
- b. middle distillate fuels (#2 fuel oil, diesel and kerosene): n-nonane, n-decane, n-undecane, n-dodecane, ethylbenzene, xylenes, trimethylbenzene isomers, tetramethylbenzene isomers, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene;
- c. manufactured gas plant sites: trimethylbenzene isomers, tetramethylbenzene isomers, thiopenes, indene, indane, and naphthalene;
- d. natural gas: propane, propene, butane, iso-butane, methylbutane, and n-pentane with lower levels of higher molecular weight aliphatic, olefinic, and some aromatic compounds; and
- e. solvent-using industries: the solvent and its expected degradation products (e.g., tetrachloroethene, trichloroethene, dichloroethene(s), and vinyl chloride).

2.9.2 Indoor air

Indoor and outdoor air samples should be analyzed for a wide range of volatile chemicals if there are no existing data for subsurface vapors — unless it can be demonstrated that an abbreviated or site-specific analyte list is appropriate. If indoor air sampling is appropriate based on the levels of volatile chemicals in subsurface vapors, analysis of indoor air samples specifically for those volatile chemicals may be considered.

2.9.3 Outdoor air

Outdoor air samples should be analyzed in a manner consistent with corresponding indoor air samples.

2.10 **Field laboratories and mobile gas chromatographs (GCs)**

Use of field laboratories and mobile GCs as screening tools when collecting soil vapor samples may be considered on a site-specific basis. However, without ELAP certification, screening tools such as these are not acceptable when collecting sub-slab vapor, indoor air and outdoor air samples for the purpose of evaluating exposures related to soil vapor intrusion. ELAP certification for a particular laboratory does not indicate mobile laboratory or GC certification. Mobile laboratories and GCs have specific certification requirements through ELAP. Questions regarding a mobile laboratory's certification should be directed to the laboratory itself.

2.11 **Surveys and pre-sampling building preparation**

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

2.11.1 Pre-sampling building inspection and preparation

A pre-sampling inspection should be performed prior to each sampling event to identify and minimize conditions that may interfere with the proposed testing. The inspection should evaluate the type of structure, floor layout, air flows and physical conditions of the building(s) being studied. This information, along with information on sources of potential

indoor air contamination [Section 2.11.2], should be identified on a building inventory form. An example of a building inventory form is given in Appendix B. Items to be included in the building inventory include the following:

- a. construction characteristics, including foundation cracks and utility penetrations or other openings that may serve as preferential pathways for vapor intrusion;
- b. presence of an attached garage;
- c. recent renovations or maintenance to the building (e.g., fresh paint, new carpet or furniture);
- d. mechanical equipment that can affect pressure gradients (e.g., heating systems, clothes dryers or exhaust fans);
- e. use or storage of petroleum products (e.g., fuel containers, gasoline operated equipment and unvented kerosene heaters); and
- f. recent use of petroleum-based finishes or products containing volatile chemicals.

Each room on the floor of the building being tested and on lower floors, if possible, should be inspected. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building. Where applicable, readings should be provided in units that denote the calibration gas (e.g., isobutylene-equivalent ppm, benzene-equivalent ppm, etc.).

Potential interference from products or activities releasing volatile chemicals should be controlled to the extent practicable. Removing the source from the indoor environment prior to testing is the most effective means of reducing interference. Ensuring that containers are tightly sealed may be sufficient. When testing for volatile organic compounds, containers should be tested with portable vapor monitoring equipment to determine whether compounds are leaking. The inability to eliminate potential interference may be justification for not testing, especially when testing for similar compounds at low levels. The investigator should consider the possibility that chemicals may adsorb onto porous materials and may take time to dissipate.

In some cases, the goal of the testing is to evaluate the impact from products used or stored in the building (e.g., pesticide misapplications, school renovation projects). If the goal of the testing is to determine whether products are an indoor volatile chemical contaminant source, the removing these sources does not apply.

Once interfering conditions are corrected (if applicable), ventilation may be appropriate prior to sampling to minimize residual contamination in the indoor air. If ventilation is appropriate, it should be completed 24 hours or more prior to the scheduled sampling time. Where applicable, ventilation can be accomplished by operating the building's HVAC system to maximize outside air intake. Opening windows and doors, and operating exhaust fans may also help or may be appropriate if the building has no HVAC system.

Air samples are sometimes designed to represent typical exposure in a mechanically ventilated building and the operation of HVAC systems during sampling should be noted on

the building inventory form [Appendix B]. When samples are collected, the building's HVAC system should be operating in a manner consistent with normal operating conditions when the building is occupied (e.g., schools, businesses, etc.). Unnecessary building ventilation should be avoided within 24 hours prior to and during sampling. During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time.

Depending upon the goal of the indoor air sampling, some situations may warrant deviation from the above protocol regarding building ventilation. In such cases, building conditions and sampling efforts should be understood and noted within the framework and scope of the investigation.

To avoid potential interferences and dilution effects, occupants should make a reasonable effort to avoid the following for 24 hours prior to sampling:

- a. opening any windows, fireplace dampers, openings or vents;
- b. operating ventilation fans unless special arrangements are made;
- c. smoking in the building;
- d. painting;
- e. using a wood stove, fireplace or other auxiliary heating equipment (e.g., kerosene heater);
- f. operating or storing automobile in an attached garage;
- g. allowing containers of gasoline or oil to remain within the house or garage area, except for fuel oil tanks;
- h. cleaning, waxing or polishing furniture, floors or other woodwork with petroleum- or oil-based products;
- i. using air fresheners, scented candles or odor eliminators;
- j. engaging in any hobbies that use materials containing volatile chemicals;
- k. using cosmetics including hairspray, nail polish, nail polish removers, perfume/cologne, etc.;
- l. lawn mowing, paving with asphalt, or snow blowing;
- m. applying pesticides;
- n. using building repair or maintenance products, such as caulk or roofing tar; and
- o. bringing freshly dry-cleaned clothing or furnishings into the building.

2.11.2 Product inventory

The primary objective of the product inventory is to identify potential air sampling interference by characterizing the occurrence and use of chemicals and products throughout the building, keeping in mind the goal of the investigation and site-specific contaminants of concern. For example, it is not appropriate to provide detailed information for each individual container of like items. However, it is appropriate to indicate that "20 bottles of perfume" or "12 cans of latex paint" were present with containers in good condition. This information is used to help formulate an indoor environment profile.

An inventory should be provided for each room on the floor of the building being tested and on lower floors, if possible. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building. Where applicable, readings should be provided in units that denote the calibration gas (e.g., isobutylene-equivalent ppm, benzene-equivalent ppm, etc.).

Products in buildings should be inventoried every time air is tested to provide an accurate assessment of the potential contribution of volatile chemicals. If available, chemical ingredients of interest (e.g., analyte list) should be recorded for each product. If the ingredients are not listed on the label, record the product's exact and full name, and the manufacturer's name, address and telephone number, if available. In some cases, material Safety Data Sheets may be useful for identifying confounding sources of volatile chemicals in air. Adequately documented photographs of the products and their labeled ingredients can supplement the inventory and facilitate recording the information.

2.12 Role of modeling

At sites where there is a potential for human exposures to subsurface contamination due to soil vapor intrusion (as described in Section 2.1), use of modeling as the sole means of evaluating potential exposures should be avoided. The limitations of modeling (e.g., exclusion of preferential migration pathways) introduce uncertainty as to whether human exposure is occurring, in absence of actual field data. Conclusions drawn from modeling should be verified with actual field data. For example, if modeling results indicate indoor air concentrations are predicted to be below applicable guidelines or levels of concern, indoor air and/or sub-slab vapor sampling would be appropriate to verify a conclusion that mitigation or other actions are not needed.

Modeling may, however, be used as a tool in the evaluation process. Examples of situations in which modeling may be used as a tool include, but are not limited to, the following:

- a. to help identify potential migration pathways on the basis of site-specific conditions;
- b. to estimate potential exposures when field samples cannot be collected (e.g., access to collect the samples is denied or buildings have not yet been constructed over the subsurface contamination); and
- c. to identify a preferred order for sampling buildings by predicting expected indoor air concentrations within each of the buildings if there are numerous buildings overlying the subsurface contamination.

Use of any model at a site should be discussed with the agencies prior to the model's development and application. If a model is used, it should incorporate site-specific parameters (e.g., attenuation factors, soil conditions, concentrations of volatile chemicals, depth to subsurface source, characteristics of subsurface source, and foundation slab thickness) as much as possible. Furthermore, both the limitations of the model (e.g., exclusion of preferential migration pathways) and the sensitivity of the variables in the model should be understood and identified with the modeling results.

Soil Vapor/Indoor Air Matrix 1

October 2006

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)			
	< 0.25	0.25 to < 1	1 to < 5.0	5.0 and above
< 5	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
5 to < 50	5. No further action	6. MONITOR	7. MONITOR	8. MITIGATE
50 to < 250	9. MONITOR	10. MONITOR / MITIGATE	11. MITIGATE	12. MITIGATE
250 and above	13. MITIGATE	14. MITIGATE	15. MITIGATE	16. MITIGATE

No further action:

Given that the compound was not detected in the indoor air sample and that the concentration detected in the sub-slab vapor sample is not expected to significantly affect indoor air quality, no additional actions are needed to address human exposures.

Take reasonable and practical actions to identify source(s) and reduce exposures:

The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile organic compound-containing products in places where people do not spend much time, such as a garage or outdoor shed). Resampling may be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

MONITOR:

Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MITIGATE:

Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system, and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MONITOR / MITIGATE:

Monitoring or mitigation may be recommended after considering the magnitude of sub-slab vapor and indoor air concentrations along with building- and site-specific conditions.

See additional notes on page 2.

ADDITIONAL NOTES FOR MATRIX 1

This matrix summarizes the minimum actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, resampling may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Additionally, actions more protective of public health than those specified within the matrix may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action is usually undertaken for reasons other than public health (e.g., seeking community acceptance, reducing excessive costs, etc.).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of vapor contamination, nor does it preclude remediating contaminated soil vapors or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.25 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples, a minimum reporting limit of 5 micrograms per cubic meter is recommended for buildings with full slab foundations, and 1 microgram per cubic meter for buildings with less than a full slab foundation.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions may be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including the identified source of the volatile chemicals, the environmental remediation program, and site-specific and building-specific conditions. For example, to the extent that all site data and site conditions demonstrate that soil vapor intrusion is not occurring and that the potential for soil vapor intrusion to occur is not likely, the soil vapor intrusion investigation would be considered complete. In general, if indoor exposures represent a concern due to indoor sources, then the State will provide guidance to the property owner and/or tenant on ways to reduce their exposure. If indoor exposures represent a concern due to outdoor sources, then the NYSDEC will decide who is responsible for further investigation and any necessary remediation. Depending upon the outdoor source, this responsibility may or may not fall upon the party conducting the soil vapor intrusion investigation.

Soil Vapor/Indoor Air Matrix 2

October 2006

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)			
	< 3	3 to < 30	30 to < 100	100 and above
< 100	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
100 to < 1,000	5. MONITOR	6. MONITOR / MITIGATE	7. MITIGATE	8. MITIGATE
1,000 and above	9. MITIGATE	10. MITIGATE	11. MITIGATE	12. MITIGATE

No further action:

Given that the compound was not detected in the indoor air sample and that the concentration detected in the sub-slab vapor sample is not expected to significantly affect indoor air quality, no additional actions are needed to address human exposures.

Take reasonable and practical actions to identify source(s) and reduce exposures:

The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile organic compound-containing products in places where people do not spend much time, such as a garage or outdoor shed). Resampling may be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

MONITOR:

Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MITIGATE:

Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system, and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MONITOR / MITIGATE:

Monitoring or mitigation may be recommended after considering the magnitude of sub-slab vapor and indoor air concentrations along with building- and site-specific conditions.

See additional notes on page 2.

ADDITIONAL NOTES FOR MATRIX 2

This matrix summarizes the minimum actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, resampling may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Additionally, actions more protective of public health than those specified within the matrix may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action is usually undertaken for reasons other than public health (e.g., seeking community acceptance, reducing excessive costs, etc.).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of vapor contamination, nor does it preclude remediating contaminated soil vapors or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 3 micrograms per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples, a minimum reporting limit of 5 micrograms per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions may be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including the identified source of the volatile chemicals, the environmental remediation program, and site-specific and building-specific conditions. For example, to the extent that all site data and site conditions demonstrate that soil vapor intrusion is not occurring and that the potential for soil vapor intrusion to occur is not likely, the soil vapor intrusion investigation would be considered complete. In general, if indoor exposures represent a concern due to indoor sources, then the State will provide guidance to the property owner and/or tenant on ways to reduce their exposure. If indoor exposures represent a concern due to outdoor sources, then the NYSDEC will decide who is responsible for further investigation and any necessary remediation. Depending upon the outdoor source, this responsibility may or may not fall upon the party conducting the soil vapor intrusion investigation.

Section 4: Soil Vapor Intrusion Mitigation

As discussed in Section 1.1, soil vapor can enter a building through cracks or perforations in slabs or basement floors and walls, and through openings around sump pumps or where pipes and electrical wires go through the foundation primarily because of a difference between interior and exterior pressures. This intrusion is similar to how radon gas enters buildings from the subsurface. Fortunately, given this similarity, well-established techniques for mitigating exposures to radon may also be used to mitigate exposures related to soil vapor intrusion.

Once it is determined that steps should be taken to address exposures associated with soil vapor intrusion, they should be implemented with all due expediency. This section provides an overview of:

- a. methods of mitigation,
- b. installation and design of mitigation systems,
- c. post-mitigation testing,
- d. operation, maintenance and monitoring of mitigation systems,
- e. termination of mitigation system operations, and
- f. annual certification.

Mitigation is considered to be an interim measure to address exposures until contaminated environmental media are remediated, or until mitigation is no longer needed to address exposures related to soil vapor intrusion.

4.1 Methods of mitigation

The most effective mitigation methods involve sealing infiltration points and actively manipulating the pressure differential between the building's interior and exterior (on a continuous basis). As discussed in the following subsections, the appropriate method to use will largely depend upon the building's foundation design. Furthermore, buildings having more than one foundation design feature (e.g., a basement under one portion of the house and a crawl space beneath the remainder) may require a combination of mitigation methods. This section describes methods of mitigation that are expected to be the most reliable options under a wide range of circumstances. Occasionally, there are site-specific or building-specific conditions under which alternative methods (such as HVAC modification, sealing, room pressurization, passive ventilation systems, or vapor barriers) may be more appropriate. Such mitigation proposals may be considered on a case-by-case basis.

4.1.1 Buildings with a basement slab or slab-on-grade foundation

In conjunction with *sealing* potential subsurface vapor entry points, an active *sub-slab depressurization system* (SSD system) is the preferred mitigation method for buildings with a basement slab or slab-on-grade foundation. A SSD system uses a fan-powered vent and piping to draw vapors from the soil beneath the building's slab (i.e., essentially creating a vacuum beneath the slab) and discharge them to the atmosphere. This results in lower sub-slab air pressure relative to indoor air pressure, which prevents the infiltration of sub-slab vapors into the building.

The most common approach to achieving depressurization beneath the slab is to insert the piping through the floor slab into the crushed rock or soil underneath. However, the EPA, in their "Consumer's Guide to Radon Reduction" (EPA 402-K-03-002; revised February 2003), lists the following approaches as ways to reduce radon levels in a building, either in place of the more common sub-slab suction point method or in conjunction with that method:

- a. *Drain tile suction* — Some houses have drain tiles or perforated pipe to direct water away from the foundation of the house. Suction on these tiles or pipes is often effective;
- b. *Sump hole suction* — If the building has a sump pump to remove unwanted water, the sump can be capped so that it can continue to drain water and serve as the location for piping. If the sump is not used as the suction or extraction point, the associated wiring and piping should be sealed and an air-tight cover should be installed to enhance the performance of the SSD system; and
- c. *Block wall suction* — If the building has hollow block foundation walls, the void network within the wall may be depressurized by drawing air from inside the wall and venting it to the outside. This method is often used in combination with sub-slab depressurization.

The depressurization approach, or combination of approaches, selected for a building should be determined on a building-specific basis due to building-specific features that may be conducive to a specific depressurization approach. For example, if the contaminants are entering the building through a block wall, block wall suction in conjunction with traditional sub-slab depressurization may be more effective at minimizing exposures related to soil vapor intrusion rather than sub-slab depressurization alone.

Although sealing is not a reliable mitigation technique on its own, it can significantly improve the effectiveness of a SSD system since it limits the flow of subsurface vapors into the building. All joints, cracks and other penetrations of slabs, floor assemblies and foundation walls below or in contact with the ground surface should be sealed with materials that prevent air leakage.

If the State concurs that a SSD system is not a practicable alternative or that exposures will be mitigated concurrently by a method selected to remediate subsurface contamination, alternative mitigation methods may be considered, such as the following:

- a. *HVAC modification* — a technique where the building's HVAC system is modified to avoid depressurization of the building relative to underlying and surrounding soil (i.e., to maintain a positive pressure within the building); and
- b. *Soil vapor extraction (SVE) system* — a technique used to remediate contaminated subsurface soil vapor. SVE systems use high flow rates, induced vacuum or both to collect and remove contamination, while SSD systems use a minimal flow rate to effect the minimum pressure gradient (see the EPA's technical guidance documents for recommended gradients; Section 4.2.3) needed to reverse air flow across a building's foundation. Depending upon the SVE system's design, the system may also serve to mitigate exposures. For example, the SVE system's radius of influence includes the subsurface beneath affected buildings or horizontal legs of the system will be installed beneath affected buildings. However, complications can arise if the SVE system is no longer effective at remediating contaminated vapors, exposures should still be mitigated due to residual vapor contamination.

4.1.2 Buildings with a crawl space foundation

A *soil vapor retarder with sub-membrane depressurization (SMD) system* is the preferred mitigation method for buildings with a crawl space foundation. A soil vapor retarder is a synthetic membrane or other comparable material that is placed on the ground in the crawl space to retard the flow of soil vapors into the building. A SMD system is similar to a SSD system. It uses a fan-powered vent and piping to draw vapors from beneath the soil vapor retarder and discharge them to the atmosphere. This results in lower air pressure beneath the membrane relative to air pressure in the crawl space, which prevents the infiltration of subsurface vapors into the building.

If the State concurs that a soil vapor retarder with a SMD system is not a practicable alternative or that exposures will be mitigated concurrently by a method selected to remediate subsurface contamination, alternative mitigation methods may be considered, such as the following:

- a. *HVAC modification* — a technique where the building's HVAC system is modified to avoid depressurization of the building relative to the crawl space;
- b. *Crawl space ventilation with sealing* — a technique that uses a fan to draw air out of the crawl space; and
- c. *SVE system* [Section 4.1.1].

4.1.3 Buildings with dirt floor basements

Either a SSD system with a newly poured slab or a SMD system with a soil vapor retarder may be used. However, the former method is preferred.

4.1.4 Buildings with multiple foundation types

Mitigation in a building with a combination of foundations should be achieved by applying the specific methods described previously [Sections 4.1.1 through 4.1.3] to the corresponding foundation segments of the building. Special consideration should be given to the points at which different foundation types join, since additional soil vapor entry routes exist in such locations. Often, the various systems can be installed and connected to a common depressurization system and fan.

4.1.5 Undeveloped parcels

If sampling results indicate a mitigation system is recommended to address exposures in buildings that may be constructed, then a SSD system with sealing, or a SMD system with a soil vapor retarder, or a combination of these methods is recommended, as appropriate to the design of the proposed buildings.

4.1.6 Additional references

The following documents provide additional information on selecting an appropriate mitigation method:

- a. *A Consumer's Guide to Radon Reduction*
EPA [EPA 402-K-03-002, revised February 2003]

This document provides assistance in selecting a qualified radon mitigation contractor to reduce the radon levels in a home, determining an appropriate radon reduction method, and maintaining a radon reduction system. It is available at the EPA's web site: <http://www.epa.gov/iaq/radon/pubs/index.html>; and

- b. *Reducing Radon in Schools: A Team Approach*
EPA [EPA 402-R-94-008, April 1994]

This document will provide assistance in determining the best way to reduce elevated radon levels found in a school. It provides guidance on the process of confirming a radon problem, selecting the best mitigation strategy, and directing the efforts of a multidisciplinary team assembled to address elevated radon levels in a way that will contribute to the improvement of the overall indoor air quality of the school. Copies can be ordered from the EPA's Indoor Air Quality Information Clearinghouse at 1-800-438-4318.

4.2 Design and installation of mitigation systems

Once a mitigation method is selected, it should be designed and installed. The components of the design and installation of mitigation systems, the procedures for specific mitigation techniques, and references for technical guidance are provided in the following subsections.

4.2.1 General recommendations

Systems should be designed and installed by a professional engineer or environmental professional. In most areas of the state, there are contractors who have met certain requirements and are trained to identify and fix radon problems in buildings. To obtain the names of local contractors, contact the NYSDOH's Radon Program at 1-800-458-1158, extension 27556, or visit the National Radon Safety Board's web site (www.nrsb.org) or National Environmental Health Association's web site (www.neha.org).

Typically, the party responsible for remediating the site is responsible for arranging design and installation activities. If no responsible party is available, the State will arrange for the design and installation of the system. All design and installation activities should be documented and reported to the agencies. Furthermore, once a mitigation system is installed, an information package should be given to the building's owner and tenants, if applicable, to facilitate their understanding of the system's operation, maintenance and monitoring [Section 5.6].

With the exception of SVE systems, the mitigation methods introduced in Section 4.1 are not intended to remediate the source of subsurface vapors (e.g., contaminated groundwater, soil, etc.). Rather, they are designed to minimize the infiltration of subsurface vapors into a building. For consistency in implementing the techniques in residential buildings, mitigation systems should be designed and installed in accordance with the following:

- a. *Standard Practice for Installing Radon Mitigation Systems in Existing Low-rise Residential Buildings* (ASTM E-2121)

American Society for Testing and Materials (ASTM) International [ASTM E-2121-03, February 10, 2003]

This document applies to existing buildings. The purpose of this document is to provide radon mitigation contractors with uniform standards that will ensure quality and effectiveness in the design, installation, and evaluation of radon mitigation systems in detached and attached residential buildings three stories or less in height. Information on how to obtain a copy of this standard is available in Appendix E; and

- b. *Model Standards and Techniques for Control of Radon in New Residential Buildings* EPA [EPA 402-R-94-009, March 1994]

This document applies to new construction and contains information on how to incorporate radon reduction techniques and materials in residential construction. A copy of this document is provided in Appendix F.

4.2.2 System-specific recommendations

Basic design and installation recommendations for mitigation systems follow. These are based upon recommendations and requirements given by the EPA for mitigating exposures related to radon intrusion (for additional information see EPA's web site on radon at <http://www.epa.gov/iaq/radon/pubs/index.html>).

- a. *Sealing* — To improve the effectiveness of depressurization and ventilation systems and to limit the flow of subsurface vapors into the building, materials that prevent air leakage should be used, such as elastomeric joint sealant (as defined in ASTM C920-87), compatible caulks, non-shrink mortar, grouts, expanding foam, "Dranjer" drain seals, or airtight gaskets. Some effective sealants may contain volatile organic compounds; in some situations, this may be a consideration in choosing an appropriate sealing material.
- b. *Soil vapor retarder (membrane)* —
1. To retard the infiltration of subsurface vapors into the building and enhance the performance of a SMD system, a minimum 6 mil (or 3 mil cross-laminated) polyethylene or equivalent flexible sheeting material should be used.
 2. The sheet should cover the entire floor area and be sealed at seams (with at least a 12 inch overlap) and penetrations, around the perimeter of interior piers and to the foundation walls.
 3. Enough of the sheeting should be used so it will not be pulled away from the walls when the depressurization system is turned on and the sheet is drawn down.
 4. If a membrane is installed in areas that may have future foot traffic (e.g., a dirt floor in a basement), consideration should be given to also installing a wearing surface such as sand or stone to protect the integrity of the membrane. Additionally, a layer of fine sand may be prudent beneath the membrane to protect it from penetrations by sharp objects in the dirt floor.

c. *Depressurization systems* —

1. The systems should be designed to avoid the creation of other health, safety, or environmental hazards to building occupants (e.g., backdrafting of natural draft combustion appliances).
2. The systems should be designed to minimize soil vapor intrusion effectively while minimizing excess energy usage, to avoid compromising moisture and temperature controls and other comfort features, and to minimize noise.
3. To evaluate the potential effectiveness of a SSD before it is installed, a diagnostic test (commonly referred to as a "communication" test) should be performed to measure the ability of a suction field and air flow to extend through the material beneath the slab. This test is commonly conducted by applying suction on a centrally located hole drilled through the concrete slab and simultaneously observing the movement of smoke downward into small holes drilled in the slab at locations separated from the central suction hole. A similar quantitative evaluation may also be performed by using a digital micromanometer or comparable instrument. Depending on test results, multiple suction points may be needed to achieve the desired effectiveness of the system.
4. Passive systems (i.e., a SSD system without a vent fan) are not as effective as active systems and their performance varies depending upon ambient temperatures and wind conditions. Therefore, active systems should be used to ensure exposures are being addressed.
5. The vent fan and discharge piping should not be located in or below a livable or occupied area of the building to avoid entry of extracted subsurface vapors into the building in the event of a fan or pipe leak.
6. To avoid entry of extracted subsurface vapors into the building, the vent pipe's exhaust should be
 - i. above the eave of the roof (preferably, above the highest eave of the building at least 12 inches above the surface of the roof),
 - ii. at least 10 feet above ground level,
 - iii. at least 10 feet away from any opening that is less than 2 feet below the exhaust point, and
 - iv. 10 feet from any adjoining or adjacent buildings, or HVAC intakes or supply registers.
7. Rain caps, if used, should be installed so as not to increase the potential for extracted subsurface vapors to enter the building.
8. To avoid accidental changes to the system that could disrupt its function, the depressurization system should be labeled clearly. An example of such labeling is shown in Figure 5.1.
9. A warning device or indicator should be installed to alert building occupants if the active system stops working properly. Examples of system failure warning devices and indicators include the following: a liquid gauge (e.g., a

manometer), a sound alarm, a light indicator, and a dial (needle display) gauge. The warning device or indicator should be placed where it can be easily heard or seen. The party installing the system should verify the warning device or indicator is working properly. Building occupants should be made aware of the warning device or indicator (what it is, where it is located, how it works, how to read/understand it, and what to do if it indicates the system is not working properly).

- d. *HVAC systems* — HVAC systems should be carefully designed, installed and operated to avoid depressurization of basements and other areas in contact with the soil.
- e. *Crawl space ventilation* —
 1. Ventilation systems should be designed to avoid the creation of other health, safety, or environmental hazards to building occupants (e.g., backdrafting of natural draft combustion appliances).
 2. Openings and cracks in floors above the crawl space that would permit conditioned air to pass into or out of the occupied spaces of the building, should be identified, closed and sealed.
- f. *SVE systems designed to also mitigate exposures* —
 1. The systems should be designed to avoid the creation of other health, safety, or environmental hazards to building occupants (e.g., backdrafting of natural draft combustion appliances).
 2. To avoid reentry of soil vapor into the building(s), the exhaust point should be located away from the openings of buildings and HVAC air intakes. Depending upon the concentrations of volatile chemicals in subsurface vapors and the expected mass removal rate, treatment (e.g., via carbon filters) of the SVE system effluent may be appropriate to minimize outdoor air effects.
 3. The SVE system's radius of influence should adequately address buildings requiring mitigation, as well as subsurface sources requiring remediation. If it does not, additional actions may be appropriate. For example, if the radius of influence does not completely extend beneath a building, a complementary air monitoring program may be appropriate to confirm that exposures are being addressed adequately while the SVE system is operating.

4.2.3 Technical guidance

To address exposures effectively in larger buildings, some of the same techniques used in residential buildings can be scaled up in size, number, or performance (e.g., adjustments in the size and air movement capacity of the vent pipe fan, or installation of multiple suction points through the slab instead of a single point). The design of the techniques may also be modified (e.g., installation of horizontal pipes beneath the building instead of a single suction point).

Detailed technical guidance on designing and installing mitigation systems in residential and non-residential buildings is provided in various documents, such as the following, released by the EPA and others:

- a. References provided in ASTM's E-2121 (see Appendix E for information on how to obtain a copy) and the EPA's *Model Standards and Techniques for Control of Radon in New Residential Buildings* (Appendix F);
- b. *Radon Reduction Techniques for Existing Detached Houses: Technical Guidance (Third Edition) for Active Soil Depressurization Systems*
EPA [EPA 625/R-93-011, October 1993]

This technical guidance document has been prepared to serve as a comprehensive aid in the detailed selection, design, installation, and operation of indoor radon reduction measures for existing houses based on active soil depressurization techniques. It is intended for use by radon mitigation contractors, building contractors, concerned homeowners, state and local officials and other interested persons. Copies can be ordered from the EPA's Indoor Air Quality Information Clearinghouse at 1-800-438-4318;

- c. *Protecting Your Home From Radon: A Step-by-Step Manual for Radon Reduction*
Kladder *et al.*, 1993

This manual is designed to provide sufficient information to a homeowner to make many of the basic repairs that can significantly reduce radon levels in the home;

- d. *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes*
EPA [EPA 402-K-01-002, April 2001]

This fully illustrated guide contains all the information needed in one place to educate home builders about radon-resistant new construction (RRNC), including the following: basic questions and detailed answers about radon and RRNC, specific planning steps before installing a system, detailed installation instructions with helpful illustrations, tips and tricks when installing a system, marketing know-how when dealing with homebuyers, and architectural drawings. This document is available at the EPA's web site: <http://www.epa.gov/iaq/radon/pubs/index.html>; and

- e. *Radon Prevention in the Design and Construction of Schools and Other Large Buildings*
EPA [EPA 625-R-92-016, June 1994]

It is typically easier and much less expensive to design and construct a new building with radon-resistant and/or easy-to-mitigate features, than to add these features after the building is completed and occupied. Specific guidelines on how to incorporate radon prevention features in the design and construction of schools and other large buildings are detailed in this manual. Copies can be ordered from the EPA's Indoor Air Quality Information Clearinghouse at 1-800-438-4318. This document is also available on the EPA Office of Research and Development's web site: <http://www.epa.gov/ORD/NRMRL/pubs/625r92016/625r92016.htm>.

4.3 Post-mitigation or confirmation testing

Once a mitigation system is installed, its effectiveness and proper installation should be confirmed. The party that installed the system should conduct post-mitigation testing and for developing a post-mitigation testing plan. Minimum objectives for post-mitigation testing associated with specific mitigation methods are provided in the following

subsections. All post-mitigation testing activities should be documented and reported to the agencies.

4.3.1 SSD systems with sealing

- a. Reasonable and practical actions should be taken to identify and fix leaks. With the depressurization system operating, smoke tubes are used to check for leaks through concrete cracks, floor joints, and at the suction point. Any leaks identified should be resealed until smoke is no longer observed flowing through the opening.
- b. Once a depressurization system is installed, its operation may compete with the proper venting of fireplaces, wood stoves and other combustion or vented appliances (e.g., furnaces, clothes dryers, and water heaters), resulting in the accumulation of exhaust gases in the building and the potential for carbon monoxide poisoning. Therefore, in buildings with natural draft combustion appliances, the building should be tested for backdrafting of the appliances. Backdrafting conditions should be corrected before the depressurization system is placed in operation.
- c. The distance that a pressure change is induced in the sub-slab area (i.e., a pressure field extension test) should be conducted. Analogous to a communication test, this test is commonly conducted by operating the depressurization system and simultaneously observing the movement of smoke downward into small holes (e.g., 3/8 inch) drilled through the slab at sufficient locations to demonstrate that a vacuum is being created beneath the entire slab. A similar quantitative evaluation may also be performed by using a digital micromanometer or comparable instrument. If adequate depressurization is not occurring, the reason (e.g., improper fan operation) should be identified and corrected.
- d. Adequate operation of the warning device or indicator should be confirmed.
- e. Except as indicated below, post-mitigation indoor and outdoor air sampling should be conducted in all buildings where pre-mitigation samples were collected and in all buildings where physical data suggest possible impediments to comprehensive sub-slab communication of the depressurization system (i.e., locations with wet or dense sub-slab soils, multiple foundations and footings, minimal pressure differentials between the interior and sub-slab). Generally, indoor and outdoor air sampling locations, protocols and analytical methods should be consistent between pre-mitigation and post-mitigation sampling, where applicable. In buildings with basements, post-mitigation indoor air sampling from the basement alone (i.e., without a concurrent indoor air sample from the first floor) is recommended in most circumstances.

Typically, post-mitigation sampling should be conducted no sooner than 30 days after installing a depressurization system. If the system is installed outside of the heating season or at the end of a season, post-mitigation air sampling may be postponed until the heating season.

In cases of widespread mitigation due to vapor contamination and depending upon the basis of making decisions (e.g., a "blanket mitigation" approach within a specified area of documented vapor contamination [Section 3.3.1]), a representative number of buildings from an identified study area, rather than each building, may be

sampled. Prior to implementation, this type of post-mitigation sampling approach should be approved by State agency personnel.

In newly constructed buildings, a site-specific and building-specific indoor air sampling plan is recommended due to potential interferences caused by the off-gassing of volatile chemicals in new building materials (e.g., paints, carpets, furniture, etc. [Section 1.4]). In these situations, if indoor air sampling is appropriate samples should be

- i. collected while the system is operational but before potentially interfering factors are brought into the building,
- ii. analyzed for a targeted list of volatile chemicals based on previous environmental sampling (e.g., groundwater, soil, soil vapor, etc.), and/or
- iii. collected while the system is operational but after potentially interfering factors have had an opportunity to off-gas.

If post-mitigation sampling results do not indicate a significant decrease in the concentrations of volatile chemicals previously believed to be present in the indoor air due to soil vapor intrusion, the reason (e.g., indoor or outdoor sources, improper operation of the mitigation system, etc.) should be identified and corrected as appropriate.

4.3.2 SMD systems with soil vapor retarder

- a. Reasonable and practical actions should be taken to identify and fix leaks. With the depressurization system operating, smoke tubes are used to check for leaks in the membrane at seams, edge seals and at locations where the sheet was sealed around obstructions. Any leaks identified should be resealed until smoke is no longer observed flowing through the opening.
- b. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].
- c. Adequate operation of the warning device or indicator should be confirmed.
- d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [as discussed in Section 4.3.1].

4.3.3 HVAC modifications

- a. Check the building for positive pressure conditions (e.g., verify a pressure controller is maintaining the desired pressure differential and/or measure the pressure differential between the sub-slab and indoor air by using field instruments).
- b. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].
- c. Adequate operation of the warning device or indicator, if applicable, should be confirmed.
- d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [Section 4.3.1].

4.3.4 Crawl space ventilation and sealing

- a. Reasonable and practical actions should be taken to identify and fix leaks. With the ventilation system operating, smoke tubes are used to check for leaks in openings and cracks in floors above the crawl space that were sealed during installation of the system. Any leaks identified should be resealed until smoke is no longer observed flowing through the opening.
- b. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].
- c. Adequate operation of the warning device or indicator, if applicable, should be confirmed.
- d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [as discussed in Section 4.3.1].

4.3.5 SVE systems designed to also mitigate exposures

- a. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].
- b. The distance that a pressure change is induced in the sub-slab area should be conducted. This may be done by operating the SVE system and simultaneously observing the movement of smoke downward into small holes (e.g., 3/8 inch) drilled through the building's slab at sufficient locations to demonstrate that a vacuum is being created beneath the entire slab.
- c. Adequate operation of the warning device or indicator, if applicable, should be confirmed.
- d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [Section 4.3.1].

4.4 Operation, maintenance and monitoring of mitigation systems

When mitigation systems are implemented at a site, the operation, maintenance and monitoring (OM&M) protocols for the systems should be included in a site-specific site management plan (formerly referred to as operation, maintenance and monitoring plan). The party that installed the system should conduct OM&M activities and should develop the site management plan. Recommendations for minimum OM&M activities associated with specific mitigation methods are provided in the following subsections. Also included is a discussion of non-routine maintenance. All routine and non-routine OM&M activities should be documented and reported to the agencies.

4.4.1 SSD and SMD systems

Routine maintenance should commence within 18 months after the system becomes operational, and should occur every 12 to 18 months thereafter. Based upon a demonstration of the system's reliability, the State recommends that, if a different frequency is desired, a petition describing the alternative frequency and the reasons that frequency is preferred be submitted to the State. Any comments the State may have on the petition should be considered before the frequency is altered.

During routine maintenance, the following activities (at a minimum) should be conducted:

- a. a visual inspection of the complete system (e.g., vent fan, piping, warning device or indicator, labeling on systems, soil vapor retarder integrity, etc.),
- b. identification and repair of leaks [Sections 4.3.1 and 4.3.2], and
- c. inspection of the exhaust or discharge point to verify no air intakes have been located nearby.

As appropriate preventative maintenance (e.g., replacing vent fans), repairs and/or adjustments should be made to the system to ensure its continued effectiveness at mitigating exposures related to soil vapor intrusion. The need for preventative maintenance will depend upon the life expectancy and warranty for the specific part, as well as visual observations over time. The need for repairs and/or adjustments will depend upon the results of a specific activity compared to that obtained when system operations were initiated.

If significant changes are made to the system or when the system's performance is unacceptable, the system may need to be redesigned and restarted. Many, if not all, of the post-mitigation testing activities, as described in Sections 4.3.1 and/or 4.3, may be appropriate. The extent of such activities will primarily depend upon the reason for the changes and the documentation of sub-slab depressurization.

Generally, air monitoring is not recommended if the system has been installed properly and is maintaining a vacuum beneath the entire slab.

In addition to the routine OM&M activities described here, the building's owner and tenants are given information packages that explains the system's operation, maintenance and monitoring [Section 5.6]. Therefore, at any time during the system's operation, the building's owner or tenants may check that the system is operating properly.

4.4.2 Other mitigation systems

For other mitigation systems (e.g., HVAC modifications, crawl space ventilation, etc.), routine maintenance activities are generally comparable to post-mitigation testing activities [Section 4.3]. Activities typically include a visual inspection of the complete system, and identification and repair of leaks. System performance checks, such as air stream velocity measurements of ventilation systems, also should be performed.

As appropriate, preventative maintenance (e.g., replacing filters, cleaning lines, etc.), repairs and/or adjustments should be made to the system to ensure its continued effectiveness at mitigating exposures related to soil vapor intrusion. If significant changes are made to the system or when the system's performance is unacceptable, redesigning and restarting the system may be appropriate [Section 4.4.1].

Air monitoring, such as periodic sub-slab vapor, indoor air and outdoor air sampling, may be appropriate to determine whether existing building conditions are maintaining the desired mitigation endpoint and to determine whether changes are appropriate. The type and frequency of monitoring is determined based upon site-specific and building-specific conditions, taking into account applicable environmental data, building operating conditions, and the mitigation method employed.

4.4.3 Non-routine maintenance

Non-routine maintenance may also be appropriate during the operation of a mitigation system. Examples of such situations include the following:

- a. the building's owners or occupants report that the warning device or indicator indicates the mitigation system is not operating properly;
- b. the mitigation system becomes damaged; or
- c. the building has undergone renovations that may reduce the effectiveness of the mitigation system.

Activities conducted during non-routine maintenance visits will vary depending upon the reason for the visit. In general, building-related activities may include examining the building for structural or HVAC system changes, or other changes that may affect the performance of the depressurization system (e.g., new combustion appliances, deterioration of the concrete slab, or significant changes to any of the building factors listed in Table 1.2). Depressurization system-related activities may include examining the operation of the warning device or indicator and the vent fan, or the extent of sub-slab depressurization. Repairs or adjustments should be made to the system as appropriate. If appropriate, the system should be redesigned and restarted [Section 4.4.1].

4.5 Termination of mitigation system operations

Mitigation systems should not be turned off, until the State receives, and has had the opportunity to comment on, a proposal to turn off mitigation systems. The party seeking to turn off the mitigation systems should consider any comments the State may have on the proposal, except in emergency situations. Systems should remain in place and operational until they are no longer needed to address current or potential exposures related to soil vapor intrusion. This determination should be based upon several factors, including the following:

- a. subsurface sources (e.g., groundwater, soil, etc.) of volatile chemical contamination in subsurface vapors have been remediated based upon an evaluation of appropriate post-remedial sampling results;
- b. residual contamination, if any, in subsurface vapors is not expected to affect indoor air quality significantly based upon soil vapor and/or sub-slab vapor sampling results;
- c. residual contamination, if any, in subsurface vapors is not affecting indoor air quality when active mitigation systems are turned off based upon indoor air, outdoor air and sub-slab vapor sampling results at a representative number of buildings; and
- d. there is no "rebound" effect for which additional mitigation efforts would be appropriate observed when the mitigation system is turned off for prolonged periods of time. This determination should be based upon indoor air, outdoor air and/or sub-slab vapor sampling from the building over a time period, determined by site-specific conditions.

Given the prevalence of radon throughout the State of New York, consideration should be given to leaving the system in place and operating to address exposures related to radon intrusion after concurrence is reached that the system is no longer needed to mitigate exposures related to soil vapor intrusion. This action should be done only with permission of the property owner and after the property owner is aware of their responsibilities in

operating, monitoring and maintaining the system for this specific purpose. If the property owner declines the offer, the system should be shut down and, if requested, removed in a timely manner.

4.6 Annual certification and notification recommendations

Mitigation systems are considered engineering controls, defined as any physical barrier or method employed to

1. actively or passively contain, stabilize, or monitor hazardous waste or petroleum,
2. restrict the movement of hazardous waste or petroleum to ensure the long-term effectiveness of remedial actions, or
3. eliminate potential exposure pathways to hazardous waste or petroleum.

Therefore, depending upon the remedial program, submission of an annual certification to the State may be required. This certification must be prepared and submitted by a professional engineer or environmental professional and affirm that the engineering controls are in place, are performing properly and remain effective. This requirement of certification remains in effect until the State provides notification, in writing, that this certification is no longer needed.

If a property owner declines a mitigation system, the party responsible for arranging the design and installation of the system should renew the offer on an annual basis, unless they demonstrate environmental conditions have changed such that a system is no longer needed.

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Appendix 3

DER-13 / Strategy For Evaluating Soil Vapor Intrusion at Remedial Sites in New York

New York State Department of Environmental Conservation

DEC Program Policy

Issuing Authority: Carl Johnson

Title: Deputy Commissioner
Office of Air and Waste Management

Date Issued: October 18, 2006

Latest Date Revised:

I. SUMMARY:

Improvements in analytical techniques and knowledge gained from site investigations in New York and other states has led to an increased awareness of soil vapor as a medium of concern and of the potential for exposures from the soil vapor intrusion pathway. Based on this additional information, New York is currently re-evaluating previous assumptions and decisions regarding the potential for soil vapor intrusion exposures at sites. As a result, all past, current, and future contaminated sites will be evaluated to determine whether these sites have the potential for exposures related to soil vapor intrusion. These include all Resource Conservation and Recovery Act (RCRA) Corrective Action sites, inactive hazardous waste disposal sites (State Superfund), Voluntary Cleanup Program sites, Brownfield Cleanup Program sites, and Environmental Restoration Program sites. New York's approach to evaluating the soil vapor intrusion pathway at remedial sites is described in two complementary documents: this New York State Department of Environmental Conservation (Department) Program Policy and the New York State Department of Health (DOH) "Guidance for Evaluating Soil Vapor Intrusion in the State of New York." The combined goal of these documents is to conduct soil vapor intrusion evaluations as efficiently and effectively as possible at remedial sites. This policy describes the approach by which the Agencies (the Department, in consultation with the DOH) will address soil vapor intrusion at remedial sites. The approach presented reflects the following:

1. Soil vapor intrusion evaluations are among the Agencies' top priorities;
2. the likelihood of soil vapor intrusion-related exposures varies from site to site;
3. the number of sites at which soil vapor intrusion evaluations are warranted is quite large; and
4. revisiting this issue concurrently at all volatile chemical sites where remedial or corrective actions have been implemented is not feasible.

The Department is evaluating soil vapor intrusion at all sites currently in the pre-remedial decision phase and will evaluate soil vapor intrusion at all future sites during the remedial investigation phase. The identification and prioritization procedures described in Section V.2 of this policy were used to identify past sites with the highest potential for soil vapor intrusion. Past sites are defined as sites with known or suspected volatile organic compound (VOC) contamination where remedial decisions for part or all of the site were made prior to January 1, 2003.

II. POLICY:

The soil vapor intrusion pathway will be evaluated at all contaminated sites in New York. This includes sites that are currently being reviewed under one of the Department of Environmental Conservation's (DEC's) remedial programs which include sites that are reviewed in the future as well as sites where remedial decisions have already been made.

III. PURPOSE AND BACKGROUND:

Purpose

This guidance, coupled with the DOH "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" serve differing, but complementary purposes. The combined purpose of the documents is to develop a process to conduct soil vapor intrusion evaluations as efficiently and effectively as possible at all remedial sites.

This Department strategy describes the process by which the Agencies will prioritize remedial sites for soil vapor intrusion evaluations. The approach presented reflects the following:

1. Soil vapor intrusion evaluations are among the Agencies' top priorities;
2. the likelihood of soil vapor intrusion-related exposures varies from site to site;
3. the number of sites at which soil vapor intrusion evaluations are warranted is quite large, and
4. revisiting this issue concurrently at all volatile chemical sites where remedial or corrective actions have been implemented is not feasible.

The companion DOH document provides general guidance for parties evaluating soil vapor intrusion in New York State. Specifically, the DOH document provides guidance on the following:

1. Collecting appropriate and relevant data;
2. evaluating investigation data;
3. selecting appropriate actions to address potential and current human exposures;
4. implementing soil vapor intrusion mitigation methods; and
5. carrying out community outreach.

Taken together, the two documents provide a basis for deciding how, where, and when to conduct soil vapor intrusion evaluations. Because the evaluation of soil vapor intrusion is an evolving process, the Agencies anticipate that knowledge gained from the investigation and mitigation of soil vapor intrusion sites in New York and other states will be used to refine and improve our approach to addressing soil vapor intrusion. Consequently, these documents are viewed as dynamic tools that may be refined and revised over time.

Background

Soil vapor intrusion is the migration of volatile chemicals (in vapor form) from the subsurface into overlying or adjacent buildings. Volatile chemicals can be found in buried wastes, contaminated soils, and/or contaminated groundwater and can emit vapors that may migrate through subsurface soils into buildings. Typically, if vapors migrate into buildings, the levels are relatively low and health concerns,

if any, relate to chronic effects based on long term exposure to low chemical concentrations. In extreme cases, the vapors may accumulate in buildings to levels that may pose near-term safety hazards (e.g., explosion), acute health effects, or aesthetic problems (e.g., odors). In the past, soil vapor intrusion was considered to be a phenomenon caused by soil vapors emanating from a source of volatile chemicals (separate-phase or sorbed) located adjacent to or directly beneath the foundation of an occupied building. Investigation of potential human exposure to these volatile chemicals generally involved soil vapor surveys and indoor air sampling. If an off-site dissolved contaminant plume flowing beneath a home or business was deep, the assumption was that the concentrations of any vapors entering buildings above would be so low by the time it reached the basement level that it would not represent an indoor air concern.

Although the Agencies may have previously evaluated the soil vapor pathway at a site, improvements in analytical techniques and knowledge gained from the investigation of sites in New York and other states has led to an increased awareness regarding soil vapor as a media of concern and the potential for exposures from the soil vapor intrusion pathway. Based on this additional information, New York is currently re-evaluating previous assumptions and decisions regarding the potential for soil vapor intrusion exposures at sites. The result is that additional work may be required to investigate and, where appropriate, remediate sites. This includes sites that are in the operation, maintenance and monitoring phase or have been delisted.

Based on a review of the Division of Environmental Remediation's (DER's) database of remediation sites, as well as information from the Division of Solid and Hazardous Materials (DSHM), it is estimated that solvents or other volatile organic compounds have been disposed at over 750 sites (chlorinated and nonchlorinated), resulting in contaminated soil or groundwater. Many of these sites have already been remediated and are either in the long-term monitoring phase or were closed once remedial objectives established for the cleanup were met. However, based on recent evidence and a better understanding of soil vapor intrusion and mobility, the soil vapor intrusion pathway may need to be re-evaluated at these sites since current exposures related to soil vapor intrusion may exist despite remedial actions having already been completed.

IV. RESPONSIBILITY:

This policy was jointly developed by staff from the DER, DSHM, and DOH. Responsibility for interpreting and updating this document will reside with the DER.

V. PROCEDURE:

This policy divides the universe of sites into two groups: 1) sites where remedial decisions have not yet been made (ongoing sites) and, 2) sites where remedial decisions for part or all of the site were made prior to January 1, 2003 (past sites).

1. Evaluation of Ongoing Sites

For ongoing sites where final remedial decisions have not been made, the soil vapor intrusion pathway will be evaluated as a component of the investigation. This is consistent with the State's approach to any other media (e.g., groundwater and soil). Guidance on evaluating the soil vapor intrusion pathway in New York (e.g., investigation procedures, data interpretation, and mitigation or remediation

alternatives) is presented in the DOH companion document: “Guidance for Evaluating Soil Vapor Intrusion in the State of New York.” Based on the findings of the soil vapor intrusion evaluation, appropriate decisions will be made and will be included as part of the remedy selected for the site, or as an interim remedial measure, if warranted.

2. Evaluation of Past Sites

All past sites will be evaluated for the potential for soil vapor intrusion. Evaluations at past sites will be completed in the same manner that ongoing sites are evaluated in accordance with “Guidance for Evaluating Soil Vapor Intrusion in the State of New York.” Priority will be placed upon those sites where CVOCs (chlorinated volatile organic compounds) were disposed of or detected in soil or groundwater. CVOCs include many of the common organic solvents used at former industrial sites and dry cleaning facilities (e.g., trichloroethene, tetrachloroethene). The Department is targeting sites with CVOC contamination first (as opposed to non-chlorinated volatile chemicals) because they are found at the vast majority of contaminated sites, they do not readily biodegrade, and they may accumulate indoors without being noticed by the occupant because of their high odor threshold. Review of our records has generated a list of 421 sites where CVOCS were involved.

The Department recognizes that although non-chlorinated VOCs (such as benzene and naphthalene) also have some potential for soil vapor intrusion, they represent less of a priority in the evaluation of past sites for two reasons: non-chlorinated VOCs readily biodegrade in the presence of oxygen, which is generally available in the vadose zone (zone above the groundwater table) through which contaminants must pass before entering a basement or crawl space; and non-chlorinated volatile compounds also generally have an odor or taste when they are present in drinking water or breathing space and are noticed by impacted individuals. Sites having these characteristics are currently addressed as they are identified. For these reasons, action at the majority of sites with non-chlorinated VOCs will be deferred while the results of further monitoring are evaluated and used to verify these assumptions. The priority of non-chlorinated VOC sites may be modified at a later date based on new information and a revised conceptual understanding of soil vapor intrusion.

The Department, the DOH, and the United States Environmental Protection Agency (USEPA) will either lead or provide oversight to the soil vapor intrusion evaluation. The USEPA has agreed to be the lead at all former and current sites on the National Priorities List (NPL) that are located in New York State. The Department will be the lead at all remaining sites. The Department will seek to have the parties responsible for contaminating the site conduct soil vapor intrusion evaluations. Attachment 1 depicts who will lead the evaluation of the different groups of sites. Letters have been sent to the responsible parties asking them to perform the evaluation and provide the Department with any data or information pertaining to the potential for soil vapor intrusion. At remedial sites where responsible parties are unwilling or unable to conduct a soil vapor intrusion evaluation, or there are no responsible parties to do so, the Department will proceed with the evaluation. The Department will subsequently seek to recover the costs incurred as part of that evaluation where appropriate and authorized by law.

Because it is not feasible to conduct soil vapor intrusion evaluations concurrently at all sites where the Department is responsible for leading or overseeing the evaluation, a process to prioritize the evaluation of past sites has been developed. The process involves an initial screening step followed by a scoring and ranking step. The prioritization process was developed to assist the Agencies in conducting soil vapor intrusion investigations as effectively and efficiently as possible at past remedial sites.

Initial Screening

The initial screening process was designed to be applied with a general knowledge of the site and the chemicals known or reasonably suspected to be present in the subsurface. It acknowledges that soil vapor intrusion may be driven by contamination within the groundwater, within the soil or both. Attachment 2 is a flowchart that depicts the decision logic used to screen the sites.

Ranking and Prioritization of Department-Lead Sites

The following procedure applies to the prioritization of Department-lead sites where responsible parties are unwilling or unable to conduct a soil vapor intrusion evaluation, or there are no responsible parties to do so. The ranking criteria were chosen based on site conditions that are believed to play a significant role in the soil vapor intrusion pathway. The following four criteria were chosen:

1. Total chlorinated volatile organic compound (CVOC) concentration
2. Depth to contamination
3. Soil characteristics
4. Land use at and adjacent to the site above impacted soil or groundwater

A set of weighting factors were then assigned to each of the criteria. The weighting factors (shown on the attached score sheets) for the various criteria were selected in order to distinguish the potential for soil vapor intrusion and to establish separation between sites on the list. For example, a site where the depth to contaminated groundwater is between 15 and 50 feet below grade would be assigned a weighting factor of 4 for that criterion but a site where the depth to groundwater is greater than 60 feet would only be assigned a weighting factor of 1 because depth to groundwater is considered inversely proportional to the potential for soil vapor intrusion. Additional sampling points may be added, or subtracted in some cases, based on such site conditions as proximity to sensitive receptors (e.g., daycare facilities, schools, and hospitals), presence of grossly contaminated soil or NAPL, or current information pertaining to the completion of remedial activities.

Separate score sheets, one for soil (Attachment 3) and one for groundwater (Attachment 4), have been developed to help in the prioritization of past sites. Separate sheets have been developed because the mechanism for soil vapor intrusion (either soil driven or groundwater driven) are not necessarily related. Initially, sites with soil contamination and sites with groundwater contamination will be prioritized separately. As we move forward with soil vapor intrusion investigations at these older sites, we will use the new information to assess whether the assigned weighting factors serve as a useful tool for predicting whether soil vapor intrusion is likely to be a significant exposure pathway at a site. Adjustments to the weighting factors may be made to improve their usefulness as predictors.

Score sheets were completed for each of the past sites in order to prioritize the sites. The sources of information that were used to complete the score sheets were Records of Decision (ROD), Statements of Basis (SOB), Facility Fact Sheets, and other summary-level data sources. After reviewing the available information, the Department ranked each of the sites.

The list of sites generated through the identification and prioritization process outlined above was cross-checked with other efforts that have identified sites with the potential for soil vapor intrusion issues, such as those brought to the Department's attention by county health departments or citizens groups. As a final measure, staff were requested to review the prioritized list and confirm the information used to score and rank the sites.

Evaluation process

The process of conducting a soil vapor intrusion evaluation will begin with a review of available historical data that was generated since the remedial decision was made. In some cases, there may be sufficient historical data to evaluate the soil vapor intrusion pathway without further investigation. For instance, where historical data indicate that VOCs are no longer present, either on-site or off-site, and the Agencies concur that there is no potential for soil vapor intrusion, then the soil vapor intrusion evaluation will be deemed complete.

At sites where it is determined that further investigation is required, it may be necessary to collect any or all of the following samples: groundwater, soil vapor, sub-slab vapor, and indoor and outdoor air. Site-specific vapor investigations performed by the Department will be planned and implemented in accordance with the DOH guidance document.

Schedule

The Agencies' goal is to evaluate the past sites for soil vapor intrusion impacts as quickly as possible. Attachment 1 outlines who will conduct these evaluations. For those sites that the U.S. EPA has agreed to lead, the evaluations will be completed according to a schedule set by the U.S. EPA. At sites where a responsible party has been identified, the Department has requested that they complete the evaluations as soon as possible. Agency staff will work with the responsible parties to facilitate this effort. For the remaining sites, the Department will proceed with the evaluations generally in priority order utilizing the process described in this policy. In general, sites where the perceived potential for soil vapor intrusion is greatest (corresponding to the sites with the highest score), will be addressed first. Soil vapor intrusion evaluations have already commenced. As we gain experience in performing soil vapor intrusion evaluations, this experience will be applied to future investigations as well as be incorporated into future State guidance.

VI. RELATED REFERENCES:

New York State Department of Health (DOH) "Guidance for Evaluating Soil Vapor Intrusion in the State of New York." http://www.health.state.ny.us/nysdoh/gas/svi_guidance/index.htm

Attachments:

Attachment 1 - Vapor Intrusion Evaluation of Legacy Sites - Who Will Conduct The Evaluation ?

Attachment 2 - Vapor Intrusion Screening Approach Used to Prioritize Soil Vapor Intrusion Evaluations of " DEC - Lead" Legacy Sites

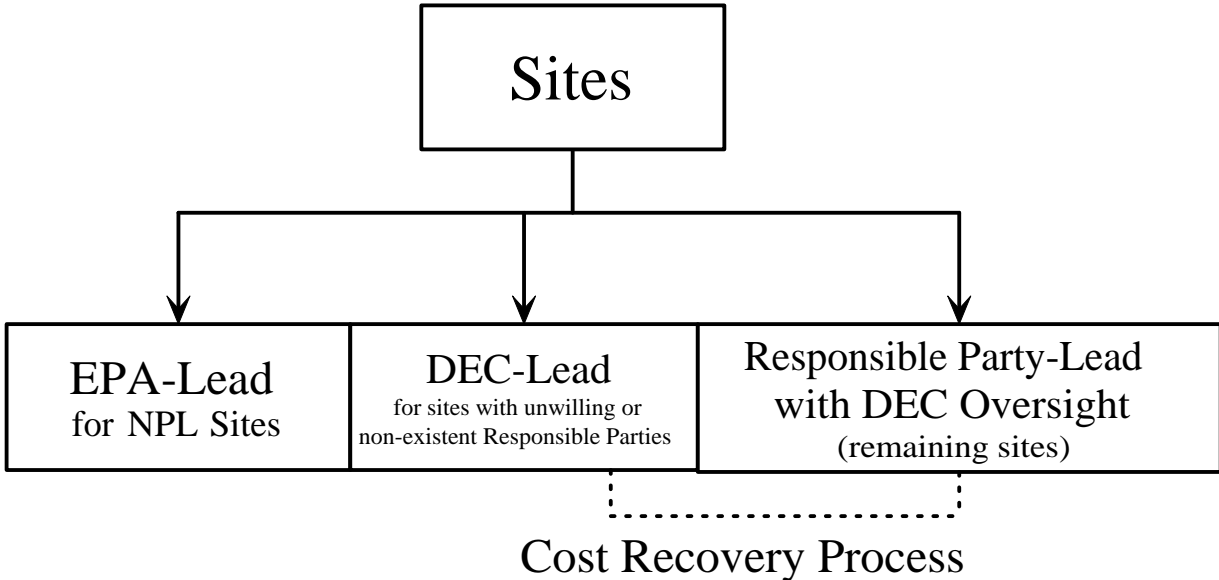
Attachment 3 - Soil Weighting Factors Used to Prioritize " DEC - Lead" Legacy Sites For Soil Vapor Intrusion Evaluations

Attachment 4 - Groundwater Weighting Factors Used to Prioritize " DEC - Lead" Legacy Sites For Soil Vapor Intrusion Evaluations

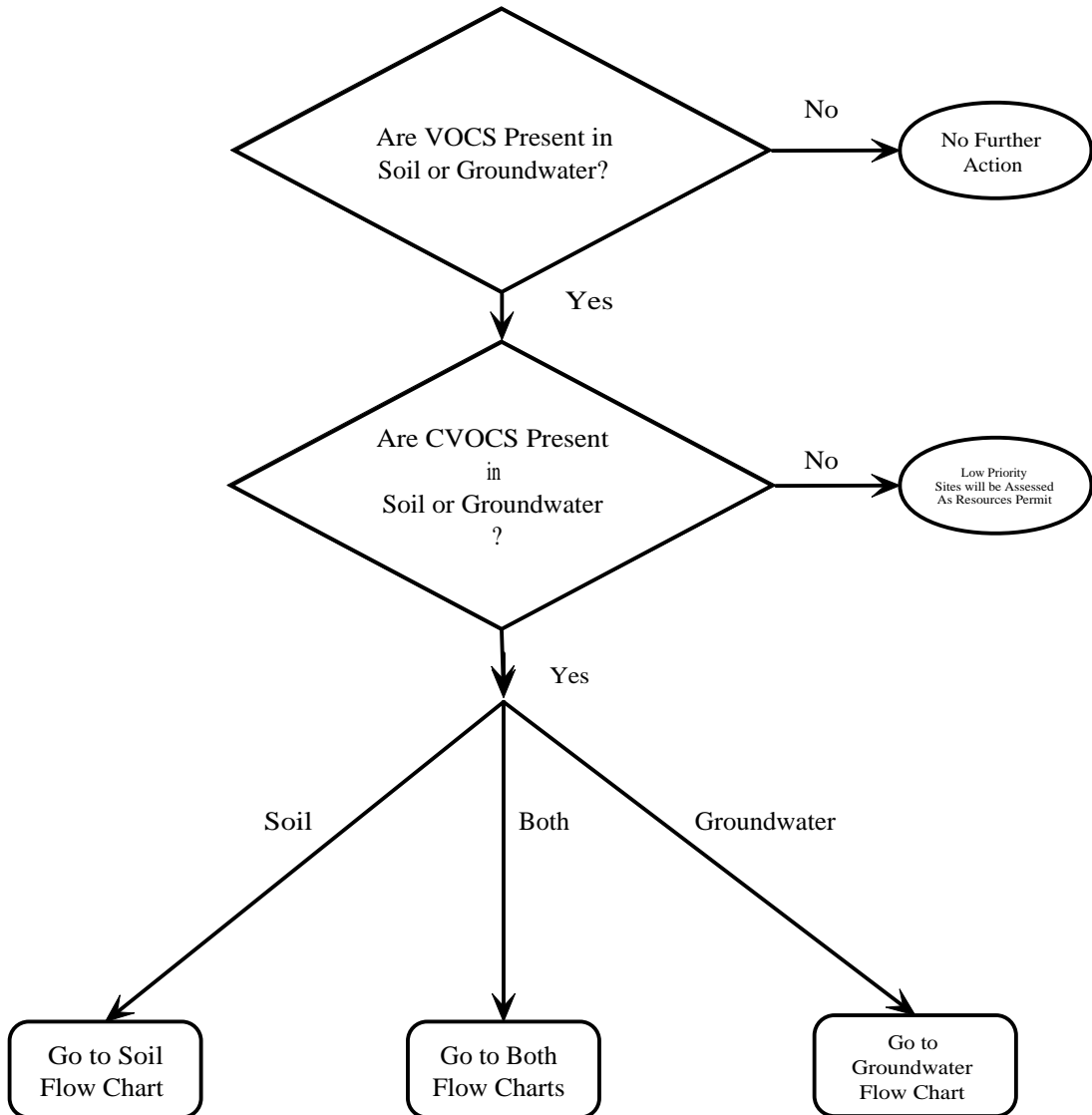
Attachment 1

Vapor Intrusion Evaluations of Legacy Sites

Who Will Conduct The Evaluations?



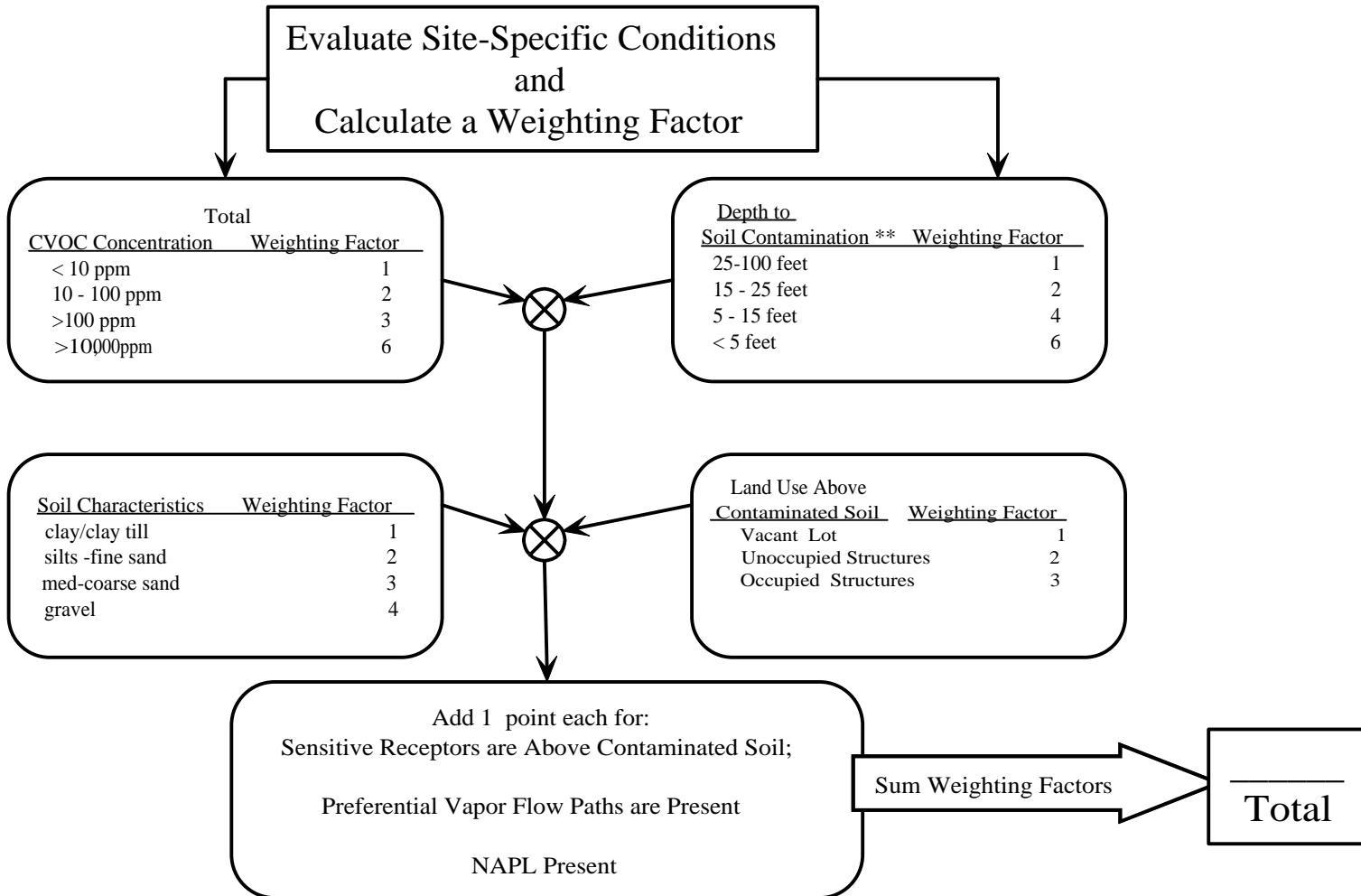
Attachment 2
Vapor Intrusion Screening Approach
Used to Prioritize
Soil Vapor Intrusion Evaluations
of "DEC-Lead" Legacy Sites



Attachment 3

Soil Weighting Factors

Used to Prioritize "DEC-Lead" Legacy Sites For Soil Vapor Intrusion Evaluations

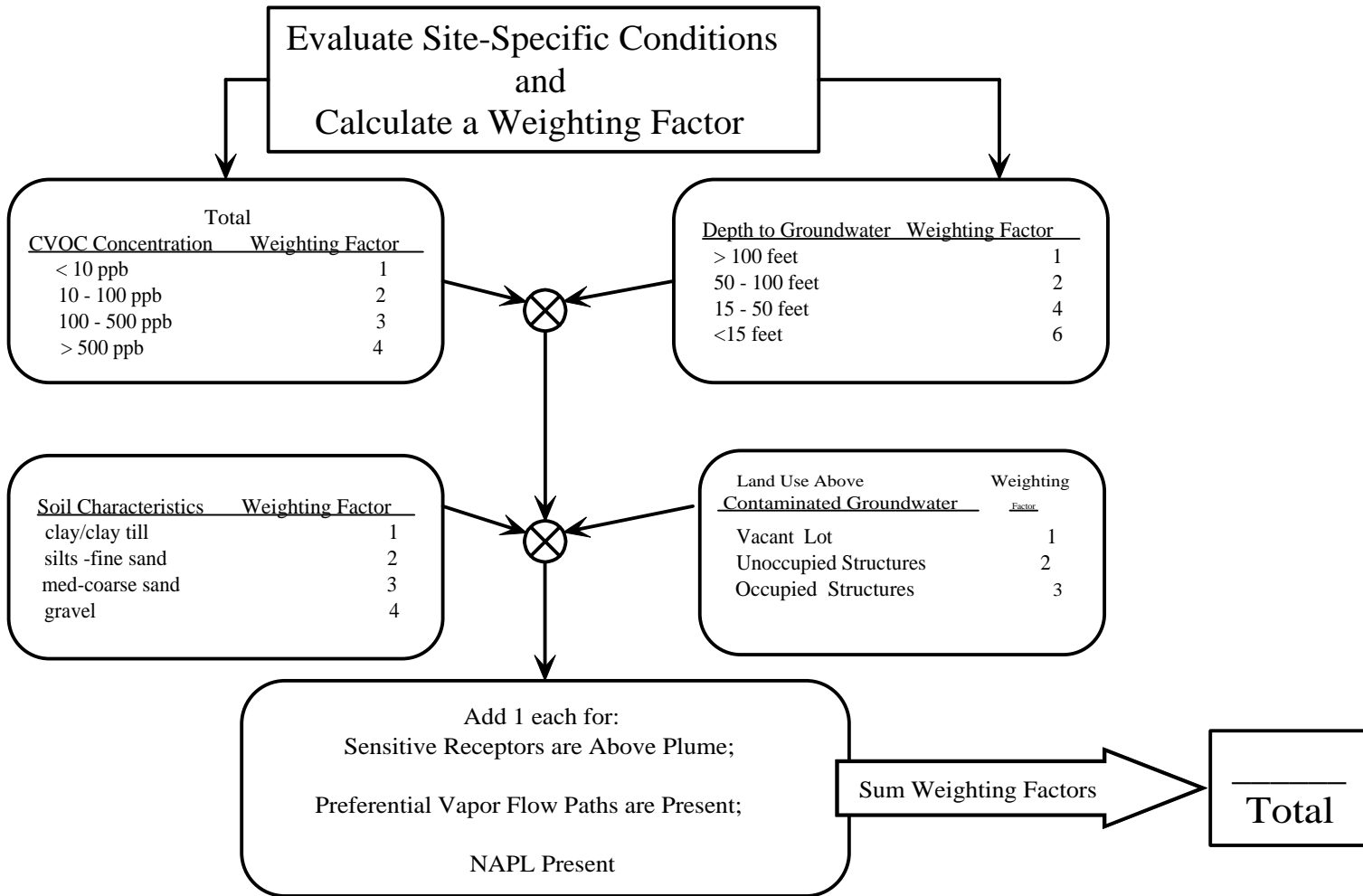


Note: Sensitive Receptors = (day care centers, elder care facilities, hospital, etc.)
 Preferential Flow Paths = (pipes & pipe bedding, joints and fractures, sumps and other penetrations)

** The weighting factor for the depth to soil can be adjusted upward or downward to account for the stratigraphic distribution of the contamination and the building types that sit over it. (For example, shallow soil contamination in areas where there are no buildings should be given a low weighting; soil contamination at foundation depths should be given a higher weighting if buildings that sit over it have basements.)

Attachment 4

Groundwater Weighting Factors Used to Prioritize "DEC-Lead" Legacy Sites For Soil Vapor Intrusion Evaluations



Note: Sensitive Receptors = (day care centers, elder care facilities, hospital, etc.)

Preferential Flow Paths = (pipes & pipe bedding, joints and fractures, sumps and other penetrations)

SUMMARY OF REVIEW AND RESOLUTION OF MAJOR ISSUES AND COMMENTS

Program Policy DER-13: Strategy for Prioritizing Soil Vapor Intrusion Evaluations at Remedial Sites in New York

The draft Program Policy (DER 13) was published in the Environmental Notice Bulletin (ENB) on November 24, 2004. The original public comment period was extended for 30 days and ended on January 24, 2005, during which time over 130 comments were received (including five from the Office of the Attorney General marked confidential). In order to summarize the comments, they were organized by category.

Many of the technical comments are answered simply by referring the commentators to an appropriate section of the draft Department of Health (DOH) vapor guidance, which was released for public comment in February 2005. The following table summarizes the scope of the major comments and the Department's responses to each of the major issues.

Issue	Summary of Comment	Resolution
100 ft distance	Questioned the technical basis for screening out sites from further investigation that are more than 100 ft from an occupied structure.	The Department has decided to revise the draft policy and not apply a generic threshold criterion based on distance from a source of contamination to an occupied structure. At this point in time, there is not sufficient evidence to support setting such a criterion.
Access to database	Requests for public access to site-specific information compiled by the Department and used to rank and prioritize past sites.	Most of the information utilized in scoring and ranking the sites is already available to the public through the Department web site (http://www.dec.state.ny.us/cfm/extapps/derfoil/index.cfm). Detailed data on specific sites can be reviewed at the local document repositories located in the impacted communities. These documents include Remedial Investigation Reports, Feasibility Study Reports, Records of Decision, and Site Fact Sheets. Information relative to the location of these repositories can be obtained by sending an email to the Division (derweb@gw.dec.state.ny.us).

**Program Policy DER-13: Strategy for Prioritizing Soil Vapor Intrusion Evaluations at Remedial Sites in New York
Summary of Review and Resolution of Major Issues and Comments**

Issue	Summary of Comment	Resolution
Applicability of OSHA	Concern expressed that the Agencies' indoor air quality guidelines will supersede existing OSHA requirements (i.e., will the State defer to OSHA for non-residential or occupational exposures?)	Whether or not OSHA regulations apply at a particular site is beyond the scope of this policy. Occupational exposures are discussed in the draft DOH guidance document (Section 2.12). The document: Guidance for Evaluating Soil Vapor Intrusion in the State of New York - Working Draft and the response to comments: Response to Comments Received on the Public Comment Draft of the New York State Department of Health's Guidance for Evaluating Soil Vapor Intrusion in the State of New York are available on the DOH web site at http://www.health.state.ny.us/environmental/indoors/vapor_intrusion/index.htm
Community participation	Need for additional public outreach after Department completes the proposed list for further investigation. When investigation is complete the public should be made aware of sampling results.	No further public input on the proposed list of legacy sites is being solicited. All sites on the list will be evaluated. The public will be made aware of the evaluations as they proceed and the results of the evaluation. Building specific results will be provided to occupants and owners of buildings sampled.
Consideration of background	Background (ambient outdoor and indoor) sources should be considered when evaluating soil vapor intrusion.	Consideration of background sources and how they impact the decisions made at a particular site is beyond the scope of this policy and is addressed in the DOH guidance document (Section 3.4.2).
Consistent with EPA vapor guidance	Concern that the procedures outlined in the strategy complement and not contradict the well-established EPA soil vapor intrusion guidance procedures.	Approaches to completing soil vapor intrusion evaluations are discussed in the companion DOH guidance document and are beyond the scope of this policy. However, neither the strategy for prioritizing legacy sites nor the proposed soil vapor intrusion guidance document contradicts the intent of the EPA guidance.

**Program Policy DER-13: Strategy for Prioritizing Soil Vapor Intrusion Evaluations at Remedial Sites in New York
Summary of Review and Resolution of Major Issues and Comments**

Issue	Summary of Comment	Resolution
Cost-benefit	Comments centering on the economic impacts of implementing this policy and concerns that resources will be spent unnecessarily with little benefit.	The Department believes that there may be sites that were previously remediated which still pose unacceptable soil vapor intrusion exposure. Since there may be sites with unacceptable exposures we believe that the benefit of reducing these unacceptable exposures will outweigh the cost of investigation past sites.
Exit strategy/no exposures	Concern that sites with little or no reasonable risk will be required to “prove a negative” and be retained on the vapor list indefinitely. The policy should clarify what criteria will be used to identify sites that do not pose a reasonable risk of soil vapor intrusion and should be removed from further consideration.	The strategy does not specify how the soil vapor intrusion evaluations will be conducted (or completed). Sites that were included on the list have the potential for exposures related to soil vapor intrusion. This potential may not have been evaluated during investigation of the nature and extent of contamination of the site. Data are required to resolve the question. Data may already exist (from site investigation, remedial action, or operation, maintenance and monitoring) to resolve it. Whenever, based on the review of existing (or new) data, a determination is made that a particular site does not present an unacceptable soil vapor intrusion exposure, the evaluation will be considered complete.
Future exposure	If development or occupation of an existing building could result in conditions that favor soil vapor intrusion in the future, will institutional controls be established?	The strategy does not specify how the soil vapor intrusion evaluations will be conducted. Data evaluation and recommended actions are discussed in Chapter 3 of the DOH guidance document.
General/applicability	General comments on the applicability of the policy and requests for minor edits and clarification of terms.	Incorporated as appropriate

**Program Policy DER-13: Strategy for Prioritizing Soil Vapor Intrusion Evaluations at Remedial Sites in New York
Summary of Review and Resolution of Major Issues and Comments**

Issue	Summary of Comment	Resolution
Investigation scope	Technical questions pertaining to the details of a site-specific investigation.	The intent of the policy is to state that the potential for soil vapor intrusion will be evaluated at all sites and to describe the process used by the Department to select and to prioritize past sites for soil vapor intrusion evaluations. The companion DOH guidance document (Section 2) provides recommendations on how these evaluations are to be conducted.
Legal authority	Questioned the State’s authority to require sampling at sites that have been delisted or closed without demonstrating that a potential significant threat exists.	The Department has the authority and responsibility to require these evaluations. ECL 1-0101, 3-0301.1(I), 27-1305.2(a) and 27-1309. The Department is also authorized to recover the cost of such sampling and analysis from any responsible person. (see e.g. ECL 27-1309.5). The Commissioner, after investigation, providing notice and the respondent an opportunity to be heard, may also issue, modify and revoke orders as may be necessary or appropriate. ECL 71-2727.
Odor threshold	Questioned the technical basis for stating that the odor threshold of non-chlorinated hydrocarbons was lower than levels that would cause health impacts.	Non chlorinated hydrocarbons (petroleum) generally have odor thresholds that are very low . Our experience has been that the levels which could be detected by smell did not always present an unacceptable exposure. The vapor intrusion potential of these sites will be evaluated but only after the sites with chlorinated VOCs are evaluated first.
Preferential flow	Questioned the validity of increasing the weighting factor based on the presence of a preferential pathway for vapor migration.	Preferential pathways have the potential to facillitate vapor transport. If a preferential pathway is known, the weighting was increased. The actual impact of any preferential pathways cannot be predetermined and will be evaluated in more detail during the investigation phase.

**Program Policy DER-13: Strategy for Prioritizing Soil Vapor Intrusion Evaluations at Remedial Sites in New York
Summary of Review and Resolution of Major Issues and Comments**

Issue	Summary of Comment	Resolution
Ranking/scoring	The policy lacks necessary information explaining how and why the ranking system was developed, making it difficult to evaluate the appropriateness of such screening and ranking procedures and apply the criteria consistently.	The ranking system was developed to prioritize and to provide some separation between the different sites in order to manage the use of resources. Specific criteria were based on factors that are thought to have the most impact on the potential for soil vapor intrusion. The actual ranking of the sites was done based on data from the decision documents as well as other factors known specifically about the site. However, the ranking system has less relevance because all sites on the list will be evaluated for soil vapor intrusion potential. The evaluation will be conducted by either EPA, the Responsible Party (under the oversight of DEC) or in cases where a Responsible Party does not exist or is unwilling, by DEC. The ranking system will be used to prioritize the sites where DEC will lead the evaluation to ensure that sites with the highest potential for vapor intrusion are evaluated first.
Schedule	Questioned how many sites will be investigated and when will the investigations be completed.	The Agencies goal is to evaluate all of the past sites for soil vapor intrusion at all sites as quickly as possible. It is not possible to set a time frame for completion of the evaluation of all past sites.
Updates/revisions	Request for the opportunity to provide input on the ranking and prioritization of individual sites and to comment on future revisions.	The ranking process has been completed. As explained above, the ranking system is somewhat irrelevant now because all sites will be evaluated. Site owners will be informed of the Department's interest in evaluating their site for soil vapor intrusion and will be given the opportunity to provide updated information. Adjacent residents will have opportunities to participate in the investigative process via Citizen Participation activities.

**Program Policy DER-13: Strategy for Prioritizing Soil Vapor Intrusion Evaluations at Remedial Sites in New York
Summary of Review and Resolution of Major Issues and Comments**

Issue	Summary of Comment	Resolution
Who will conduct/pay?	Questioned who will be required to pay for the initial vapor investigation at sites where there is no clear threat. Request that the initial rounds of sampling be completed using State funds.	The USEPA has agreed to be the lead at all former and current sites on the National Priorities List (NPL) that are located in New York State. For the remaining sites, the Department will ask the party responsible for contaminating the site to pay for and perform the soil vapor intrusion evaluation, as well as any site investigations and remedial action required. If the responsible party declines to perform these activities, or if no viable entity exists, the State will proceed with the evaluation and seek to recover the costs incurred as part of that evaluation, and any necessary remediation.

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Appendix 4



OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)

November 2002

EPA530-D-02-004

Table 1: Question 1 Summary Sheet.

CAS No.	Chemical	Is Chemical Sufficiently Toxic? ¹	Is Chemical Sufficiently Volatile? ²	Check Here if Known or Reasonably Suspected To Be Present ³
83329	Acenaphthene	YES	YES	
75070	Acetaldehyde	YES	YES	
67641	Acetone	YES	YES	
75058	Acetonitrile	YES	YES	
98862	Acetophenone	YES	YES	
107028	Acrolein	YES	YES	
107131	Acrylonitrile	YES	YES	
309002	Aldrin	YES	YES	
319846	alpha-HCH (alpha-BHC)	YES	YES	
62533	Aniline	YES	NO	NA
120127	Anthracene	NO	YES	NA
56553	Benzo(a)anthracene	YES	NO	NA
100527	Benzaldehyde	YES	YES	
71432	Benzene	YES	YES	
50328	Benzo(a)pyrene	YES	NO	NA
205992	Benzo(b)fluoranthene	YES	YES	
207089	Benzo(k)fluoranthene	NO	NO	NA
65850	Benzoic Acid	NO	NO	NA
100516	Benzyl alcohol	YES	NO	NA
100447	Benzylchloride	YES	YES	
91587	beta-Chloronaphthalene	YES	YES	
319857	beta-HCH (beta-BHC)	YES	NO	NA
92524	Biphenyl	YES	YES	
111444	Bis(2-chloroethyl)ether	YES	YES	
108601	Bis(2-chloroisopropyl)ether	YES	YES	
117817	Bis(2-ethylhexyl)phthalate	NO	NO	NA
542881	Bis(chloromethyl)ether	YES	YES	
75274	Bromodichloromethane	YES	YES	
75252	Bromoform	YES	YES	
106990	1,3-Butadiene	YES	YES	
71363	Butanol	YES	NO	NA
85687	Butyl benzyl phthalate	NO	NO	NA
86748	Carbazole	YES	NO	NA
75150	Carbon disulfide	YES	YES	
56235	Carbon tetrachloride	YES	YES	
57749	Chlordane	YES	YES	
126998	2-Chloro-1,3-butadiene (chloroprene)	YES	YES	
108907	Chlorobenzene	YES	YES	
109693	1-Chlorobutane	YES	YES	
124481	Chlorodibromomethane	YES	YES	
75456	Chlorodifluoromethane	YES	YES	
75003	Chloroethane (ethyl chloride)	YES	YES	
67663	Chloroform	YES	YES	
95578	2-Chlorophenol	YES	YES	
75296	2-Chloropropane	YES	YES	
218019	Chrysene	YES	YES	
156592	cis-1,2-Dichloroethylene	YES	YES	
123739	Crotonaldehyde (2-butenal)	YES	YES	
98828	Cumene	YES	YES	
72548	DDD	YES	NO	NA
72559	DDE	YES	YES	
50293	DDT	YES	NO	NA
53703	Dibenz(a,h)anthracene	YES	NO	NA
132649	Dibenzofuran	YES	YES	
96128	1,2-Dibromo-3-chloropropane	YES	YES	
106934	1,2-Dibromoethane (ethylene dibromide)	YES	YES	
541731	1,3-Dichlorobenzene	YES	YES	
95501	1,2-Dichlorobenzene	YES	YES	
106467	1,4-Dichlorobenzene	YES	YES	
91941	3,3-Dichlorobenzidine	YES	NO	NA
75718	Dichlorodifluoromethane	YES	YES	

Table 1: Question 1 Summary Sheet.

CAS No.	Chemical	Is Chemical Sufficiently Toxic? ¹	Is Chemical Sufficiently Volatile? ²	Check Here if Known or Reasonably Suspected To Be Present ³
75343	1,1-Dichloroethane	YES	YES	
107062	1,2-Dichloroethane	YES	YES	
75354	1,1-Dichloroethylene	YES	YES	
120832	2,4-Dichlorophenol	YES	NO	NA
78875	1,2-Dichloropropane	YES	YES	
542756	1,3-Dichloropropene	YES	YES	
60571	Dieldrin	YES	YES	
84662	Diethylphthalate	YES	NO	NA
105679	2,4-Dimethylphenol	YES	NO	NA
131113	Dimethylphthalate	NA	NO	NA
84742	Di-n-butyl phthalate	NO	NO	NA
534521	4,6-Dinitro-2-methylphenol (4,6-dinitro-o-cresol)	YES	NO	NA
51285	2,4-Dinitrophenol	YES	NO	NA
121142	2,4-Dinitrotoluene	YES	NO	NA
606202	2,6-Dinitrotoluene	YES	NO	NA
117840	Di-n-octyl phthalate	NO	YES	NA
115297	Endosulfan	YES	YES	
72208	Endrin	YES	NO	NA
106898	Epichlorohydrin	YES	YES	
60297	Ethyl ether	YES	YES	
141786	Ethylacetate	YES	YES	
100414	Ethylbenzene	YES	YES	
75218	Ethylene oxide	YES	YES	
97632	Ethylmethacrylate	YES	YES	
206440	Fluoranthene	NO	YES	NA
86737	Fluorene	YES	YES	
110009	Furan	YES	YES	
58899	gamma-HCH (Lindane)	YES	YES	
76448	Heptachlor	YES	YES	
1024573	Heptachlor epoxide	YES	NO	NA
87683	Hexachloro-1,3-butadiene	YES	YES	
118741	Hexachlorobenzene	YES	YES	
77474	Hexachlorocyclopentadiene	YES	YES	
67721	Hexachloroethane	YES	YES	
110543	Hexane	YES	YES	
74908	Hydrogen cyanide	YES	YES	
193395	Indeno(1,2,3-cd)pyrene	NO	NO	NA
78831	Isobutanol	YES	YES	
78591	Isophorone	YES	NO	NA
7439976	Mercury (elemental)	YES	YES	
126987	Methacrylonitrile	YES	YES	
72435	Methoxychlor	YES	YES	
79209	Methyl acetate	YES	YES	
96333	Methyl acrylate	YES	YES	
74839	Methyl bromide	YES	YES	
74873	Methyl chloride (chloromethane)	YES	YES	
108872	Methylcyclohexane	YES	YES	
74953	Methylene bromide	YES	YES	
75092	Methylene chloride	YES	YES	
78933	Methylethylketone (2-butanone)	YES	YES	
108101	Methylisobutylketone	YES	YES	
80626	Methylmethacrylate	YES	YES	
91576	2-Methylnaphthalene	YES	YES	
108394	3-Methylphenol (m-cresol)	YES	NO	NA
95487	2-Methylphenol (o-cresol)	YES	NO	NA
106455	4-Methylphenol (p-cresol)	YES	NO	NA
99081	m-Nitrotoluene	YES	NO	NA
1634044	MTBE	YES	YES	
108383	m-Xylene	YES	YES	
91203	Naphthalene	YES	YES	
104518	n-Butylbenzene	YES	YES	

Table 1: Question 1 Summary Sheet.

CAS No.	Chemical	Is Chemical Sufficiently Toxic? ¹	Is Chemical Sufficiently Volatile? ²	Check Here if Known or Reasonably Suspected To Be Present ³
98953	Nitrobenzene	YES	YES	
100027	4-Nitrophenol	YES	NO	NA
79469	2-Nitropropane	YES	YES	
924163	N-Nitroso-di-n-butylamine	YES	YES	
621647	N-Nitrosodi-n-propylamine	YES	NO	NA
86306	N-Nitrosodiphenylamine	YES	NO	NA
103651	n-Propylbenzene	YES	YES	
88722	o-Nitrotoluene	YES	YES	
95476	o-Xylene	YES	YES	
106478	p-Chloroaniline	YES	NO	NA
87865	Pentachlorophenol	YES	NO	NA
108952	Phenol	YES	NO	NA
99990	p-Nitrotoluene	YES	NO	NA
106423	p-Xylene	YES	YES	
129000	Pyrene	YES	YES	
110861	Pyridine	YES	NO	NA
135988	sec-Butylbenzene	YES	YES	
100425	Styrene	YES	YES	
98066	tert-Butylbenzene	YES	YES	
630206	1,1,1,2-Tetrachloroethane	YES	YES	
79345	1,1,2,2-Tetrachloroethane	YES	YES	
127184	Tetrachloroethylene	YES	YES	
108883	Toluene	YES	YES	
8001352	Toxaphene	YES	NO	NA
156605	trans-1,2-Dichloroethylene	YES	YES	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane	YES	YES	
120821	1,2,4-Trichlorobenzene	YES	YES	
79005	1,1,2-Trichloroethane	YES	YES	
71556	1,1,1-Trichloroethane	YES	YES	
79016	Trichloroethylene	YES	YES	
75694	Trichlorofluoromethane	YES	YES	
95954	2,4,5-Trichlorophenol	YES	NO	NA
88062	2,4,6-Trichlorophenol	YES	NO	NA
96184	1,2,3-Trichloropropane	YES	YES	
95636	1,2,4-Trimethylbenzene	YES	YES	
108678	1,3,5-Trimethylbenzene	YES	YES	
108054	Vinyl acetate	YES	YES	
75014	Vinyl chloride (chloroethene)	YES	YES	

¹ A chemical is considered sufficiently toxic if the vapor concentration of the pure component (see Appendix D) poses an incremental lifetime cancer risk greater than 10^{-6} or a non-cancer hazard index greater than 1.

² A chemical is considered sufficiently volatile if its Henry's Law Constant is 1×10^{-5} atm-m³/mol or greater (US EPA, 1991).

³ Users should check off compounds that meet the criteria for toxicity and volatility and are known or reasonably suspected to be present.

Table 2a: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁴

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁴ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)			
83329	Acenaphthene	X	NC	2.1E+02	3.3E+01		2.1E+03	3.3E+02		2.1E+04	3.3E+03		**	
75070	Acetaldehyde		NC	9.0E+00	5.0E+00		9.0E+01	5.0E+01		9.0E+02	5.0E+02		2.8E+03	
67641	Acetone	X	NC	3.5E+02	1.5E+02		3.5E+03	1.5E+03		3.5E+04	1.5E+04		2.2E+05	
75058	Acetonitrile		NC	6.0E+01	3.6E+01		6.0E+02	3.6E+02		6.0E+03	3.6E+03		4.2E+04	
98862	Acetophenone	X	NC	3.5E+02	7.1E+01		3.5E+03	7.1E+02		3.5E+04	7.1E+03		8.0E+05	
107028	Acrolein		NC	2.0E-02	8.7E-03		2.0E-01	8.7E-02		2.0E+00	8.7E-01		4.0E+00	
107131	Acrylonitrile		NC	2.0E+00	9.2E-01		2.0E+01	9.2E+00		2.0E+02	9.2E+01		4.7E+02	
309002	Aldrin		C	5.0E-02	3.3E-03		5.0E-01	3.3E-02		5.0E+00	3.3E-01		7.1E+00	
319846	alpha-HCH (alpha-BHC)		C	1.4E-01	1.1E-02		1.4E+00	1.1E-01		1.4E+01	1.1E+00		3.1E+02	
100527	Benzaldehyde	X	NC	3.5E+02	8.1E+01		3.5E+03	8.1E+02		3.5E+04	8.1E+03		3.6E+05	
71432	Benzene		C	3.1E+01	9.8E+00		3.1E+02	9.8E+01		3.1E+03	9.8E+02		1.4E+02	
205992	Benzo(b)fluoranthene	X	C	1.2E+00	1.1E-01		**	**		**	**		**	
100447	Benzylchloride	X	C	5.0E+00	9.7E-01		5.0E+01	9.7E+00		5.0E+02	9.7E+01		3.0E+02	
91587	beta-Chloronaphthalene	X	NC	2.8E+02	4.2E+01		2.8E+03	4.2E+02		2.8E+04	4.2E+03		**	
92524	Biphenyl	X	NC	1.8E+02	2.8E+01		1.8E+03	2.8E+02		1.8E+04	2.8E+03		**	
111444	Bis(2-chloroethyl)ether		C	7.4E-01	1.3E-01		7.4E+00	1.3E+00		7.4E+01	1.3E+01		1.0E+03	
108601	Bis(2-chloroisopropyl)ether		C	2.4E+01	3.5E+00		2.4E+02	3.5E+01		2.4E+03	3.5E+02		5.1E+03	
542881	Bis(chloromethyl)ether		C	3.9E-03	8.4E-04		3.9E-02	8.4E-03		3.9E-01	8.4E-02		4.5E-01	
75274	Bromodichloromethane	X	C	1.4E+01	2.1E+00		1.4E+02	2.1E+01		1.4E+03	2.1E+02		2.1E+02	
75252	Bromoform		C	2.2E+02	2.1E+01		2.2E+03	2.1E+02		2.2E+04	2.1E+03		8.3E-01	
106990	1,3-Butadiene		C	8.7E-01	3.9E-01		8.7E+00	3.9E+00		8.7E+01	3.9E+01		2.9E-01	
75150	Carbon disulfide		NC	7.0E+02	2.2E+02		7.0E+03	2.2E+03		7.0E+04	2.2E+04		5.6E+02	
56235	Carbon tetrachloride		C	1.6E+01	2.6E+00		1.6E+02	2.6E+01		1.6E+03	2.6E+02		1.3E+01	
57749	Chlordane		NC	7.0E-01	4.2E-02		7.0E+00	4.2E-01		7.0E+01	4.2E+00		**	
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	7.0E+00	1.9E+00		7.0E+01	1.9E+01		7.0E+02	1.9E+02		1.4E+01	
108907	Chlorobenzene		NC	6.0E+01	1.3E+01		6.0E+02	1.3E+02		6.0E+03	1.3E+03		3.9E+02	
109693	1-Chlorobutane	X	NC	1.4E+03	3.7E+02		1.4E+04	3.7E+03		1.4E+05	3.7E+04		2.0E+03	
124481	Chlorodibromomethane	X	C	1.0E+01	1.2E+00		1.0E+02	1.2E+01		1.0E+03	1.2E+02		3.2E+02	
75456	Chlorodifluoromethane		NC	5.0E+04	1.4E+04		5.0E+05	1.4E+05		**	**		**	
75003	Chloroethane (ethyl chloride)		NC	1.0E+04	3.8E+03		1.0E+05	3.8E+04		1.0E+06	3.8E+05		2.8E+04	
67663	Chloroform		C	1.1E+01	2.2E+00		1.1E+02	2.2E+01		1.1E+03	2.2E+02		8.0E+01 [†]	
95578	2-Chlorophenol	X	NC	1.8E+01	3.3E+00		1.8E+02	3.3E+01		1.8E+03	3.3E+02		1.1E+03	
75296	2-Chloropropane		NC	1.0E+02	3.2E+01		1.0E+03	3.2E+02		1.0E+04	3.2E+03		1.7E+02	
218019	Chrysene	X	*	*	*		*	*		*	*		*	
156592	cis-1,2-Dichloroethylene	X	NC	3.5E+01	8.8E+00		3.5E+02	8.8E+01		3.5E+03	8.8E+02		2.1E+02	
123739	Crotonaldehyde (2-butenal)	X	C	4.5E-01	1.6E-01		4.5E+00	1.6E+00		4.5E+01	1.6E+01		5.6E+02	
98828	Cumene		NC	4.0E+02	8.1E+01		4.0E+03	8.1E+02		4.0E+04	8.1E+03		8.4E+00	

Table 2a: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁴

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁴ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)			
72559	DDE	X	C	2.5E+00	1.9E-01		2.5E+01	1.9E+00		**	**		**	
132649	Dibenzofuran	X	NC	1.4E+01	2.0E+00		1.4E+02	2.0E+01		1.4E+03	2.0E+02		**	
96128	1,2-Dibromo-3-chloropropane		NC	2.0E-01	2.1E-02		2.0E+00	2.1E-01		2.0E+01	2.1E+00		3.3E+01	
106934	1,2-Dibromoethane (ethylene dibromide)		NC	2.0E-01	2.6E-02		2.0E+00	2.6E-01		2.0E+01	2.6E+00		6.6E+00	
541731	1,3-Dichlorobenzene	X	NC	1.1E+02	1.7E+01		1.1E+03	1.7E+02		1.1E+04	1.7E+03		8.3E+02	
95501	1,2-Dichlorobenzene		NC	2.0E+02	3.3E+01		2.0E+03	3.3E+02		2.0E+04	3.3E+03		2.6E+03	
106467	1,4-Dichlorobenzene		NC	8.0E+02	1.3E+02		8.0E+03	1.3E+03		8.0E+04	1.3E+04		8.2E+03	
75718	Dichlorodifluoromethane		NC	2.0E+02	4.0E+01		2.0E+03	4.0E+02		2.0E+04	4.0E+03		1.4E+01	
75343	1,1-Dichloroethane		NC	5.0E+02	1.2E+02		5.0E+03	1.2E+03		5.0E+04	1.2E+04		2.2E+03	
107062	1,2-Dichloroethane		C	9.4E+00	2.3E+00		9.4E+01	2.3E+01		9.4E+02	2.3E+02		2.3E+02	
75354	1,1-Dichloroethylene		NC	2.0E+02	5.0E+01		2.0E+03	5.0E+02		2.0E+04	5.0E+03		1.9E+02	
78875	1,2-Dichloropropane		NC	4.0E+00	8.7E-01		4.0E+01	8.7E+00		4.0E+02	8.7E+01		3.5E+01	
542756	1,3-Dichloropropene		NC	2.0E+01	4.4E+00		2.0E+02	4.4E+01		2.0E+03	4.4E+02		2.8E+01	
60571	Dieldrin		C	5.3E-02	3.4E-03		5.3E-01	3.4E-02		5.3E+00	3.4E-01		8.6E+01	
115297	Endosulfan	X	NC	2.1E+01	1.3E+00		2.1E+02	1.3E+01		**	**		**	
106898	Epichlorohydrin		NC	1.0E+00	2.6E-01		1.0E+01	2.6E+00		1.0E+02	2.6E+01		8.0E+02	
60297	Ethyl ether	X	NC	7.0E+02	2.3E+02		7.0E+03	2.3E+03		7.0E+04	2.3E+04		5.2E+02	
141786	Ethylacetate	X	NC	3.2E+03	8.7E+02		3.2E+04	8.7E+03		3.2E+05	8.7E+04		5.6E+05	
100414	Ethylbenzene		C	2.2E+02	5.1E+01		2.2E+03	5.1E+02		2.2E+04	5.1E+03		7.0E+02 †	
75218	Ethylene oxide		C	2.4E+00	1.4E+00		2.4E+01	1.4E+01		2.4E+02	1.4E+02		1.1E+02	
97632	Ethylmethacrylate	X	NC	3.2E+02	6.8E+01		3.2E+03	6.8E+02		3.2E+04	6.8E+03		9.1E+03	
86737	Fluorene	X	NC	1.4E+02	2.1E+01		1.4E+03	2.1E+02		**	**		**	
110009	Furan	X	NC	3.5E+00	1.3E+00		3.5E+01	1.3E+01		3.5E+02	1.3E+02		1.6E+01	
58899	gamma-HCH (Lindane)	X	C	6.6E-01	5.5E-02		6.6E+00	5.5E-01		6.6E+01	5.5E+00		1.1E+03	
76448	Heptachlor		C	1.9E-01	1.2E-02		1.9E+00	1.2E-01		1.9E+01	1.2E+00		4.0E-01 †	
87683	Hexachloro-1,3-butadiene		C	1.1E+01	1.0E+00		1.1E+02	1.0E+01		1.1E+03	1.0E+02		3.3E+01	
118741	Hexachlorobenzene		C	5.3E-01	4.5E-02		5.3E+00	4.5E-01		5.3E+01	4.5E+00		**	
77474	Hexachlorocyclopentadiene		NC	2.0E-01	1.8E-02		2.0E+00	1.8E-01		2.0E+01	1.8E+00		5.0E+01 †	
67721	Hexachloroethane		C	6.1E+01	6.3E+00		6.1E+02	6.3E+01		6.1E+03	6.3E+02		3.8E+02	
110543	Hexane		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		2.9E+00	
74908	Hydrogen cyanide		NC	3.0E+00	2.7E+00		3.0E+01	2.7E+01		3.0E+02	2.7E+02		5.5E+02	
78831	Isobutanol	X	NC	1.1E+03	3.5E+02		1.1E+04	3.5E+03		1.1E+05	3.5E+04		2.2E+06	
7439976	Mercury (elemental)		NC	3.0E-01	3.7E-02		3.0E+00	3.7E-01		3.0E+01	3.7E+00		6.8E-01	
126987	Methacrylonitrile		NC	7.0E-01	2.6E-01		7.0E+00	2.6E+00		7.0E+01	2.6E+01		6.9E+01	
72435	Methoxychlor	X	NC	1.8E+01	1.2E+00		**	**		**	**		**	
79209	Methyl acetate	X	NC	3.5E+03	1.2E+03		3.5E+04	1.2E+04		3.5E+05	1.2E+05		7.2E+05	
96333	Methyl acrylate	X	NC	1.1E+02	3.0E+01		1.1E+03	3.0E+02		1.1E+04	3.0E+03		1.4E+04	

Table 2a: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁴

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁴ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)			
74839	Methyl bromide		NC	5.0E+00	1.3E+00		5.0E+01	1.3E+01		5.0E+02	1.3E+02		2.0E+01	
74873	Methyl chloride (chloromethane)		NC	9.0E+01	4.4E+01		9.0E+02	4.4E+02		9.0E+03	4.4E+03		2.5E+02	
108872	Methylcyclohexane		NC	3.0E+03	7.5E+02		3.0E+04	7.5E+03		3.0E+05	7.5E+04		7.1E+02	
74953	Methylene bromide	X	NC	3.5E+01	4.9E+00		3.5E+02	4.9E+01		3.5E+03	4.9E+02		9.9E+02	
75092	Methylene chloride		C	5.2E+02	1.5E+02		5.2E+03	1.5E+03		5.2E+04	1.5E+04		5.8E+03	
78933	Methylethylketone (2-butanone)		NC	1.0E+03	3.4E+02		1.0E+04	3.4E+03		1.0E+05	3.4E+04		4.4E+05	
108101	Methylisobutylketone		NC	8.0E+01	2.0E+01		8.0E+02	2.0E+02		8.0E+03	2.0E+03		1.4E+04	
80626	Methylmethacrylate		NC	7.0E+02	1.7E+02		7.0E+03	1.7E+03		7.0E+04	1.7E+04		5.1E+04	
91576	2-Methylnaphthalene	X	NC	7.0E+01	1.2E+01		7.0E+02	1.2E+02		7.0E+03	1.2E+03		3.3E+03	
1634044	MTBE		NC	3.0E+03	8.3E+02		3.0E+04	8.3E+03		3.0E+05	8.3E+04		1.2E+05	
108383	m-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.3E+04	
91203	Naphthalene		NC	3.0E+00	5.7E-01		3.0E+01	5.7E+00		3.0E+02	5.7E+01		1.5E+02	
104518	n-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.6E+02	
98953	Nitrobenzene		NC	2.0E+00	4.0E-01		2.0E+01	4.0E+00		2.0E+02	4.0E+01		2.0E+03	
79469	2-Nitropropane		C	9.0E-02	2.5E-02		9.0E-01	2.5E-01		9.0E+00	2.5E+00		1.8E+01	
924163	N-Nitroso-di-n-butylamine		C	1.5E-01	2.4E-02		1.5E+00	2.4E-01		1.5E+01	2.4E+00		1.2E+01	
103651	n-Propylbenzene	X	NC	1.4E+02	2.8E+01		1.4E+03	2.8E+02		1.4E+04	2.8E+03		3.2E+02	
88722	o-Nitrotoluene	X	NC	3.5E+01	6.2E+00		3.5E+02	6.2E+01		3.5E+03	6.2E+02		6.8E+04	
95476	o-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		3.3E+04	
106423	p-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.2E+04	
129000	Pyrene	X	NC	1.1E+02	1.3E+01		**	**		**	**		**	
135988	sec-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.5E+02	
100425	Styrene		NC	1.0E+03	2.3E+02		1.0E+04	2.3E+03		1.0E+05	2.3E+04		8.9E+03	
98066	tert-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.9E+02	
630206	1,1,1,2-Tetrachloroethane		C	3.3E+01	4.8E+00		3.3E+02	4.8E+01		3.3E+03	4.8E+02		3.3E+02	
79345	1,1,2,2-Tetrachloroethane		C	4.2E+00	6.1E-01		4.2E+01	6.1E+00		4.2E+02	6.1E+01		3.0E+02	
127184	Tetrachloroethylene		C	8.1E+01	1.2E+01		8.1E+02	1.2E+02		8.1E+03	1.2E+03		1.1E+02	
108883	Toluene		NC	4.0E+02	1.1E+02		4.0E+03	1.1E+03		4.0E+04	1.1E+04		1.5E+03	
156605	trans-1,2-Dichloroethylene	X	NC	7.0E+01	1.8E+01		7.0E+02	1.8E+02		7.0E+03	1.8E+03		1.8E+02	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	3.0E+04	3.9E+03		3.0E+05	3.9E+04		3.0E+06	3.9E+05		1.5E+03	
120821	1,2,4-Trichlorobenzene		NC	2.0E+02	2.7E+01		2.0E+03	2.7E+02		2.0E+04	2.7E+03		3.4E+03	
79005	1,1,2-Trichloroethane		C	1.5E+01	2.8E+00		1.5E+02	2.8E+01		1.5E+03	2.8E+02		4.1E+02	
71556	1,1,1-Trichloroethane		NC	2.2E+03	4.0E+02		2.2E+04	4.0E+03		2.2E+05	4.0E+04		3.1E+03	
79016	Trichloroethylene ^{††}	X	C	2.2E+00	4.1E-01		2.2E+01	4.1E+00		2.2E+02	4.1E+01		5.3E+00	
75694	Trichlorofluoromethane		NC	7.0E+02	1.2E+02		7.0E+03	1.2E+03		7.0E+04	1.2E+04		1.8E+02	
96184	1,2,3-Trichloropropane		NC	4.9E+00	8.1E-01		4.9E+01	8.1E+00		4.9E+02	8.1E+01		2.9E+02	
95636	1,2,4-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.4E+01	

Table 2a: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁴

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁴ , HI=1] C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)			
108678	1,3,5-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.5E+01	
108054	Vinyl acetate		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		9.6E+03	
75014	Vinyl chloride (chloroethene)		C	2.8E+01	1.1E+01		2.8E+02	1.1E+02		2.8E+03	1.1E+03		2.5E+01	

¹ AF = 0.1 for Shallow Soil Gas Target Concentration
AF = 0.01 for Deep Soil Gas Target Concentration
AF = 0.001 for Groundwater Target Concentration
* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)
** Target soil gas concentration exceeds maximum possible vapor concentration (pathway incomplete)
† The target groundwater concentration is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.)
†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 2b: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁵

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁵ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)			
83329	Acenaphthene	X	NC	2.1E+02	3.3E+01		2.1E+03	3.3E+02		2.1E+04	3.3E+03		**	
75070	Acetaldehyde		NC	9.0E+00	5.0E+00		9.0E+01	5.0E+01		9.0E+02	5.0E+02		2.8E+03	
67641	Acetone	X	NC	3.5E+02	1.5E+02		3.5E+03	1.5E+03		3.5E+04	1.5E+04		2.2E+05	
75058	Acetonitrile		NC	6.0E+01	3.6E+01		6.0E+02	3.6E+02		6.0E+03	3.6E+03		4.2E+04	
98862	Acetophenone	X	NC	3.5E+02	7.1E+01		3.5E+03	7.1E+02		3.5E+04	7.1E+03		8.0E+05	
107028	Acrolein		NC	2.0E-02	8.7E-03		2.0E-01	8.7E-02		2.0E+00	8.7E-01		4.0E+00	
107131	Acrylonitrile		C	3.6E-01	1.7E-01		3.6E+00	1.7E+00		3.6E+01	1.7E+01		8.5E+01	
309002	Aldrin		C	5.0E-03	3.3E-04		5.0E-02	3.3E-03		5.0E-01	3.3E-02		7.1E-01	
319846	alpha-HCH (alpha-BHC)		C	1.4E-02	1.1E-03		1.4E-01	1.1E-02		1.4E+00	1.1E-01		3.1E+01	
100527	Benzaldehyde	X	NC	3.5E+02	8.1E+01		3.5E+03	8.1E+02		3.5E+04	8.1E+03		3.6E+05	
71432	Benzene		C	3.1E+00	9.8E-01		3.1E+01	9.8E+00		3.1E+02	9.8E+01		1.4E+01	
205992	Benzo(b)fluoranthene	X	C	1.2E-01	1.1E-02		1.2E+00	1.1E-01		**	**		**	
100447	Benzylchloride	X	C	5.0E-01	9.7E-02		5.0E+00	9.7E-01		5.0E+01	9.7E+00		3.0E+01	
91587	beta-Chloronaphthalene	X	NC	2.8E+02	4.2E+01		2.8E+03	4.2E+02		2.8E+04	4.2E+03		**	
92524	Biphenyl	X	NC	1.8E+02	2.8E+01		1.8E+03	2.8E+02		1.8E+04	2.8E+03		**	
111444	Bis(2-chloroethyl)ether		C	7.4E-02	1.3E-02		7.4E-01	1.3E-01		7.4E+00	1.3E+00		1.0E+02	
108601	Bis(2-chloroisopropyl)ether		C	2.4E+00	3.5E-01		2.4E+01	3.5E+00		2.4E+02	3.5E+01		5.1E+02	
542881	Bis(chloromethyl)ether		C	3.9E-04	8.4E-05		3.9E-03	8.4E-04		3.9E-02	8.4E-03		4.5E-02	
75274	Bromodichloromethane	X	C	1.4E+00	2.1E-01		1.4E+01	2.1E+00		1.4E+02	2.1E+01		2.1E+01	
75252	Bromoform		C	2.2E+01	2.1E+00		2.2E+02	2.1E+01		2.2E+03	2.1E+02		8.3E-02	
106990	1,3-Butadiene		C	8.7E-02	3.9E-02		8.7E-01	3.9E-01		8.7E+00	3.9E+00		2.9E-02	
75150	Carbon disulfide		NC	7.0E+02	2.2E+02		7.0E+03	2.2E+03		7.0E+04	2.2E+04		5.6E+02	
56235	Carbon tetrachloride		C	1.6E+00	2.6E-01		1.6E+01	2.6E+00		1.6E+02	2.6E+01		5.0E+00 †	
57749	Chlordane		C	2.4E-01	1.5E-02		2.4E+00	1.5E-01		2.4E+01	1.5E+00		**	
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	7.0E+00	1.9E+00		7.0E+01	1.9E+01		7.0E+02	1.9E+02		1.4E+01	
108907	Chlorobenzene		NC	6.0E+01	1.3E+01		6.0E+02	1.3E+02		6.0E+03	1.3E+03		3.9E+02	
109693	1-Chlorobutane	X	NC	1.4E+03	3.7E+02		1.4E+04	3.7E+03		1.4E+05	3.7E+04		2.0E+03	
124481	Chlorodibromomethane	X	C	1.0E+00	1.2E-01		1.0E+01	1.2E+00		1.0E+02	1.2E+01		3.2E+01	
75456	Chlorodifluoromethane		NC	5.0E+04	1.4E+04		5.0E+05	1.4E+05		**	**		**	
75003	Chloroethane (ethyl chloride)		NC	1.0E+04	3.8E+03		1.0E+05	3.8E+04		1.0E+06	3.8E+05		2.8E+04	
67663	Chloroform		C	1.1E+00	2.2E-01		1.1E+01	2.2E+00		1.1E+02	2.2E+01		8.0E+01 †	
95578	2-Chlorophenol	X	NC	1.8E+01	3.3E+00		1.8E+02	3.3E+01		1.8E+03	3.3E+02		1.1E+03	
75296	2-Chloropropane		NC	1.0E+02	3.2E+01		1.0E+03	3.2E+02		1.0E+04	3.2E+03		1.7E+02	
218019	Chrysene	X	C	1.2E+01	1.2E+00		**	**		**	**		**	
156592	cis-1,2-Dichloroethylene	X	NC	3.5E+01	8.8E+00		3.5E+02	8.8E+01		3.5E+03	8.8E+02		2.1E+02	
123739	Crotonaldehyde (2-butenal)	X	C	4.5E-02	1.6E-02		4.5E-01	1.6E-01		4.5E+00	1.6E+00		5.6E+01	
98828	Cumene		NC	4.0E+02	8.1E+01		4.0E+03	8.1E+02		4.0E+04	8.1E+03		8.4E+00	

Table 2b: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁵

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁵ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw} (ug/L)	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)			
72559	DDE	X	C	2.5E-01	1.9E-02		2.5E+00	1.9E-01		2.5E+01	1.9E+00		**	
132649	Dibenzofuran	X	NC	1.4E+01	2.0E+00		1.4E+02	2.0E+01		1.4E+03	2.0E+02		**	
96128	1,2-Dibromo-3-chloropropane		NC	2.0E-01	2.1E-02		2.0E+00	2.1E-01		2.0E+01	2.1E+00		3.3E+01	
106934	1,2-Dibromoethane (ethylene dibromide)		C	1.1E-01	1.4E-02		1.1E+00	1.4E-01		1.1E+01	1.4E+00		3.6E+00	
541731	1,3-Dichlorobenzene	X	NC	1.1E+02	1.7E+01		1.1E+03	1.7E+02		1.1E+04	1.7E+03		8.3E+02	
95501	1,2-Dichlorobenzene		NC	2.0E+02	3.3E+01		2.0E+03	3.3E+02		2.0E+04	3.3E+03		2.6E+03	
106467	1,4-Dichlorobenzene		NC	8.0E+02	1.3E+02		8.0E+03	1.3E+03		8.0E+04	1.3E+04		8.2E+03	
75718	Dichlorodifluoromethane		NC	2.0E+02	4.0E+01		2.0E+03	4.0E+02		2.0E+04	4.0E+03		1.4E+01	
75343	1,1-Dichloroethane		NC	5.0E+02	1.2E+02		5.0E+03	1.2E+03		5.0E+04	1.2E+04		2.2E+03	
107062	1,2-Dichloroethane		C	9.4E-01	2.3E-01		9.4E+00	2.3E+00		9.4E+01	2.3E+01		2.3E+01	
75354	1,1-Dichloroethylene		NC	2.0E+02	5.0E+01		2.0E+03	5.0E+02		2.0E+04	5.0E+03		1.9E+02	
78875	1,2-Dichloropropane		NC	4.0E+00	8.7E-01		4.0E+01	8.7E+00		4.0E+02	8.7E+01		3.5E+01	
542756	1,3-Dichloropropene		C	6.1E+00	1.3E+00		6.1E+01	1.3E+01		6.1E+02	1.3E+02		8.4E+00	
60571	Dieldrin		C	5.3E-03	3.4E-04		5.3E-02	3.4E-03		5.3E-01	3.4E-02		8.6E+00	
115297	Endosulfan	X	NC	2.1E+01	1.3E+00		2.1E+02	1.3E+01		**	**		**	
106898	Epichlorohydrin		NC	1.0E+00	2.6E-01		1.0E+01	2.6E+00		1.0E+02	2.6E+01		8.0E+02	
60297	Ethyl ether	X	NC	7.0E+02	2.3E+02		7.0E+03	2.3E+03		7.0E+04	2.3E+04		5.2E+02	
141786	Ethylacetate	X	NC	3.2E+03	8.7E+02		3.2E+04	8.7E+03		3.2E+05	8.7E+04		5.6E+05	
100414	Ethylbenzene		C	2.2E+01	5.1E+00		2.2E+02	5.1E+01		2.2E+03	5.1E+02		7.0E+02 †	
75218	Ethylene oxide		C	2.4E-01	1.4E-01		2.4E+00	1.4E+00		2.4E+01	1.4E+01		1.1E+01	
97632	Ethylmethacrylate	X	NC	3.2E+02	6.8E+01		3.2E+03	6.8E+02		3.2E+04	6.8E+03		9.1E+03	
86737	Fluorene	X	NC	1.4E+02	2.1E+01		1.4E+03	2.1E+02		**	**		**	
110009	Furan	X	NC	3.5E+00	1.3E+00		3.5E+01	1.3E+01		3.5E+02	1.3E+02		1.6E+01	
58899	gamma-HCH (Lindane)	X	C	6.6E-02	5.5E-03		6.6E-01	5.5E-02		6.6E+00	5.5E-01		1.1E+02	
76448	Heptachlor		C	1.9E-02	1.2E-03		1.9E-01	1.2E-02		1.9E+00	1.2E-01		4.0E-01 †	
87683	Hexachloro-1,3-butadiene		C	1.1E+00	1.0E-01		1.1E+01	1.0E+00		1.1E+02	1.0E+01		3.3E+00	
118741	Hexachlorobenzene		C	5.3E-02	4.5E-03		5.3E-01	4.5E-02		5.3E+00	4.5E-01		1.0E+00 †	
77474	Hexachlorocyclopentadiene		NC	2.0E-01	1.8E-02		2.0E+00	1.8E-01		2.0E+01	1.8E+00		5.0E+01 †	
67721	Hexachloroethane		C	6.1E+00	6.3E-01		6.1E+01	6.3E+00		6.1E+02	6.3E+01		3.8E+01	
110543	Hexane		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		2.9E+00	
74908	Hydrogen cyanide		NC	3.0E+00	2.7E+00		3.0E+01	2.7E+01		3.0E+02	2.7E+02		5.5E+02	
78831	Isobutanol	X	NC	1.1E+03	3.5E+02		1.1E+04	3.5E+03		1.1E+05	3.5E+04		2.2E+06	
743976	Mercury (elemental)		NC	3.0E-01	3.7E-02		3.0E+00	3.7E-01		3.0E+01	3.7E+00		6.8E-01	
126987	Methacrylonitrile		NC	7.0E-01	2.6E-01		7.0E+00	2.6E+00		7.0E+01	2.6E+01		6.9E+01	
72435	Methoxychlor	X	NC	1.8E+01	1.2E+00		**	**		**	**		**	
79209	Methyl acetate	X	NC	3.5E+03	1.2E+03		3.5E+04	1.2E+04		3.5E+05	1.2E+05		7.2E+05	
96333	Methyl acrylate	X	NC	1.1E+02	3.0E+01		1.1E+03	3.0E+02		1.1E+04	3.0E+03		1.4E+04	

Table 2b: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁵

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁵ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)		(ug/m ³)	(ppbv)			
74839	Methyl bromide		NC	5.0E+00	1.3E+00		5.0E+01	1.3E+01		5.0E+02	1.3E+02		2.0E+01	
74873	Methyl chloride (chloromethane)		C	2.4E+01	1.2E+01		2.4E+02	1.2E+02		2.4E+03	1.2E+03		6.7E+01	
108872	Methylcyclohexane		NC	3.0E+03	7.5E+02		3.0E+04	7.5E+03		3.0E+05	7.5E+04		7.1E+02	
74953	Methylene bromide	X	NC	3.5E+01	4.9E+00		3.5E+02	4.9E+01		3.5E+03	4.9E+02		9.9E+02	
75092	Methylene chloride		C	5.2E+01	1.5E+01		5.2E+02	1.5E+02		5.2E+03	1.5E+03		5.8E+02	
78933	Methyl ethyl ketone (2-butanone)		NC	1.0E+03	3.4E+02		1.0E+04	3.4E+03		1.0E+05	3.4E+04		4.4E+05	
108101	Methyl isobutyl ketone		NC	8.0E+01	2.0E+01		8.0E+02	2.0E+02		8.0E+03	2.0E+03		1.4E+04	
80626	Methyl methacrylate		NC	7.0E+02	1.7E+02		7.0E+03	1.7E+03		7.0E+04	1.7E+04		5.1E+04	
91576	2-Methylnaphthalene	X	NC	7.0E+01	1.2E+01		7.0E+02	1.2E+02		7.0E+03	1.2E+03		3.3E+03	
1634044	MTBE		NC	3.0E+03	8.3E+02		3.0E+04	8.3E+03		3.0E+05	8.3E+04		1.2E+05	
108383	m-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.3E+04	
91203	Naphthalene		NC	3.0E+00	5.7E-01		3.0E+01	5.7E+00		3.0E+02	5.7E+01		1.5E+02	
104518	n-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.6E+02	
98953	Nitrobenzene		NC	2.0E+00	4.0E-01		2.0E+01	4.0E+00		2.0E+02	4.0E+01		2.0E+03	
79469	2-Nitropropane		C	9.0E-03	2.5E-03		9.0E-02	2.5E-02		9.0E-01	2.5E-01		1.8E+00	
924163	N-Nitroso-di-n-butylamine		C	1.5E-02	2.4E-03		1.5E-01	2.4E-02		1.5E+00	2.4E-01		1.2E+00	
103651	n-Propylbenzene	X	NC	1.4E+02	2.8E+01		1.4E+03	2.8E+02		1.4E+04	2.8E+03		3.2E+02	
88722	o-Nitrotoluene	X	NC	3.5E+01	6.2E+00		3.5E+02	6.2E+01		3.5E+03	6.2E+02		6.8E+04	
95476	o-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		3.3E+04	
106423	p-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.2E+04	
129000	Pyrene	X	NC	1.1E+02	1.3E+01		**	**		**	**		**	
135988	sec-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.5E+02	
100425	Styrene		NC	1.0E+03	2.3E+02		1.0E+04	2.3E+03		1.0E+05	2.3E+04		8.9E+03	
98066	tert-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.9E+02	
630206	1,1,1,2-Tetrachloroethane		C	3.3E+00	4.8E-01		3.3E+01	4.8E+00		3.3E+02	4.8E+01		3.3E+01	
79345	1,1,2,2-Tetrachloroethane		C	4.2E-01	6.1E-02		4.2E+00	6.1E-01		4.2E+01	6.1E+00		3.0E+01	
127184	Tetrachloroethylene		C	8.1E+00	1.2E+00		8.1E+01	1.2E+01		8.1E+02	1.2E+02		1.1E+01	
108883	Toluene		NC	4.0E+02	1.1E+02		4.0E+03	1.1E+03		4.0E+04	1.1E+04		1.5E+03	
156605	trans-1,2-Dichloroethylene	X	NC	7.0E+01	1.8E+01		7.0E+02	1.8E+02		7.0E+03	1.8E+03		1.8E+02	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	3.0E+04	3.9E+03		3.0E+05	3.9E+04		3.0E+06	3.9E+05		1.5E+03	
120821	1,2,4-Trichlorobenzene		NC	2.0E+02	2.7E+01		2.0E+03	2.7E+02		2.0E+04	2.7E+03		3.4E+03	
79005	1,1,2-Trichloroethane		C	1.5E+00	2.8E-01		1.5E+01	2.8E+00		1.5E+02	2.8E+01		4.1E+01	
71556	1,1,1-Trichloroethane		NC	2.2E+03	4.0E+02		2.2E+04	4.0E+03		2.2E+05	4.0E+04		3.1E+03	
79016	Trichloroethylene ^{††}	X	C	2.2E-01	4.1E-02		2.2E+00	4.1E-01		2.2E+01	4.1E+00		5.0E+00 [†]	
75694	Trichlorofluoromethane		NC	7.0E+02	1.2E+02		7.0E+03	1.2E+03		7.0E+04	1.2E+04		1.8E+02	
96184	1,2,3-Trichloropropane		NC	4.9E+00	8.1E-01		4.9E+01	8.1E+00		4.9E+02	8.1E+01		2.9E+02	
95636	1,2,4-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.4E+01	

Table 2b: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1×10^{-5}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R= 10^{-5} , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m3)	(ppbv)		(ug/m3)	(ppbv)		(ug/m3)	(ppbv)			
108678	1,3,5-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.5E+01	
108054	Vinyl acetate		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		9.6E+03	
75014	Vinyl chloride (chloroethene)		C	2.8E+00	1.1E+00		2.8E+01	1.1E+01		2.8E+02	1.1E+02		2.5E+00	

† AF = 0.1 for Shallow Soil Gas Target Concentration
 AF = 0.01 for Deep Soil Gas Target Concentration
 AF = 0.001 for Groundwater Target Concentration
 * Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)
 ** Target soil gas concentration exceeds maximum possible vapor concentration (pathway incomplete)
 † The target groundwater concentration is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.)
 †† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 2c: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁶

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁶ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m3)	(ppbv)		(ug/m3)	(ppbv)		(ug/m3)	(ppbv)			
83329	Acenaphthene	X	NC	2.1E+02	3.3E+01		2.1E+03	3.3E+02		2.1E+04	3.3E+03		**	
75070	Acetaldehyde		C	1.1E+00	6.1E-01		1.1E+01	6.1E+00		1.1E+02	6.1E+01		3.4E+02	
67641	Acetone	X	NC	3.5E+02	1.5E+02		3.5E+03	1.5E+03		3.5E+04	1.5E+04		2.2E+05	
75058	Acetonitrile		NC	6.0E+01	3.6E+01		6.0E+02	3.6E+02		6.0E+03	3.6E+03		4.2E+04	
98862	Acetophenone	X	NC	3.5E+02	7.1E+01		3.5E+03	7.1E+02		3.5E+04	7.1E+03		8.0E+05	
107028	Acrolein		NC	2.0E-02	8.7E-03		2.0E-01	8.7E-02		2.0E+00	8.7E-01		4.0E+00	
107131	Acrylonitrile		C	3.6E-02	1.7E-02		3.6E-01	1.7E-01		3.6E+00	1.7E+00		8.5E+00	
309002	Aldrin		C	5.0E-04	3.3E-05		5.0E-03	3.3E-04		5.0E-02	3.3E-03		7.1E-02	
319846	alpha-HCH (alpha-BHC)		C	1.4E-03	1.1E-04		1.4E-02	1.1E-03		1.4E-01	1.1E-02		3.1E+00	
100527	Benzaldehyde	X	NC	3.5E+02	8.1E+01		3.5E+03	8.1E+02		3.5E+04	8.1E+03		3.6E+05	
71432	Benzene		C	3.1E-01	9.8E-02		3.1E+00	9.8E-01		3.1E+01	9.8E+00		5.0E+00 †	
205992	Benzo(b)fluoranthene	X	C	1.2E-02	1.1E-03		1.2E-01	1.1E-02		1.2E+00	1.1E-01		**	
100447	Benzylchloride	X	C	5.0E-02	9.7E-03		5.0E-01	9.7E-02		5.0E+00	9.7E-01		3.0E+00	
91587	beta-Chloronaphthalene	X	NC	2.8E+02	4.2E+01		2.8E+03	4.2E+02		2.8E+04	4.2E+03		**	
92524	Biphenyl	X	NC	1.8E+02	2.8E+01		1.8E+03	2.8E+02		1.8E+04	2.8E+03		**	
111444	Bis(2-chloroethyl)ether		C	7.4E-03	1.3E-03		7.4E-02	1.3E-02		7.4E-01	1.3E-01		1.0E+01	
108601	Bis(2-chloroisopropyl)ether		C	2.4E-01	3.5E-02		2.4E+00	3.5E-01		2.4E+01	3.5E+00		5.1E+01	
542881	Bis(chloromethyl)ether		C	3.9E-05	8.4E-06		3.9E-04	8.4E-05		3.9E-03	8.4E-04		4.5E-03	
75274	Bromodichloromethane	X	C	1.4E-01	2.1E-02		1.4E+00	2.1E-01		1.4E+03	2.1E+00		2.1E+00	
75252	Bromoform		C	2.2E+00	2.1E-01		2.2E+01	2.1E+00		2.2E+02	2.1E+01		8.3E-03	
106990	1,3-Butadiene		C	8.7E-03	3.9E-03		8.7E-02	3.9E-02		8.7E-01	3.9E-01		2.9E-03	
75150	Carbon disulfide		NC	7.0E+02	2.2E+02		7.0E+03	2.2E+03		7.0E+04	2.2E+04		5.6E+02	
56235	Carbon tetrachloride		C	1.6E-01	2.6E-02		1.6E+00	2.6E-01		1.6E+01	2.6E+00		5.0E+00 †	
57749	Chlordane		C	2.4E-02	1.5E-03		2.4E-01	1.5E-02		2.4E+00	1.5E-01		1.2E+01	
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	7.0E+00	1.9E+00		7.0E+01	1.9E+01		7.0E+02	1.9E+02		1.4E+01	
108907	Chlorobenzene		NC	6.0E+01	1.3E+01		6.0E+02	1.3E+02		6.0E+03	1.3E+03		3.9E+02	
109693	1-Chlorobutane	X	NC	1.4E+03	3.7E+02		1.4E+04	3.7E+03		1.4E+05	3.7E+04		2.0E+03	
124481	Chlorodibromomethane	X	C	1.0E-01	1.2E-02		1.0E+00	1.2E-01		1.0E+01	1.2E+00		3.2E+00	
75456	Chlorodifluoromethane		NC	5.0E+04	1.4E+04		5.0E+05	1.4E+05		**	**		**	
75003	Chloroethane (ethyl chloride)		NC	1.0E+04	3.8E+03		1.0E+05	3.8E+04		1.0E+06	3.8E+05		2.8E+04	
67663	Chloroform		C	1.1E-01	2.2E-02		1.1E+00	2.2E-01		1.1E+01	2.2E+00		8.0E+01 †	
95578	2-Chlorophenol	X	NC	1.8E+01	3.3E+00		1.8E+02	3.3E+01		1.8E+03	3.3E+02		1.1E+03	
75296	2-Chloropropane		NC	1.0E+02	3.2E+01		1.0E+03	3.2E+02		1.0E+04	3.2E+03		1.7E+02	
218019	Chrysene	X	C	1.2E+00	1.2E-01		1.2E+01	1.2E+00		**	**		**	
156592	cis-1,2-Dichloroethylene	X	NC	3.5E+01	8.8E+00		3.5E+02	8.8E+01		3.5E+03	8.8E+02		2.1E+02	
123739	Crotonaldehyde (2-butenal)	X	C	4.5E-03	1.6E-03		4.5E-02	1.6E-02		4.5E-01	1.6E-01		5.6E+00	
98828	Cumene		NC	4.0E+02	8.1E+01		4.0E+03	8.1E+02		4.0E+04	8.1E+03		8.4E+00	

Table 2c: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁶

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁶ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m3)	(ppbv)		(ug/m3)	(ppbv)		(ug/m3)	(ppbv)			
72559	DDE	X	C	2.5E-02	1.9E-03		2.5E-01	1.9E-02		2.5E+00	1.9E-01		2.9E+01	
132649	Dibenzofuran	X	NC	1.4E+01	2.0E+00		1.4E+02	2.0E+01		1.4E+03	2.0E+02		**	
96128	1,2-Dibromo-3-chloropropane		NC	2.0E-01	2.1E-02		2.0E+00	2.1E-01		2.0E+01	2.1E+00		3.3E+01	
106934	1,2-Dibromoethane (ethylene dibromide)		C	1.1E-02	1.4E-03		1.1E-01	1.4E-02		1.1E+00	1.4E-01		3.6E-01	
541731	1,3-Dichlorobenzene	X	NC	1.1E+02	1.7E+01		1.1E+03	1.7E+02		1.1E+04	1.7E+03		8.3E+02	
95501	1,2-Dichlorobenzene		NC	2.0E+02	3.3E+01		2.0E+03	3.3E+02		2.0E+04	3.3E+03		2.6E+03	
106467	1,4-Dichlorobenzene		NC	8.0E+02	1.3E+02		8.0E+03	1.3E+03		8.0E+04	1.3E+04		8.2E+03	
75718	Dichlorodifluoromethane		NC	2.0E+02	4.0E+01		2.0E+03	4.0E+02		2.0E+04	4.0E+03		1.4E+01	
75343	1,1-Dichloroethane		NC	5.0E+02	1.2E+02		5.0E+03	1.2E+03		5.0E+04	1.2E+04		2.2E+03	
107062	1,2-Dichloroethane		C	9.4E-02	2.3E-02		9.4E-01	2.3E-01		9.4E+00	2.3E+00		5.0E+00 †	
75354	1,1-Dichloroethylene		NC	2.0E+02	5.0E+01		2.0E+03	5.0E+02		2.0E+04	5.0E+03		1.9E+02	
78875	1,2-Dichloropropane		NC	4.0E+00	8.7E-01		4.0E+01	8.7E+00		4.0E+02	8.7E+01		3.5E+01	
542756	1,3-Dichloropropene		C	6.1E-01	1.3E-01		6.1E+00	1.3E+00		6.1E+01	1.3E+01		8.4E-01	
60571	Dieldrin		C	5.3E-04	3.4E-05		5.3E-03	3.4E-04		5.3E-02	3.4E-03		8.6E-01	
115297	Endosulfan	X	NC	2.1E+01	1.3E+00		2.1E+02	1.3E+01		**	**		**	
106898	Epichlorohydrin		NC	1.0E+00	2.6E-01		1.0E+01	2.6E+00		1.0E+02	2.6E+01		8.0E+02	
60297	Ethyl ether	X	NC	7.0E+02	2.3E+02		7.0E+03	2.3E+03		7.0E+04	2.3E+04		5.2E+02	
141786	Ethylacetate	X	NC	3.2E+03	8.7E+02		3.2E+04	8.7E+03		3.2E+05	8.7E+04		5.6E+05	
100414	Ethylbenzene		C	2.2E+00	5.1E-01		2.2E+01	5.1E+00		2.2E+02	5.1E+01		7.0E+02 †	
75218	Ethylene oxide		C	2.4E-02	1.4E-02		2.4E-01	1.4E-01		2.4E+00	1.4E+00		1.1E+00	
97632	Ethylmethacrylate	X	NC	3.2E+02	6.8E+01		3.2E+03	6.8E+02		3.2E+04	6.8E+03		9.1E+03	
86737	Fluorene	X	NC	1.4E+02	2.1E+01		1.4E+03	2.1E+02		**	**		**	
110009	Furan	X	NC	3.5E+00	1.3E+00		3.5E+01	1.3E+01		3.5E+02	1.3E+02		1.6E+01	
58899	gamma-HCH (Lindane)	X	C	6.6E-03	5.5E-04		6.6E-02	5.5E-03		6.6E-01	5.5E-02		1.1E+01	
76448	Heptachlor		C	1.9E-03	1.2E-04		1.9E-02	1.2E-03		1.9E-01	1.2E-02		4.0E-01 †	
87683	Hexachloro-1,3-butadiene		C	1.1E-01	1.0E-02		1.1E+00	1.0E-01		1.1E+01	1.0E+00		3.3E-01	
118741	Hexachlorobenzene		C	5.3E-03	4.5E-04		5.3E-02	4.5E-03		5.3E-01	4.5E-02		1.0E+00 †	
77474	Hexachlorocyclopentadiene		NC	2.0E-01	1.8E-02		2.0E+00	1.8E-01		2.0E+01	1.8E+00		5.0E+01 †	
67721	Hexachloroethane		C	6.1E-01	6.3E-02		6.1E+00	6.3E-01		6.1E+01	6.3E+00		3.8E+00	
110543	Hexane		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		2.9E+00	
74908	Hydrogen cyanide		NC	3.0E+00	2.7E+00		3.0E+01	2.7E+01		3.0E+02	2.7E+02		5.5E+02	
78831	Isobutanol	X	NC	1.1E+03	3.5E+02		1.1E+04	3.5E+03		1.1E+05	3.5E+04		2.2E+06	
7439976	Mercury (elemental)		NC	3.0E-01	3.7E-02		3.0E+00	3.7E-01		3.0E+01	3.7E+00		6.8E-01	
126987	Methacrylonitrile		NC	7.0E-01	2.6E-01		7.0E+00	2.6E+00		7.0E+01	2.6E+01		6.9E+01	
72435	Methoxychlor	X	NC	1.8E+01	1.2E+00		**	**		**	**		**	
79209	Methyl acetate	X	NC	3.5E+03	1.2E+03		3.5E+04	1.2E+04		3.5E+05	1.2E+05		7.2E+05	
96333	Methyl acrylate	X	NC	1.1E+02	3.0E+01		1.1E+03	3.0E+02		1.1E+04	3.0E+03		1.4E+04	

Table 2c: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1 x 10⁻⁶

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R=10 ⁻⁶ , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m3)	(ppbv)		(ug/m3)	(ppbv)		(ug/m3)	(ppbv)			
74839	Methyl bromide		NC	5.0E+00	1.3E+00		5.0E+01	1.3E+01		5.0E+02	1.3E+02		2.0E+01	
74873	Methyl chloride (chloromethane)		C	2.4E+00	1.2E+00		2.4E+01	1.2E+01		2.4E+02	1.2E+02		6.7E+00	
108872	Methylcyclohexane		NC	3.0E+03	7.5E+02		3.0E+04	7.5E+03		3.0E+05	7.5E+04		7.1E+02	
74953	Methylene bromide	X	NC	3.5E+01	4.9E+00		3.5E+02	4.9E+01		3.5E+03	4.9E+02		9.9E+02	
75092	Methylene chloride		C	5.2E+00	1.5E+00		5.2E+01	1.5E+01		5.2E+02	1.5E+02		5.8E+01	
78933	Methylethylketone (2-butanone)		NC	1.0E+03	3.4E+02		1.0E+04	3.4E+03		1.0E+05	3.4E+04		4.4E+05	
108101	Methylisobutylketone		NC	8.0E+01	2.0E+01		8.0E+02	2.0E+02		8.0E+03	2.0E+03		1.4E+04	
80626	Methylmethacrylate		NC	7.0E+02	1.7E+02		7.0E+03	1.7E+03		7.0E+04	1.7E+04		5.1E+04	
91576	2-Methylnaphthalene	X	NC	7.0E+01	1.2E+01		7.0E+02	1.2E+02		7.0E+03	1.2E+03		3.3E+03	
1634044	MTBE		NC	3.0E+03	8.3E+02		3.0E+04	8.3E+03		3.0E+05	8.3E+04		1.2E+05	
108383	m-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.3E+04	
91203	Naphthalene		NC	3.0E+00	5.7E-01		3.0E+01	5.7E+00		3.0E+02	5.7E+01		1.5E+02	
104518	n-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.6E+02	
98953	Nitrobenzene		NC	2.0E+00	4.0E-01		2.0E+01	4.0E+00		2.0E+02	4.0E+01		2.0E+03	
79469	2-Nitropropane		C	9.0E-04	2.5E-04		9.0E-03	2.5E-03		9.0E-02	2.5E-02		1.8E-01	
924163	N-Nitroso-di-n-butylamine		C	1.5E-03	2.4E-04		1.5E-02	2.4E-03		1.5E-01	2.4E-02		1.2E-01	
103651	n-Propylbenzene	X	NC	1.4E+02	2.8E+01		1.4E+03	2.8E+02		1.4E+04	2.8E+03		3.2E+02	
88722	o-Nitrotoluene	X	NC	3.5E+01	6.2E+00		3.5E+02	6.2E+01		3.5E+03	6.2E+02		6.8E+04	
95476	o-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		3.3E+04	
106423	p-Xylene	X	NC	7.0E+03	1.6E+03		7.0E+04	1.6E+04		7.0E+05	1.6E+05		2.2E+04	
129000	Pyrene	X	NC	1.1E+02	1.3E+01		**	**		**	**		**	
135988	sec-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.5E+02	
100425	Styrene		NC	1.0E+03	2.3E+02		1.0E+04	2.3E+03		1.0E+05	2.3E+04		8.9E+03	
98066	tert-Butylbenzene	X	NC	1.4E+02	2.6E+01		1.4E+03	2.6E+02		1.4E+04	2.6E+03		2.9E+02	
630206	1,1,1,2-Tetrachloroethane		C	3.3E-01	4.8E-02		3.3E+00	4.8E-01		3.3E+01	4.8E+00		3.3E+00	
79345	1,1,2,2-Tetrachloroethane		C	4.2E-02	6.1E-03		4.2E-01	6.1E-02		4.2E+00	6.1E-01		3.0E+00	
127184	Tetrachloroethylene		C	8.1E-01	1.2E-01		8.1E+00	1.2E+00		8.1E+01	1.2E+01		5.0E+00 †	
108883	Toluene		NC	4.0E+02	1.1E+02		4.0E+03	1.1E+03		4.0E+04	1.1E+04		1.5E+03	
156605	trans-1,2-Dichloroethylene	X	NC	7.0E+01	1.8E+01		7.0E+02	1.8E+02		7.0E+03	1.8E+03		1.8E+02	
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	3.0E+04	3.9E+03		3.0E+05	3.9E+04		3.0E+06	3.9E+05		1.5E+03	
120821	1,2,4-Trichlorobenzene		NC	2.0E+02	2.7E+01		2.0E+03	2.7E+02		2.0E+04	2.7E+03		3.4E+03	
79005	1,1,2-Trichloroethane		C	1.5E-01	2.8E-02		1.5E+00	2.8E-01		1.5E+01	2.8E+00		5.0E+00 †	
71556	1,1,1-Trichloroethane		NC	2.2E+03	4.0E+02		2.2E+04	4.0E+03		2.2E+05	4.0E+04		3.1E+03	
79016	Trichloroethylene ††	X	C	2.2E-02	4.1E-03		2.2E-01	4.1E-02		2.2E+00	4.1E-01		5.0E+00 †	
75694	Trichlorofluoromethane		NC	7.0E+02	1.2E+02		7.0E+03	1.2E+03		7.0E+04	1.2E+04		1.8E+02	
96184	1,2,3-Trichloropropane		NC	4.9E+00	8.1E-01		4.9E+01	8.1E+00		4.9E+02	8.1E+01		2.9E+02	
95636	1,2,4-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.4E+01	

Table 2c: Question 4 Generic Screening Levels and Summary Sheet ¹

Risk = 1×10^{-6}

CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	Target Indoor Air Concentration to Satisfy Both the Prescribed Risk Level and the Target Hazard Index [R= 10^{-6} , HI=1) C _{target}		Measured or Reasonably Estimated Indoor Air Concentration [if available] (specify units)	Target Shallow Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.1 C _{soil-gas}		Measured or Reasonably Estimated Shallow Soil Gas Concentration [if available] (specify units)	Target Deep Soil Gas Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor=0.01 C _{soil-gas}		Measured or Reasonably Estimated Deep Soil Gas Concentration [if available] (specify units)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration Where the Soil Gas to Indoor Air Attenuation Factor = 0.001 and Partitioning Across the Water Table Obeys Henry's Law C _{gw}	Measured or Reasonably Estimated Groundwater Concentration [if available] (specify units)
				(ug/m3)	(ppbv)		(ug/m3)	(ppbv)		(ug/m3)	(ppbv)			
108678	1,3,5-Trimethylbenzene		NC	6.0E+00	1.2E+00		6.0E+01	1.2E+01		6.0E+02	1.2E+02		2.5E+01	
108054	Vinyl acetate		NC	2.0E+02	5.7E+01		2.0E+03	5.7E+02		2.0E+04	5.7E+03		9.6E+03	
75014	Vinyl chloride (chloroethene)		C	2.8E-01	1.1E-01		2.8E+00	1.1E+00		2.8E+01	1.1E+01		2.0E+00 †	

¹ AF = 0.1 for Shallow Soil Gas Target Concentration
 AF = 0.01 for Deep Soil Gas Target Concentration
 AF = 0.001 for Groundwater Target Concentration
 * Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)
 ** Target soil gas concentration exceeds maximum possible vapor concentration (pathway incomplete)
 † The target groundwater concentration is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.)
 †† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3a-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-4}

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Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
83329	Acenaphthene	X	NC	**	**	**	**	**	**	**	**	**	**
75070	Acetaldehyde		NC	4.5E+03	2.5E+03	9.0E+03	5.0E+03	1.3E+04	7.1E+03	2.2E+04	1.2E+04	4.5E+04	2.5E+04
67641	Acetone	X	NC	1.8E+05	7.4E+04	3.5E+05	1.5E+05	5.0E+05	2.1E+05	8.8E+05	3.7E+05	1.8E+06	7.4E+05
75058	Acetonitrile		NC	3.0E+04	1.8E+04	6.0E+04	3.6E+04	8.6E+04	5.1E+04	1.5E+05	8.9E+04	3.0E+05	1.8E+05
98862	Acetophenone	X	NC	1.8E+05	3.6E+04	3.5E+05	7.1E+04	5.0E+05	1.0E+05	8.8E+05	1.8E+05	1.8E+06	3.6E+05
107028	Acrolein		NC	1.0E+01	4.4E+00	2.0E+01	8.7E+00	2.9E+01	1.2E+01	5.0E+01	2.2E+01	1.0E+02	4.4E+01
107131	Acrylonitrile		NC	1.0E+03	4.6E+02	2.0E+03	9.2E+02	2.9E+03	1.3E+03	5.0E+03	2.3E+03	1.0E+04	4.6E+03
309002	Aldrin		C	2.5E+01	1.7E+00	5.0E+01	3.3E+02	7.1E+01	4.8E+00	**	**	**	**
319846	alpha-HCH (alpha-BHC)		C	6.8E+01	5.7E+00	1.4E+02	1.1E+01	1.9E+02	1.6E+01	3.4E+02	2.8E+01	6.8E+02	5.7E+01
100527	Benzaldehyde	X	NC	1.8E+05	4.0E+04	3.5E+05	8.1E+04	5.0E+05	1.2E+05	8.8E+05	2.0E+05	1.8E+06	4.0E+05
71432	Benzene		C	1.6E+04	4.9E+03	3.1E+04	9.8E+03	4.5E+04	1.4E+04	7.8E+04	2.4E+04	1.6E+05	4.9E+04
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**	**	**	**	**	**
100447	Benzylchloride	X	C	2.5E+03	4.8E+02	5.0E+03	9.7E+02	7.2E+03	1.4E+03	1.3E+04	2.4E+03	2.5E+04	4.8E+03
91587	beta-Chloronaphthalene	X	NC	1.4E+05	2.1E+04	**	**	**	**	**	**	**	**
92524	Biphenyl	X	NC	8.8E+04	1.4E+04	**	**	**	**	**	**	**	**
114444	Bis(2-chloroethoxy)ether		C	3.7E+02	6.3E+01	7.4E+02	1.3E+02	1.1E+03	1.8E+02	1.8E+03	3.2E+02	3.7E+03	6.3E+02
108601	Bis(2-chloroisopropyl)ether		C	1.2E+04	1.7E+03	2.4E+04	3.5E+03	3.5E+04	5.0E+03	6.1E+04	8.7E+03	1.2E+05	1.7E+04
542881	Bis(chloromethyl)ether		C	2.0E+00	4.2E-01	3.9E+00	8.4E-01	5.6E+00	1.2E+00	9.8E+00	2.1E+00	2.0E+01	4.2E+00
75274	Bromodichloromethane	X	C	6.9E+03	1.0E+03	1.4E+04	2.1E+03	2.0E+04	2.9E+03	3.4E+04	5.1E+03	6.9E+04	1.0E+04
75252	Bromoform		C	1.1E+05	1.1E+04	2.2E+05	2.1E+04	3.2E+05	3.1E+04	5.5E+05	5.4E+04	1.1E+06	1.1E+05
106990	1,3-Butadiene		C	4.3E+02	2.0E+02	8.7E+02	3.9E+02	1.2E+03	5.6E+02	2.2E+03	9.8E+02	4.3E+03	2.0E+03
75150	Carbon disulfide		NC	3.5E+05	1.1E+05	7.0E+05	2.2E+05	1.0E+06	3.2E+05	1.8E+06	5.6E+05	3.5E+06	1.1E+06
56235	Carbon tetrachloride		C	8.1E+03	1.3E+03	1.6E+04	2.6E+03	2.3E+04	3.7E+03	4.1E+04	6.5E+03	8.1E+04	1.3E+04
57749	Chlordane		NC	**	**	**	**	**	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	3.5E+03	9.7E+02	7.0E+03	1.9E+03	1.0E+04	2.8E+03	1.8E+04	4.8E+03	3.5E+04	9.7E+03
108907	Chlorobenzene		NC	3.0E+04	6.5E+03	6.0E+04	1.3E+04	8.5E+04	1.8E+04	1.5E+05	3.2E+04	3.0E+05	6.5E+04
109693	1-Chlorobutane	X	NC	7.0E+05	1.8E+05	1.4E+06	3.7E+05	2.0E+06	5.3E+05	3.5E+06	9.2E+05	7.0E+06	1.8E+06
124481	Chlorodibromomethane	X	C	5.1E+03	6.0E+02	1.0E+04	1.2E+03	1.4E+04	1.7E+03	2.5E+04	3.0E+03	5.1E+04	6.0E+03
75456	Chlorodifluoromethane		NC	**	**	**	**	**	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	5.0E+06	1.9E+06	1.0E+07	3.8E+06	1.4E+07	5.4E+06	2.5E+07	9.5E+06	5.0E+07	1.9E+07
67663	Chloroform		C	5.3E+03	1.1E+03	1.1E+04	2.2E+03	1.5E+04	3.1E+03	2.6E+04	5.4E+03	5.3E+04	1.1E+04
95578	2-Chlorophenol	X	NC	8.8E+03	1.7E+03	1.8E+04	3.3E+03	2.5E+04	4.8E+03	4.4E+04	8.3E+03	8.8E+04	1.7E+04
75296	2-Chloropropane		NC	5.1E+04	1.6E+04	1.0E+05	3.2E+04	1.5E+05	4.5E+04	2.5E+05	7.9E+04	5.1E+05	1.6E+05
218019	Chrysene	X	*	*	*	*	*	*	*	*	*	*	*
156592	cis-1,2-Dichloroethylene	X	NC	1.8E+04	4.4E+03	3.5E+04	8.8E+03	5.0E+04	1.3E+04	8.8E+04	2.2E+04	1.8E+05	4.4E+04
123739	Crotonaldehyde (2-butenal)	X	C	2.2E+02	7.8E+01	4.5E+02	1.6E+02	6.4E+02	2.2E+02	1.1E+03	3.9E+02	2.2E+03	7.8E+02
98828	Cumene		NC	2.0E+05	4.1E+04	4.0E+05	8.1E+04	5.7E+05	1.2E+05	1.0E+06	2.0E+05	2.0E+06	4.1E+05
72559	DDE	X	C	**	**	**	**	**	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	1.0E+02	1.0E+01	2.0E+02	2.1E+01	2.9E+02	3.0E+01	5.0E+02	5.2E+01	1.0E+03	1.0E+02
106934	1,2-Dibromoethane (ethylene dibromide)		NC	1.0E+02	1.3E+01	2.0E+02	2.6E+01	2.9E+02	3.7E+01	5.0E+02	6.5E+01	1.0E+03	1.3E+02
541731	1,3-Dichlorobenzene	X	NC	5.3E+04	8.7E+03	1.1E+05	1.7E+04	1.5E+05	2.5E+04	2.6E+05	4.4E+04	5.3E+05	8.7E+04

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Table 3a-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-4}

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Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
95501	1,2-Dichlorobenzene		NC	1.0E+05	1.7E+04	2.0E+05	3.3E+04	2.9E+05	4.8E+04	5.0E+05	8.3E+04	1.0E+06	1.7E+05
106467	1,4-Dichlorobenzene		NC	4.0E+05	6.7E+04	8.0E+05	1.3E+05	1.1E+06	1.9E+05	2.0E+06	3.3E+05	4.0E+06	6.7E+05
75718	Dichlorodifluoromethane		NC	1.0E+05	2.0E+04	2.0E+05	4.0E+04	2.9E+05	5.8E+04	5.0E+05	1.0E+05	1.0E+06	2.0E+05
75343	1,1-Dichloroethane		NC	2.5E+05	6.2E+04	5.0E+05	1.2E+05	7.1E+05	1.8E+05	1.3E+06	3.1E+05	2.5E+06	6.2E+05
107062	1,2-Dichloroethane		C	4.7E+03	1.2E+03	9.4E+03	2.3E+03	1.3E+04	3.3E+03	2.3E+04	5.8E+03	4.7E+04	1.2E+04
75354	1,1-Dichloroethylene		NC	1.0E+05	2.5E+04	2.0E+05	5.0E+04	2.9E+05	7.2E+04	5.0E+05	1.3E+05	1.0E+06	2.5E+05
78875	1,2-Dichloropropane		NC	2.0E+03	4.3E+02	4.0E+03	8.7E+02	5.7E+03	1.2E+03	1.0E+04	2.2E+03	2.0E+04	4.3E+03
542756	1,3-Dichloropropene		NC	1.0E+04	2.2E+03	2.0E+04	4.4E+03	2.9E+04	6.3E+03	5.0E+04	1.1E+04	1.0E+05	2.2E+04
60571	Dieldrin		C	2.6E+01	1.7E+00	5.3E+01	3.4E+00	7.6E+01	4.9E+00	**	**	**	**
115297	Endosulfan	X	NC	**	**	**	**	**	**	**	**	**	**
108898	Epichlorohydrin		NC	5.0E+02	1.3E+02	1.0E+03	2.6E+02	1.4E+03	3.8E+02	2.5E+03	6.6E+02	5.0E+03	1.3E+03
60297	Ethyl ether	X	NC	3.5E+05	1.2E+05	7.0E+05	2.3E+05	1.0E+06	3.3E+05	1.8E+06	5.8E+05	3.5E+06	1.2E+06
141786	Ethylacetate	X	NC	1.6E+06	4.4E+05	3.2E+06	8.7E+05	4.5E+06	1.2E+06	7.9E+06	2.2E+06	1.6E+07	4.4E+06
100414	Ethylbenzene		C	1.1E+05	2.5E+04	2.2E+05	5.1E+04	3.2E+05	7.3E+04	5.5E+05	1.3E+05	1.1E+06	2.5E+05
75218	Ethylene oxide		C	1.2E+03	6.8E+02	2.4E+03	1.4E+03	3.5E+03	1.9E+03	6.1E+03	3.4E+03	1.2E+04	6.8E+03
97632	Ethylmethacrylate	X	NC	1.6E+05	3.4E+04	3.2E+05	6.8E+04	4.5E+05	9.6E+04	7.9E+05	1.7E+05	1.6E+06	3.4E+05
86737	Fluorene	X	NC	**	**	**	**	**	**	**	**	**	**
110009	Furan	X	NC	1.8E+03	6.3E+02	3.5E+03	1.3E+03	5.0E+03	1.8E+03	8.8E+03	3.1E+03	1.8E+04	6.3E+03
58899	gamma-HCH (Lindane)	X	C	3.3E+02	2.8E+01	6.6E+02	5.5E+01	9.4E+02	7.9E+01	1.6E+03	1.4E+02	3.3E+03	2.8E+02
76448	Heptachlor		C	9.4E+01	6.1E+00	1.9E+02	1.2E+01	2.7E+02	1.8E+01	4.7E+02	3.1E+01	9.4E+02	6.1E+01
87683	Hexachloro-1,3-butadiene		C	5.5E+03	5.2E+02	1.1E+04	1.0E+03	1.6E+04	1.5E+03	2.8E+04	2.6E+03	5.5E+04	5.2E+03
118741	Hexachlorobenzene		C	2.6E+02	2.3E+01	**	**	**	**	**	**	**	**
77474	Hexachlorocyclopentadiene		NC	1.0E+02	9.0E+00	2.0E+02	1.8E+01	2.9E+02	2.6E+01	5.0E+02	4.5E+01	1.0E+03	9.0E+01
67721	Hexachloroethane		C	3.0E+04	3.1E+03	6.1E+04	6.3E+03	8.7E+04	9.0E+03	1.5E+05	1.6E+04	3.0E+05	3.1E+04
110543	Hexane		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
74908	Hydrogen cyanide		NC	1.5E+03	1.4E+03	3.0E+03	2.7E+03	4.3E+03	3.9E+03	7.5E+03	6.8E+03	1.5E+04	1.4E+04
78831	Isobutanol	X	NC	5.3E+05	1.7E+05	1.1E+06	3.5E+05	1.5E+06	5.0E+05	2.6E+06	8.7E+05	5.3E+06	1.7E+06
7439976	Mercury (elemental)		NC	1.5E+02	1.8E+01	3.0E+02	3.7E+01	4.3E+02	5.2E+01	7.5E+02	9.1E+01	1.5E+03	1.8E+02
126987	Methacrylonitrile		NC	3.5E+02	1.3E+02	7.0E+02	2.6E+02	1.0E+03	3.6E+02	1.8E+03	6.4E+02	3.5E+03	1.3E+03
72435	Methoxychlor	X	NC	**	**	**	**	**	**	**	**	**	**
79209	Methyl acetate	X	NC	1.8E+06	5.8E+05	3.5E+06	1.2E+06	5.0E+06	1.7E+06	8.8E+06	2.9E+06	**	**
96333	Methyl acrylate	X	NC	5.3E+04	1.5E+04	1.1E+05	3.0E+04	1.5E+05	4.3E+04	2.6E+05	7.5E+04	5.3E+05	1.5E+05
74839	Methyl bromide		NC	2.5E+03	6.4E+02	5.0E+03	1.3E+03	7.1E+03	1.8E+03	1.3E+04	3.2E+03	2.5E+04	6.4E+03
74873	Methyl chloride (chloromethane)		NC	4.5E+04	2.2E+04	9.0E+04	4.4E+04	1.3E+05	6.2E+04	2.3E+05	1.1E+05	4.5E+05	2.2E+05
108872	Methylcyclohexane		NC	1.5E+06	3.7E+05	3.0E+06	7.5E+05	4.3E+06	1.1E+06	7.5E+06	1.9E+06	1.5E+07	3.7E+06
74953	Methylene bromide	X	NC	1.8E+04	2.5E+03	3.5E+04	4.9E+03	5.0E+04	7.0E+03	8.8E+04	1.2E+04	1.8E+05	2.5E+04
75092	Methylene chloride		C	2.6E+05	7.5E+04	5.2E+05	1.5E+05	7.4E+05	2.1E+05	1.3E+06	3.7E+05	2.6E+06	7.5E+05
78933	Methylethylketone (2-butanone)		NC	5.0E+05	1.7E+05	1.0E+06	3.4E+05	1.4E+06	4.8E+05	2.5E+06	8.5E+05	5.0E+06	1.7E+06
108101	Methylisobutylketone		NC	4.0E+04	9.8E+03	8.0E+04	2.0E+04	1.1E+05	2.8E+04	2.0E+05	4.9E+04	4.0E+05	9.8E+04
80626	Methylmethacrylate		NC	3.5E+05	8.6E+04	7.0E+05	1.7E+05	1.0E+06	2.4E+05	1.8E+06	4.3E+05	3.5E+06	8.6E+05
91576	2-Methylnaphthalene	X	NC	3.5E+04	6.0E+03	7.0E+04	1.2E+04	1.0E+05	1.7E+04	1.8E+05	3.0E+04	3.5E+05	6.0E+04
1634044	MTBE		NC	1.5E+06	4.2E+05	3.0E+06	8.3E+05	4.3E+06	1.2E+06	7.5E+06	2.1E+06	1.5E+07	4.2E+06

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Table 3a-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

DRAFT

Risk = 1×10^{-4}

Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
108383	m-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
91203	Naphthalene		NC	1.5E+03	2.9E+02	3.0E+03	5.7E+02	4.3E+03	8.2E+02	7.5E+03	1.4E+03	1.5E+04	2.9E+03
104518	n-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
98953	Nitrobenzene		NC	1.0E+03	2.0E+02	2.0E+03	4.0E+02	2.9E+03	5.7E+02	5.0E+03	9.9E+02	1.0E+04	2.0E+03
79469	2-Nitropropane		C	4.5E+01	1.2E+01	9.0E+01	2.5E+01	1.3E+02	3.5E+01	2.3E+02	6.2E+01	4.5E+02	1.2E+02
924163	N-Nitroso-di-n-butylamine		C	7.6E+01	1.2E+01	1.5E+02	2.4E+01	2.2E+02	3.4E+01	3.8E+02	5.9E+01	7.6E+02	1.2E+02
103651	n-Propylbenzene	X	NC	7.0E+04	1.4E+04	1.4E+05	2.8E+04	2.0E+05	4.1E+04	3.5E+05	7.1E+04	7.0E+05	1.4E+05
88722	o-Nitrotoluene	X	NC	1.8E+04	3.1E+03	3.5E+04	6.2E+03	5.0E+04	8.9E+03	8.8E+04	1.6E+04	1.8E+05	3.1E+04
95476	o-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
106423	p-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
129000	Pyrene	X	NC	**	**	**	**	**	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
100425	Styrene		NC	5.0E+05	1.2E+05	1.0E+06	2.3E+05	1.4E+06	3.4E+05	2.5E+06	5.9E+05	5.0E+06	1.2E+06
98066	tert-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
630206	1,1,1,2-Tetrachloroethane		C	1.6E+04	2.4E+03	3.3E+04	4.8E+03	4.7E+04	6.8E+03	8.2E+04	1.2E+04	1.6E+05	2.4E+04
79345	1,1,2,2-Tetrachloroethane		C	2.1E+03	3.1E+02	4.2E+03	6.1E+02	6.0E+03	8.7E+02	1.0E+04	1.5E+03	2.1E+04	3.1E+03
127184	Tetrachloroethylene		C	4.1E+04	6.0E+03	8.1E+04	1.2E+04	1.2E+05	1.7E+04	2.0E+05	3.0E+04	4.1E+05	6.0E+04
108883	Toluene		NC	2.0E+05	5.3E+04	4.0E+05	1.1E+05	5.7E+05	1.5E+05	1.0E+06	2.7E+05	2.0E+06	5.3E+05
156605	trans-1,2-Dichloroethylene	X	NC	3.5E+04	8.8E+03	7.0E+04	1.8E+04	1.0E+05	2.5E+04	1.8E+05	4.4E+04	3.5E+05	8.8E+04
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	1.5E+07	2.0E+06	3.0E+07	3.9E+06	4.3E+07	5.6E+06	7.5E+07	9.8E+06	1.5E+08	2.0E+07
120821	1,2,4-Trichlorobenzene		NC	1.0E+05	1.3E+04	2.0E+05	2.7E+04	2.9E+05	3.8E+04	5.0E+05	6.7E+04	1.0E+06	1.3E+05
79005	1,1,2-Trichloroethane		C	7.6E+03	1.4E+03	1.5E+04	2.8E+03	2.2E+04	4.0E+03	3.8E+04	7.0E+03	7.6E+04	1.4E+04
71556	1,1,1-Trichloroethane		NC	1.1E+06	2.0E+05	2.2E+06	4.0E+05	3.1E+06	5.8E+05	5.5E+06	1.0E+06	1.1E+07	2.0E+06
79016	Trichloroethylene ^{††}	X	C	1.1E+03	2.1E+02	2.2E+03	4.1E+02	3.2E+03	5.9E+02	5.5E+03	1.0E+03	1.1E+04	2.1E+03
75694	Trichlorofluoromethane		NC	3.5E+05	6.2E+04	7.0E+05	1.2E+05	1.0E+06	1.8E+05	1.8E+06	3.1E+05	3.5E+06	6.2E+05
96184	1,2,3-Trichloropropane		NC	2.5E+03	4.1E+02	4.9E+03	8.1E+02	7.0E+03	1.2E+03	1.2E+04	2.0E+03	2.5E+04	4.1E+03
95636	1,2,4-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108678	1,3,5-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108054	Vinyl acetate		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
75014	Vinyl chloride (chloroethene)		C	1.4E+04	5.4E+03	2.8E+04	1.1E+04	4.0E+04	1.5E+04	6.9E+04	2.7E+04	1.4E+05	5.4E+04

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

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Table 3b-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (a)

Risk = 1×10^{-5}

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Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
83329	Acenaphthene	X	NC	**	**	**	**	**	**	**	**	**	**
75070	Acetaldehyde		NC	4.5E+03	2.5E+03	9.0E+03	5.0E+03	1.3E+04	7.1E+03	2.2E+04	1.2E+04	4.5E+04	2.5E+04
67641	Acetone	X	NC	1.8E+05	7.4E+04	3.5E+05	1.5E+05	5.0E+05	2.1E+05	8.8E+05	3.7E+05	1.8E+06	7.4E+05
75058	Acetonitrile		NC	3.0E+04	1.8E+04	6.0E+04	3.6E+04	8.6E+04	5.1E+04	1.5E+05	8.9E+04	3.0E+05	1.8E+05
98862	Acetophenone	X	NC	1.8E+05	3.6E+04	3.5E+05	7.1E+04	5.0E+05	1.0E+05	8.8E+05	1.8E+05	1.8E+06	3.6E+05
107028	Acrolein		NC	1.0E+01	4.4E+00	2.0E+01	8.7E+00	2.9E+01	1.2E+01	5.0E+01	2.2E+01	1.0E+02	4.4E+01
107131	Acrylonitrile		C	1.8E+02	8.3E+01	3.6E+02	1.7E+02	5.1E+02	2.4E+02	8.9E+02	4.1E+02	1.8E+03	8.3E+02
309002	Aldrin		C	2.5E+00	1.7E-01	5.0E+00	3.3E-01	7.1E+00	4.8E-01	1.2E+01	8.3E-01	2.5E+01	1.7E+00
319846	alpha-HCH (alpha-BHC)		C	6.8E+00	5.7E-01	1.4E+01	1.1E+00	1.9E+01	1.6E+00	3.4E+01	2.8E+00	6.8E+01	5.7E+00
100527	Benzaldehyde	X	NC	1.8E+05	4.0E+04	3.5E+05	8.1E+04	5.0E+05	1.2E+05	8.8E+05	2.0E+05	1.8E+06	4.0E+05
71432	Benzene		C	1.6E+03	4.9E+02	3.1E+03	9.8E+02	4.5E+03	1.4E+03	7.8E+03	2.4E+03	1.6E+04	4.9E+03
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**	**	**	**	**	**
100447	Benzylchloride	X	C	2.5E+02	4.8E+01	5.0E+02	9.7E+01	7.2E+02	1.4E+02	1.3E+03	2.4E+02	2.5E+03	4.8E+02
91587	beta-Chloronaphthalene	X	NC	1.4E+05	2.1E+04	**	**	**	**	**	**	**	**
92524	Biphenyl	X	NC	8.8E+04	1.4E+04	**	**	**	**	**	**	**	**
114444	Bis(2-chloroethoxy)ether		C	3.7E+01	6.3E+00	7.4E+01	1.3E+01	1.1E+02	1.8E+01	1.8E+02	3.2E+01	3.7E+02	6.3E+01
108601	Bis(2-chloroisopropyl)ether		C	1.2E+03	1.7E+02	2.4E+03	3.5E+02	3.5E+03	5.0E+02	6.1E+03	8.7E+02	1.2E+04	1.7E+03
542881	Bis(chloromethyl)ether		C	2.0E-01	4.2E-02	3.9E-01	8.4E-02	5.6E-01	1.2E-01	9.8E-01	2.1E-01	2.0E+00	4.2E-01
75274	Bromodichloromethane	X	C	6.9E+02	1.0E+02	1.4E+03	2.1E+02	2.0E+03	2.9E+02	3.4E+03	5.1E+02	6.9E+03	1.0E+03
75252	Bromoform		C	1.1E+04	1.1E+03	2.2E+04	2.1E+03	3.2E+04	3.1E+03	5.5E+04	5.4E+03	1.1E+05	1.1E+04
106990	1,3-Butadiene		C	4.3E+01	2.0E+01	8.7E+01	3.9E+01	1.2E+02	5.6E+01	2.2E+02	9.8E+01	4.3E+02	2.0E+02
75150	Carbon disulfide		NC	3.5E+05	1.1E+05	7.0E+05	2.2E+05	1.0E+06	3.2E+05	1.8E+06	5.6E+05	3.5E+06	1.1E+06
56235	Carbon tetrachloride		C	8.1E+02	1.3E+02	1.6E+03	2.6E+02	2.3E+03	3.7E+02	4.1E+03	6.5E+02	8.1E+03	1.3E+03
57749	Chlordane		C	**	**	**	**	**	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	3.5E+03	9.7E+02	7.0E+03	1.9E+03	1.0E+04	2.8E+03	1.8E+04	4.8E+03	3.5E+04	9.7E+03
108907	Chlorobenzene		NC	3.0E+04	6.5E+03	6.0E+04	1.3E+04	8.5E+04	1.8E+04	1.5E+05	3.2E+04	3.0E+05	6.5E+04
109693	1-Chlorobutane	X	NC	7.0E+05	1.8E+05	1.4E+06	3.7E+05	2.0E+06	5.3E+05	3.5E+06	9.2E+05	7.0E+06	1.8E+06
124481	Chlorodibromomethane	X	C	5.1E+02	6.0E+01	1.0E+03	1.2E+02	1.4E+03	1.7E+02	2.5E+03	3.0E+02	5.1E+03	6.0E+02
75456	Chlorodifluoromethane		NC	**	**	**	**	**	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	5.0E+06	1.9E+06	1.0E+07	3.8E+06	1.4E+07	5.4E+06	2.5E+07	9.5E+06	5.0E+07	1.9E+07
67663	Chloroform		C	5.3E+02	1.1E+02	1.1E+03	2.2E+02	1.5E+03	3.1E+02	2.6E+03	5.4E+02	5.3E+03	1.1E+03
95578	2-Chlorophenol	X	NC	8.8E+03	1.7E+03	1.8E+04	3.3E+03	2.5E+04	4.8E+03	4.4E+04	8.3E+03	8.8E+04	1.7E+04
75296	2-Chloropropane		NC	5.1E+04	1.6E+04	1.0E+05	3.2E+04	1.5E+05	4.5E+04	2.5E+05	7.9E+04	5.1E+05	1.6E+05
218019	Chrysene	X	C	**	**	**	**	**	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	1.8E+04	4.4E+03	3.5E+04	8.8E+03	5.0E+04	1.3E+04	8.8E+04	2.2E+04	1.8E+05	4.4E+04
123739	Crotonaldehyde (2-butenal)	X	C	2.2E+01	7.8E+00	4.5E+01	1.6E+01	6.4E+01	2.2E+01	1.1E+02	3.9E+01	2.2E+02	7.8E+01
98828	Cumene		NC	2.0E+05	4.1E+04	4.0E+05	8.1E+04	5.7E+05	1.2E+05	1.0E+06	2.0E+05	2.0E+06	4.1E+05
72559	DDE	X	C	**	**	**	**	**	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	1.0E+02	1.0E+01	2.0E+02	2.1E+01	2.9E+02	3.0E+01	5.0E+02	5.2E+01	1.0E+03	1.0E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.5E+01	7.2E+00	1.1E+02	1.4E+01	1.6E+02	2.1E+01	2.8E+02	3.6E+01	5.5E+02	7.2E+01
541731	1,3-Dichlorobenzene	X	NC	5.3E+04	8.7E+03	1.1E+05	1.7E+04	1.5E+05	2.5E+04	2.6E+05	4.4E+04	5.3E+05	8.7E+04

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Table 3b-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (a)

Risk = 1×10^{-5}

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Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
95501	1,2-Dichlorobenzene		NC	1.0E+05	1.7E+04	2.0E+05	3.3E+04	2.9E+05	4.8E+04	5.0E+05	8.3E+04	1.0E+06	1.7E+05
106467	1,4-Dichlorobenzene		NC	4.0E+05	6.7E+04	8.0E+05	1.3E+05	1.1E+06	1.9E+05	2.0E+06	3.3E+05	4.0E+06	6.7E+05
75718	Dichlorodifluoromethane		NC	1.0E+05	2.0E+04	2.0E+05	4.0E+04	2.9E+05	5.8E+04	5.0E+05	1.0E+05	1.0E+06	2.0E+05
75343	1,1-Dichloroethane		NC	2.5E+05	6.2E+04	5.0E+05	1.2E+05	7.1E+05	1.8E+05	1.3E+06	3.1E+05	2.5E+06	6.2E+05
107062	1,2-Dichloroethane		C	4.7E+02	1.2E+02	9.4E+02	2.3E+02	1.3E+03	3.3E+02	2.3E+03	5.8E+02	4.7E+03	1.2E+03
75354	1,1-Dichloroethylene		NC	1.0E+05	2.5E+04	2.0E+05	5.0E+04	2.9E+05	7.2E+04	5.0E+05	1.3E+05	1.0E+06	2.5E+05
78875	1,2-Dichloropropane		NC	2.0E+03	4.3E+02	4.0E+03	8.7E+02	5.7E+03	1.2E+03	1.0E+04	2.2E+03	2.0E+04	4.3E+03
542756	1,3-Dichloropropene		C	3.0E+03	6.7E+02	6.1E+03	1.3E+03	8.7E+03	1.9E+03	1.5E+04	3.4E+03	3.0E+04	6.7E+03
60571	Dieldrin		C	2.6E+00	1.7E-01	5.3E+00	3.4E-01	7.6E+00	4.9E-01	1.3E+01	8.5E-01	2.6E+01	1.7E+00
115297	Endosulfan	X	NC	**	**	**	**	**	**	**	**	**	**
108898	Epichlorohydrin		NC	5.0E+02	1.3E+02	1.0E+03	2.6E+02	1.4E+03	3.8E+02	2.5E+03	6.6E+02	5.0E+03	1.3E+03
60297	Ethyl ether	X	NC	3.5E+05	1.2E+05	7.0E+05	2.3E+05	1.0E+06	3.3E+05	1.8E+06	5.8E+05	3.5E+06	1.2E+06
141786	Ethylacetate	X	NC	1.6E+06	4.4E+05	3.2E+06	8.7E+05	4.5E+06	1.2E+06	7.9E+06	2.2E+06	1.6E+07	4.4E+06
100414	Ethylbenzene		C	1.1E+04	2.5E+03	2.2E+04	5.1E+03	3.2E+04	7.3E+03	5.5E+04	1.3E+04	1.1E+05	2.5E+04
75218	Ethylene oxide		C	1.2E+02	6.8E+01	2.4E+02	1.4E+02	3.5E+02	1.9E+02	6.1E+02	3.4E+02	1.2E+03	6.8E+02
97632	Ethylmethacrylate	X	NC	1.6E+05	3.4E+04	3.2E+05	6.8E+04	4.5E+05	9.6E+04	7.9E+05	1.7E+05	1.6E+06	3.4E+05
86737	Fluorene	X	NC	**	**	**	**	**	**	**	**	**	**
110009	Furan	X	NC	1.8E+03	6.3E+02	3.5E+03	1.3E+03	5.0E+03	1.8E+03	8.8E+03	3.1E+03	1.8E+04	6.3E+03
58899	gamma-HCH (Lindane)	X	C	3.3E+01	2.8E+00	6.6E+01	5.5E+00	9.4E+01	7.9E+00	1.6E+02	1.4E+01	3.3E+02	2.8E+01
76448	Heptachlor		C	9.4E+00	6.1E-01	1.9E+01	1.2E+00	2.7E+01	1.8E+00	4.7E+01	3.1E+00	9.4E+01	6.1E+00
87683	Hexachloro-1,3-butadiene		C	5.5E+02	5.2E+01	1.1E+03	1.0E+02	1.6E+03	1.5E+02	2.8E+03	2.6E+02	5.5E+03	5.2E+02
118741	Hexachlorobenzene		C	2.6E+01	2.3E+00	5.3E+01	4.5E+00	7.6E+01	6.5E+00	1.3E+02	1.1E+01	2.6E+02	2.3E+01
77474	Hexachlorocyclopentadiene		NC	1.0E+02	9.0E+00	2.0E+02	1.8E+01	2.9E+02	2.6E+01	5.0E+02	4.5E+01	1.0E+03	9.0E+01
67721	Hexachloroethane		C	3.0E+03	3.1E+02	6.1E+03	6.3E+02	8.7E+03	9.0E+02	1.5E+04	1.6E+03	3.0E+04	3.1E+03
110543	Hexane		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
74908	Hydrogen cyanide		NC	1.5E+03	1.4E+03	3.0E+03	2.7E+03	4.3E+03	3.9E+03	7.5E+03	6.8E+03	1.5E+04	1.4E+04
78831	Isobutanol	X	NC	5.3E+05	1.7E+05	1.1E+06	3.5E+05	1.5E+06	5.0E+05	2.6E+06	8.7E+05	5.3E+06	1.7E+06
7439976	Mercury (elemental)		NC	1.5E+02	1.8E+01	3.0E+02	3.7E+01	4.3E+02	5.2E+01	7.5E+02	9.1E+01	1.5E+03	1.8E+02
126987	Methacrylonitrile		NC	3.5E+02	1.3E+02	7.0E+02	2.6E+02	1.0E+03	3.6E+02	1.8E+03	6.4E+02	3.5E+03	1.3E+03
72435	Methoxychlor	X	NC	**	**	**	**	**	**	**	**	**	**
79209	Methyl acetate	X	NC	1.8E+06	5.8E+05	3.5E+06	1.2E+06	5.0E+06	1.7E+06	8.8E+06	2.9E+06	**	**
96333	Methyl acrylate	X	NC	5.3E+04	1.5E+04	1.1E+05	3.0E+04	1.5E+05	4.3E+04	2.6E+05	7.5E+04	5.3E+05	1.5E+05
74839	Methyl bromide		NC	2.5E+03	6.4E+02	5.0E+03	1.3E+03	7.1E+03	1.8E+03	1.3E+04	3.2E+03	2.5E+04	6.4E+03
74873	Methyl chloride (chloromethane)		C	1.2E+04	5.9E+03	2.4E+04	1.2E+04	3.5E+04	1.7E+04	6.1E+04	2.9E+04	1.2E+05	5.9E+04
108872	Methylcyclohexane		NC	1.5E+06	3.7E+05	3.0E+06	7.5E+05	4.3E+06	1.1E+06	7.5E+06	1.9E+06	1.5E+07	3.7E+06
74953	Methylene bromide	X	NC	1.8E+04	2.5E+03	3.5E+04	4.9E+03	5.0E+04	7.0E+03	8.8E+04	1.2E+04	1.8E+05	2.5E+04
75092	Methylene chloride		C	2.6E+04	7.5E+03	5.2E+04	1.5E+04	7.4E+04	2.1E+04	1.3E+05	3.7E+04	2.6E+05	7.5E+04
78933	Methylethylketone (2-butanone)		NC	5.0E+05	1.7E+05	1.0E+06	3.4E+05	1.4E+06	4.8E+05	2.5E+06	8.5E+05	5.0E+06	1.7E+06
108101	Methylisobutylketone		NC	4.0E+04	9.8E+03	8.0E+04	2.0E+04	1.1E+05	2.8E+04	2.0E+05	4.9E+04	4.0E+05	9.8E+04
80626	Methylmethacrylate		NC	3.5E+05	8.6E+04	7.0E+05	1.7E+05	1.0E+06	2.4E+05	1.8E+06	4.3E+05	3.5E+06	8.6E+05
91576	2-Methylnaphthalene	X	NC	3.5E+04	6.0E+03	7.0E+04	1.2E+04	1.0E+05	1.7E+04	1.8E+05	3.0E+04	3.5E+05	6.0E+04
1634044	MTBE		NC	1.5E+06	4.2E+05	3.0E+06	8.3E+05	4.3E+06	1.2E+06	7.5E+06	2.1E+06	1.5E+07	4.2E+06

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Table 3b-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

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Risk = 1×10^{-5}

Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
108383	m-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
91203	Naphthalene		NC	1.5E+03	2.9E+02	3.0E+03	5.7E+02	4.3E+03	8.2E+02	7.5E+03	1.4E+03	1.5E+04	2.9E+03
104518	n-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
98953	Nitrobenzene		NC	1.0E+03	2.0E+02	2.0E+03	4.0E+02	2.9E+03	5.7E+02	5.0E+03	9.9E+02	1.0E+04	2.0E+03
79469	2-Nitropropane		C	4.5E+00	1.2E+00	9.0E+00	2.5E+00	1.3E+01	3.5E+00	2.3E+01	6.2E+00	4.5E+01	1.2E+01
924163	N-Nitroso-di-n-butylamine		C	7.6E+00	1.2E+00	1.5E+01	2.4E+00	2.2E+01	3.4E+00	3.8E+01	5.9E+00	7.6E+01	1.2E+01
103651	n-Propylbenzene	X	NC	7.0E+04	1.4E+04	1.4E+05	2.8E+04	2.0E+05	4.1E+04	3.5E+05	7.1E+04	7.0E+05	1.4E+05
88722	o-Nitrotoluene	X	NC	1.8E+04	3.1E+03	3.5E+04	6.2E+03	5.0E+04	8.9E+03	8.8E+04	1.6E+04	1.8E+05	3.1E+04
95476	o-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
106423	p-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
129000	Pyrene	X	NC	**	**	**	**	**	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
100425	Styrene		NC	5.0E+05	1.2E+05	1.0E+06	2.3E+05	1.4E+06	3.4E+05	2.5E+06	5.9E+05	5.0E+06	1.2E+06
98066	tert-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
630206	1,1,1,2-Tetrachloroethane		C	1.6E+03	2.4E+02	3.3E+03	4.8E+02	4.7E+03	6.8E+02	8.2E+03	1.2E+03	1.6E+04	2.4E+03
79345	1,1,2,2-Tetrachloroethane		C	2.1E+02	3.1E+01	4.2E+02	6.1E+01	6.0E+02	8.7E+01	1.0E+03	1.5E+02	2.1E+03	3.1E+02
127184	Tetrachloroethylene		C	4.1E+03	6.0E+02	8.1E+03	1.2E+03	1.2E+04	1.7E+03	2.0E+04	3.0E+03	4.1E+04	6.0E+03
108883	Toluene		NC	2.0E+05	5.3E+04	4.0E+05	1.1E+05	5.7E+05	1.5E+05	1.0E+06	2.7E+05	2.0E+06	5.3E+05
156605	trans-1,2-Dichloroethylene	X	NC	3.5E+04	8.8E+03	7.0E+04	1.8E+04	1.0E+05	2.5E+04	1.8E+05	4.4E+04	3.5E+05	8.8E+04
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	1.5E+07	2.0E+06	3.0E+07	3.9E+06	4.3E+07	5.6E+06	7.5E+07	9.8E+06	1.5E+08	2.0E+07
120821	1,2,4-Trichlorobenzene		NC	1.0E+05	1.3E+04	2.0E+05	2.7E+04	2.9E+05	3.8E+04	5.0E+05	6.7E+04	1.0E+06	1.3E+05
79005	1,1,2-Trichloroethane		C	7.6E+02	1.4E+02	1.5E+03	2.8E+02	2.2E+03	4.0E+02	3.8E+03	7.0E+02	7.6E+03	1.4E+03
71556	1,1,1-Trichloroethane		NC	1.1E+06	2.0E+05	2.2E+06	4.0E+05	3.1E+06	5.8E+05	5.5E+06	1.0E+06	1.1E+07	2.0E+06
79016	Trichloroethylene ^{††}	X	C	1.1E+02	2.1E+01	2.2E+02	4.1E+01	3.2E+02	5.9E+01	5.5E+02	1.0E+02	1.1E+03	2.1E+02
75694	Trichlorofluoromethane		NC	3.5E+05	6.2E+04	7.0E+05	1.2E+05	1.0E+06	1.8E+05	1.8E+06	3.1E+05	3.5E+06	6.2E+05
96184	1,2,3-Trichloropropane		NC	2.5E+03	4.1E+02	4.9E+03	8.1E+02	7.0E+03	1.2E+03	1.2E+04	2.0E+03	2.5E+04	4.1E+03
95636	1,2,4-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108678	1,3,5-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108054	Vinyl acetate		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
75014	Vinyl chloride (chloroethene)		C	1.4E+03	5.4E+02	2.8E+03	1.1E+03	4.0E+03	1.5E+03	6.9E+03	2.7E+03	1.4E+04	5.4E+03

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

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Table 3c-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)Risk = 1×10^{-6}

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Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{\text{soil-gas}}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
83329	Acenaphthene	X	NC	**	**	**	**	**	**	**	**	**	**
75070	Acetaldehyde		C	5.5E+02	3.1E+02	1.1E+03	6.1E+02	1.6E+03	8.8E+02	2.8E+03	1.5E+03	5.5E+03	3.1E+03
67641	Acetone	X	NC	1.8E+05	7.4E+04	3.5E+05	1.5E+05	5.0E+05	2.1E+05	8.8E+05	3.7E+05	1.8E+06	7.4E+05
75058	Acetonitrile		NC	3.0E+04	1.8E+04	6.0E+04	3.6E+04	8.6E+04	5.1E+04	1.5E+05	8.9E+04	3.0E+05	1.8E+05
98862	Acetophenone	X	NC	1.8E+05	3.6E+04	3.5E+05	7.1E+04	5.0E+05	1.0E+05	8.8E+05	1.8E+05	1.8E+06	3.6E+05
107028	Acrolein		NC	1.0E+01	4.4E+00	2.0E+01	8.7E+00	2.9E+01	1.2E+01	5.0E+01	2.2E+01	1.0E+02	4.4E+01
107131	Acrylonitrile		C	1.8E+01	8.3E+00	3.6E+01	1.7E+01	5.1E+01	2.4E+01	8.9E+01	4.1E+01	1.8E+02	8.3E+01
309002	Aldrin		C	2.5E-01	1.7E-02	5.0E-01	3.3E-02	7.1E-01	4.8E-02	1.2E+00	8.3E-02	2.5E+00	1.7E-01
319846	alpha-HCH (alpha-BHC)		C	6.8E-01	5.7E-02	1.4E+00	1.1E-01	1.9E+00	1.6E-01	3.4E+00	2.8E-01	6.8E+00	5.7E-01
100527	Benzaldehyde	X	NC	1.8E+05	4.0E+04	3.5E+05	8.1E+04	5.0E+05	1.2E+05	8.8E+05	2.0E+05	1.8E+06	4.0E+05
71432	Benzene		C	1.6E+02	4.9E+01	3.1E+02	9.8E+01	4.5E+02	1.4E+02	7.8E+02	2.4E+02	1.6E+03	4.9E+02
205992	Benzo(b)fluoranthene	X	C	5.8E+00	5.6E-01	**	**	**	**	**	**	**	**
100447	Benzylchloride	X	C	2.5E+01	4.8E+00	5.0E+01	9.7E+00	7.2E+01	1.4E+01	1.3E+02	2.4E+01	2.5E+02	4.8E+01
91587	beta-Chloronaphthalene	X	NC	1.4E+05	2.1E+04	**	**	**	**	**	**	**	**
92524	Biphenyl	X	NC	8.8E+04	1.4E+04	**	**	**	**	**	**	**	**
114444	Bis(2-chloroethoxy)ether		C	3.7E+00	6.3E-01	7.4E+00	1.3E+00	1.1E+01	1.8E+00	1.8E+01	3.2E+00	3.7E+01	6.3E+00
108601	Bis(2-chloroisopropyl)ether		C	1.2E+02	1.7E+01	2.4E+02	3.5E+01	3.5E+02	5.0E+01	6.1E+02	8.7E+01	1.2E+03	1.7E+02
542881	Bis(chloromethyl)ether		C	2.0E-02	4.2E-03	3.9E-02	8.4E-03	5.6E-02	1.2E-02	9.8E-02	2.1E-02	2.0E-01	4.2E-02
75274	Bromodichloromethane	X	C	6.9E+01	1.0E+01	1.4E+02	2.1E+01	2.0E+02	2.9E+01	3.4E+02	5.1E+01	6.9E+02	1.0E+02
75252	Bromoform		C	1.1E+03	1.1E+02	2.2E+03	2.1E+02	3.2E+03	3.1E+02	5.5E+03	5.4E+02	1.1E+04	1.1E+03
106990	1,3-Butadiene		C	4.3E+00	2.0E+00	8.7E+00	3.9E+00	1.2E+01	5.6E+00	2.2E+01	9.8E+00	4.3E+01	2.0E+01
75150	Carbon disulfide		NC	3.5E+05	1.1E+05	7.0E+05	2.2E+05	1.0E+06	3.2E+05	1.8E+06	5.6E+05	3.5E+06	1.1E+06
56235	Carbon tetrachloride		C	8.1E+01	1.3E+01	1.6E+02	2.6E+01	2.3E+02	3.7E+01	4.1E+02	6.5E+01	8.1E+02	1.3E+02
57749	Chlordane		C	1.2E+01	7.3E-01	2.4E+01	1.5E+00	3.5E+01	2.1E+00	6.1E+01	3.6E+00	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	3.5E+03	9.7E+02	7.0E+03	1.9E+03	1.0E+04	2.8E+03	1.8E+04	4.8E+03	3.5E+04	9.7E+03
108907	Chlorobenzene		NC	3.0E+04	6.5E+03	6.0E+04	1.3E+04	8.5E+04	1.8E+04	1.5E+05	3.2E+04	3.0E+05	6.5E+04
109693	1-Chlorobutane	X	NC	7.0E+05	1.8E+05	1.4E+06	3.7E+05	2.0E+06	5.3E+05	3.5E+06	9.2E+05	7.0E+06	1.8E+06
124481	Chlorodibromomethane	X	C	5.1E+01	6.0E+00	1.0E+02	1.2E+01	1.4E+02	1.7E+01	2.5E+02	3.0E+01	5.1E+02	6.0E+01
75456	Chlorodifluoromethane		NC	**	**	**	**	**	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	5.0E+06	1.9E+06	1.0E+07	3.8E+06	1.4E+07	5.4E+06	2.5E+07	9.5E+06	5.0E+07	1.9E+07
67663	Chloroform		C	5.3E+01	1.1E+01	1.1E+02	2.2E+01	1.5E+02	3.1E+01	2.6E+02	5.4E+01	5.3E+02	1.1E+02
95578	2-Chlorophenol	X	NC	8.8E+03	1.7E+03	1.8E+04	3.3E+03	2.5E+04	4.8E+03	4.4E+04	8.3E+03	8.8E+04	1.7E+04
75296	2-Chloropropane		NC	5.1E+04	1.6E+04	1.0E+05	3.2E+04	1.5E+05	4.5E+04	2.5E+05	7.9E+04	5.1E+05	1.6E+05
218019	Chrysene	X	C	**	**	**	**	**	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	1.8E+04	4.4E+03	3.5E+04	8.8E+03	5.0E+04	1.3E+04	8.8E+04	2.2E+04	1.8E+05	4.4E+04
123739	Crotonaldehyde (2-butenal)	X	C	2.2E+00	7.8E-01	4.5E+00	1.6E+00	6.4E+00	2.2E+00	1.1E+01	3.9E+00	2.2E+01	7.8E+00
98828	Cumene		NC	2.0E+05	4.1E+04	4.0E+05	8.1E+04	5.7E+05	1.2E+05	1.0E+06	2.0E+05	2.0E+06	4.1E+05
72559	DDE	X	C	1.3E+01	9.6E-01	2.5E+01	1.9E+00	3.6E+01	2.8E+00	6.3E+01	4.8E+00	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	1.0E+02	1.0E+01	2.0E+02	2.1E+01	2.9E+02	3.0E+01	5.0E+02	5.2E+01	1.0E+03	1.0E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.5E+00	7.2E-01	1.1E+01	1.4E+00	1.6E+01	2.1E+00	2.8E+01	3.6E+00	5.5E+01	7.2E+00
541731	1,3-Dichlorobenzene	X	NC	5.3E+04	8.7E+03	1.1E+05	1.7E+04	1.5E+05	2.5E+04	2.6E+05	4.4E+04	5.3E+05	8.7E+04

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Table 3c-SG
November 20, 2002

Table 3c-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-6}

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Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
95501	1,2-Dichlorobenzene		NC	1.0E+05	1.7E+04	2.0E+05	3.3E+04	2.9E+05	4.8E+04	5.0E+05	8.3E+04	1.0E+06	1.7E+05
106467	1,4-Dichlorobenzene		NC	4.0E+05	6.7E+04	8.0E+05	1.3E+05	1.1E+06	1.9E+05	2.0E+06	3.3E+05	4.0E+06	6.7E+05
75718	Dichlorodifluoromethane		NC	1.0E+05	2.0E+04	2.0E+05	4.0E+04	2.9E+05	5.8E+04	5.0E+05	1.0E+05	1.0E+06	2.0E+05
75343	1,1-Dichloroethane		NC	2.5E+05	6.2E+04	5.0E+05	1.2E+05	7.1E+05	1.8E+05	1.3E+06	3.1E+05	2.5E+06	6.2E+05
107062	1,2-Dichloroethane		C	4.7E+01	1.2E+01	9.4E+01	2.3E+01	1.3E+02	3.3E+01	2.3E+02	5.8E+01	4.7E+02	1.2E+02
75354	1,1-Dichloroethylene		NC	1.0E+05	2.5E+04	2.0E+05	5.0E+04	2.9E+05	7.2E+04	5.0E+05	1.3E+05	1.0E+06	2.5E+05
78875	1,2-Dichloropropane		NC	2.0E+03	4.3E+02	4.0E+03	8.7E+02	5.7E+03	1.2E+03	1.0E+04	2.2E+03	2.0E+04	4.3E+03
542756	1,3-Dichloropropene		C	3.0E+02	6.7E+01	6.1E+02	1.3E+02	8.7E+02	1.9E+02	1.5E+03	3.4E+02	3.0E+03	6.7E+02
60571	Dieldrin		C	2.6E-01	1.7E-02	5.3E-01	3.4E-02	7.6E-01	4.9E-02	1.3E+00	8.5E-02	2.6E+00	1.7E-01
115297	Endosulfan	X	NC	**	**	**	**	**	**	**	**	**	**
108898	Epichlorohydrin		NC	5.0E+02	1.3E+02	1.0E+03	2.6E+02	1.4E+03	3.8E+02	2.5E+03	6.6E+02	5.0E+03	1.3E+03
60297	Ethyl ether	X	NC	3.5E+05	1.2E+05	7.0E+05	2.3E+05	1.0E+06	3.3E+05	1.8E+06	5.8E+05	3.5E+06	1.2E+06
141786	Ethylacetate	X	NC	1.6E+06	4.4E+05	3.2E+06	8.7E+05	4.5E+06	1.2E+06	7.9E+06	2.2E+06	1.6E+07	4.4E+06
100414	Ethylbenzene		C	1.1E+03	2.5E+02	2.2E+03	5.1E+02	3.2E+03	7.3E+02	5.5E+03	1.3E+03	1.1E+04	2.5E+03
75218	Ethylene oxide		C	1.2E+01	6.8E+00	2.4E+01	1.4E+01	3.5E+01	1.9E+01	6.1E+01	3.4E+01	1.2E+02	6.8E+01
97632	Ethylmethacrylate	X	NC	1.6E+05	3.4E+04	3.2E+05	6.8E+04	4.5E+05	9.6E+04	7.9E+05	1.7E+05	1.6E+06	3.4E+05
86737	Fluorene	X	NC	**	**	**	**	**	**	**	**	**	**
110009	Furan	X	NC	1.8E+03	6.3E+02	3.5E+03	1.3E+03	5.0E+03	1.8E+03	8.8E+03	3.1E+03	1.8E+04	6.3E+03
58899	gamma-HCH (Lindane)	X	C	3.3E+00	2.8E-01	6.6E+00	5.5E-01	9.4E+00	7.9E-01	1.6E+01	1.4E+00	3.3E+01	2.8E+00
76448	Heptachlor		C	9.4E-01	6.1E-02	1.9E+00	1.2E-01	2.7E+00	1.8E-01	4.7E+00	3.1E-01	9.4E+00	6.1E-01
87683	Hexachloro-1,3-butadiene		C	5.5E+01	5.2E+00	1.1E+02	1.0E+01	1.6E+02	1.5E+01	2.8E+02	2.6E+01	5.5E+02	5.2E+01
118741	Hexachlorobenzene		C	2.6E+00	2.3E-01	5.3E+00	4.5E-01	7.6E+00	6.5E-01	1.3E+01	1.1E+00	2.6E+01	2.3E+00
77474	Hexachlorocyclopentadiene		NC	1.0E+02	9.0E+00	2.0E+02	1.8E+01	2.9E+02	2.6E+01	5.0E+02	4.5E+01	1.0E+03	9.0E+01
67721	Hexachloroethane		C	3.0E+02	3.1E+01	6.1E+02	6.3E+01	8.7E+02	9.0E+01	1.5E+03	1.6E+02	3.0E+03	3.1E+02
110543	Hexane		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
74908	Hydrogen cyanide		NC	1.5E+03	1.4E+03	3.0E+03	2.7E+03	4.3E+03	3.9E+03	7.5E+03	6.8E+03	1.5E+04	1.4E+04
78831	Isobutanol	X	NC	5.3E+05	1.7E+05	1.1E+06	3.5E+05	1.5E+06	5.0E+05	2.6E+06	8.7E+05	5.3E+06	1.7E+06
7439976	Mercury (elemental)		NC	1.5E+02	1.8E+01	3.0E+02	3.7E+01	4.3E+02	5.2E+01	7.5E+02	9.1E+01	1.5E+03	1.8E+02
126987	Methacrylonitrile		NC	3.5E+02	1.3E+02	7.0E+02	2.6E+02	1.0E+03	3.6E+02	1.8E+03	6.4E+02	3.5E+03	1.3E+03
72435	Methoxychlor	X	NC	**	**	**	**	**	**	**	**	**	**
79209	Methyl acetate	X	NC	1.8E+06	5.8E+05	3.5E+06	1.2E+06	5.0E+06	1.7E+06	8.8E+06	2.9E+06	**	**
96333	Methyl acrylate	X	NC	5.3E+04	1.5E+04	1.1E+05	3.0E+04	1.5E+05	4.3E+04	2.6E+05	7.5E+04	5.3E+05	1.5E+05
74839	Methyl bromide		NC	2.5E+03	6.4E+02	5.0E+03	1.3E+03	7.1E+03	1.8E+03	1.3E+04	3.2E+03	2.5E+04	6.4E+03
74873	Methyl chloride (chloromethane)		C	1.2E+03	5.9E+02	2.4E+03	1.2E+03	3.5E+03	1.7E+03	6.1E+03	2.9E+03	1.2E+04	5.9E+03
108872	Methylcyclohexane		NC	1.5E+06	3.7E+05	3.0E+06	7.5E+05	4.3E+06	1.1E+06	7.5E+06	1.9E+06	1.5E+07	3.7E+06
74953	Methylene bromide	X	NC	1.8E+04	2.5E+03	3.5E+04	4.9E+03	5.0E+04	7.0E+03	8.8E+04	1.2E+04	1.8E+05	2.5E+04
75092	Methylene chloride		C	2.6E+03	7.5E+02	5.2E+03	1.5E+03	7.4E+03	2.1E+03	1.3E+04	3.7E+03	2.6E+04	7.5E+03
78933	Methylethylketone (2-butanone)		NC	5.0E+05	1.7E+05	1.0E+06	3.4E+05	1.4E+06	4.8E+05	2.5E+06	8.5E+05	5.0E+06	1.7E+06
108101	Methylisobutylketone		NC	4.0E+04	9.8E+03	8.0E+04	2.0E+04	1.1E+05	2.8E+04	2.0E+05	4.9E+04	4.0E+05	9.8E+04
80626	Methylmethacrylate		NC	3.5E+05	8.6E+04	7.0E+05	1.7E+05	1.0E+06	2.4E+05	1.8E+06	4.3E+05	3.5E+06	8.6E+05
91576	2-Methylnaphthalene	X	NC	3.5E+04	6.0E+03	7.0E+04	1.2E+04	1.0E+05	1.7E+04	1.8E+05	3.0E+04	3.5E+05	6.0E+04
1634044	MTBE		NC	1.5E+06	4.2E+05	3.0E+06	8.3E+05	4.3E+06	1.2E+06	7.5E+06	2.1E+06	1.5E+07	4.2E+06

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Table 3c-SG: Question 5 Soil Gas Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

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Risk = 1×10^{-6}

Target Soil Gas Concentrations for Different Attenuation Factors													
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 2 \times 10^{-3}$		$\alpha = 1 \times 10^{-3}$		$\alpha = 7 \times 10^{-4}$		$\alpha = 4 \times 10^{-4}$		$\alpha = 2 \times 10^{-4}$	
				$C_{soil-gas}$ (ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)	(ug/m ³)	(ppbv)
108383	m-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
91203	Naphthalene		NC	1.5E+03	2.9E+02	3.0E+03	5.7E+02	4.3E+03	8.2E+02	7.5E+03	1.4E+03	1.5E+04	2.9E+03
104518	n-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
98953	Nitrobenzene		NC	1.0E+03	2.0E+02	2.0E+03	4.0E+02	2.9E+03	5.7E+02	5.0E+03	9.9E+02	1.0E+04	2.0E+03
79469	2-Nitropropane		C	4.5E-01	1.2E-01	9.0E-01	2.5E-01	1.3E+00	3.5E-01	2.3E+00	6.2E-01	4.5E+00	1.2E+00
924163	N-Nitroso-di-n-butylamine		C	7.6E-01	1.2E-01	1.5E+00	2.4E-01	2.2E+00	3.4E-01	3.8E+00	5.9E-01	7.6E+00	1.2E+00
103651	n-Propylbenzene	X	NC	7.0E+04	1.4E+04	1.4E+05	2.8E+04	2.0E+05	4.1E+04	3.5E+05	7.1E+04	7.0E+05	1.4E+05
88722	o-Nitrotoluene	X	NC	1.8E+04	3.1E+03	3.5E+04	6.2E+03	5.0E+04	8.9E+03	8.8E+04	1.6E+04	1.8E+05	3.1E+04
95476	o-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
106423	p-Xylene	X	NC	3.5E+06	8.1E+05	7.0E+06	1.6E+06	1.0E+07	2.3E+06	1.8E+07	4.0E+06	3.5E+07	8.1E+06
129000	Pyrene	X	NC	**	**	**	**	**	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
100425	Styrene		NC	5.0E+05	1.2E+05	1.0E+06	2.3E+05	1.4E+06	3.4E+05	2.5E+06	5.9E+05	5.0E+06	1.2E+06
98066	tert-Butylbenzene	X	NC	7.0E+04	1.3E+04	1.4E+05	2.6E+04	2.0E+05	3.6E+04	3.5E+05	6.4E+04	7.0E+05	1.3E+05
630206	1,1,1,2-Tetrachloroethane		C	1.6E+02	2.4E+01	3.3E+02	4.8E+01	4.7E+02	6.8E+01	8.2E+02	1.2E+02	1.6E+03	2.4E+02
79345	1,1,2,2-Tetrachloroethane		C	2.1E+01	3.1E+00	4.2E+01	6.1E+00	6.0E+01	8.7E+00	1.0E+02	1.5E+01	2.1E+02	3.1E+01
127184	Tetrachloroethylene		C	4.1E+02	6.0E+01	8.1E+02	1.2E+02	1.2E+03	1.7E+02	2.0E+03	3.0E+02	4.1E+03	6.0E+02
108883	Toluene		NC	2.0E+05	5.3E+04	4.0E+05	1.1E+05	5.7E+05	1.5E+05	1.0E+06	2.7E+05	2.0E+06	5.3E+05
156605	trans-1,2-Dichloroethylene	X	NC	3.5E+04	8.8E+03	7.0E+04	1.8E+04	1.0E+05	2.5E+04	1.8E+05	4.4E+04	3.5E+05	8.8E+04
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	1.5E+07	2.0E+06	3.0E+07	3.9E+06	4.3E+07	5.6E+06	7.5E+07	9.8E+06	1.5E+08	2.0E+07
120821	1,2,4-Trichlorobenzene		NC	1.0E+05	1.3E+04	2.0E+05	2.7E+04	2.9E+05	3.8E+04	5.0E+05	6.7E+04	1.0E+06	1.3E+05
79005	1,1,2-Trichloroethane		C	7.6E+01	1.4E+01	1.5E+02	2.8E+01	2.2E+02	4.0E+01	3.8E+02	7.0E+01	7.6E+02	1.4E+02
71556	1,1,1-Trichloroethane		NC	1.1E+06	2.0E+05	2.2E+06	4.0E+05	3.1E+06	5.8E+05	5.5E+06	1.0E+06	1.1E+07	2.0E+06
79016	Trichloroethylene ^{††}	X	C	1.1E+01	2.1E+00	2.2E+01	4.1E+00	3.2E+01	5.9E+00	5.5E+01	1.0E+01	1.1E+02	2.1E+01
75694	Trichlorofluoromethane		NC	3.5E+05	6.2E+04	7.0E+05	1.2E+05	1.0E+06	1.8E+05	1.8E+06	3.1E+05	3.5E+06	6.2E+05
96184	1,2,3-Trichloropropane		NC	2.5E+03	4.1E+02	4.9E+03	8.1E+02	7.0E+03	1.2E+03	1.2E+04	2.0E+03	2.5E+04	4.1E+03
95636	1,2,4-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108678	1,3,5-Trimethylbenzene		NC	3.0E+03	6.1E+02	6.0E+03	1.2E+03	8.5E+03	1.7E+03	1.5E+04	3.0E+03	3.0E+04	6.1E+03
108054	Vinyl acetate		NC	1.0E+05	2.8E+04	2.0E+05	5.7E+04	2.9E+05	8.1E+04	5.0E+05	1.4E+05	1.0E+06	2.8E+05
75014	Vinyl chloride (chloroethene)		C	1.4E+02	5.4E+01	2.8E+02	1.1E+02	4.0E+02	1.5E+02	6.9E+02	2.7E+02	1.4E+03	5.4E+02

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

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Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-4}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
83329	Acenaphthene	X	NC	**	**	**	**	**
75070	Acetaldehyde		NC	4.0E+03	5.6E+03	9.3E+03	1.4E+04	2.8E+04
67641	Acetone	X	NC	3.2E+05	4.4E+05	7.4E+05	1.1E+06	2.2E+06
75058	Acetonitrile		NC	6.1E+04	8.5E+04	1.4E+05	2.1E+05	4.2E+05
98862	Acetophenone	X	NC	1.1E+06	1.6E+06	2.7E+06	4.0E+06	**
107028	Acrolein		NC	5.7E+00	8.0E+00	1.3E+01	2.0E+01	4.0E+01
107131	Acrylonitrile		NC	6.8E+02	9.5E+02	1.6E+03	2.4E+03	4.7E+03
309002	Aldrin		C	1.0E+01	1.4E+01	**	**	**
319846	alpha-HCH (alpha-BHC)		C	4.5E+02	6.2E+02	1.0E+03	1.6E+03	**
100527	Benzaldehyde	X	NC	5.1E+05	7.2E+05	1.2E+06	1.8E+06	**
71432	Benzene		C	2.0E+02	2.7E+02	4.6E+02	6.9E+02	1.4E+03
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**
100447	Benzylchloride	X	C	4.2E+02	5.9E+02	9.8E+02	1.5E+03	3.0E+03
91587	beta-Chloronaphthalene	X	NC	**	**	**	**	**
92524	Biphenyl	X	NC	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	1.4E+03	2.0E+03	3.3E+03	5.0E+03	1.0E+04
108601	Bis(2-chloroisopropyl)ether		C	7.3E+03	1.0E+04	1.7E+04	2.5E+04	5.1E+04
542881	Bis(chloromethyl)ether		C	6.4E-01	9.0E-01	1.5E+00	2.3E+00	4.5E+00
75274	Bromodichloromethane	X	C	3.0E+02	4.2E+02	7.0E+02	1.1E+03	2.1E+03
75252	Bromoform		C	1.2E+00	1.7E+00	2.8E+00	4.2E+00	8.3E+00
106990	1,3-Butadiene		C	4.1E-01	5.8E-01	9.6E-01	1.4E+00	2.9E+00
75150	Carbon disulfide		NC	8.1E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
56235	Carbon tetrachloride		C	1.9E+01	2.6E+01	4.3E+01	6.5E+01	1.3E+02
57749	Chlordane		NC	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
108907	Chlorobenzene		NC	5.6E+02	7.9E+02	1.3E+03	2.0E+03	3.9E+03
109693	1-Chlorobutane	X	NC	2.9E+03	4.0E+03	6.7E+03	1.0E+04	2.0E+04
124481	Chlorodibromomethane	X	C	4.5E+02	6.3E+02	1.1E+03	1.6E+03	3.2E+03
75456	Chlorodifluoromethane		NC	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	4.0E+04	5.5E+04	9.2E+04	1.4E+05	2.8E+05
67663	Chloroform		C	1.0E+02	1.4E+02	2.3E+02	3.5E+02	7.0E+02
95578	2-Chlorophenol	X	NC	1.6E+03	2.2E+03	3.6E+03	5.5E+03	1.1E+04
75296	2-Chloropropane		NC	2.4E+02	3.4E+02	5.7E+02	8.6E+02	1.7E+03

Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-4}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
218019	Chrysene	X	*	*	*	*	*	*
156592	cis-1,2-Dichloroethylene	X	NC	3.0E+02	4.2E+02	7.0E+02	1.0E+03	2.1E+03
123739	Crotonaldehyde (2-butenal)	X	C	8.0E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
98828	Cumene		NC	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
72559	DDE	X	C	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	4.8E+01	6.7E+01	1.1E+02	1.7E+02	3.3E+02
106934	1,2-Dibromoethane (ethylene dibromide)		NC	9.4E+00	1.3E+01	2.2E+01	3.3E+01	6.6E+01
541731	1,3-Dichlorobenzene	X	NC	1.2E+03	1.7E+03	2.8E+03	4.1E+03	8.3E+03
95501	1,2-Dichlorobenzene		NC	3.7E+03	5.1E+03	8.6E+03	1.3E+04	2.6E+04
106467	1,4-Dichlorobenzene		NC	1.2E+04	1.6E+04	2.7E+04	4.1E+04	**
75718	Dichlorodifluoromethane		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
75343	1,1-Dichloroethane		NC	3.1E+03	4.4E+03	7.3E+03	1.1E+04	2.2E+04
107062	1,2-Dichloroethane		C	3.3E+02	4.7E+02	7.8E+02	1.2E+03	2.3E+03
75354	1,1-Dichloroethylene		NC	2.7E+02	3.7E+02	6.2E+02	9.4E+02	1.9E+03
78875	1,2-Dichloropropane		NC	5.0E+01	7.0E+01	1.2E+02	1.7E+02	3.5E+02
542756	1,3-Dichloropropene		NC	3.9E+01	5.5E+01	9.2E+01	1.4E+02	2.8E+02
60571	Dieldrin		C	1.2E+02	1.7E+02	**	**	**
115297	Endosulfan	X	NC	**	**	**	**	**
106898	Epichlorohydrin		NC	1.1E+03	1.6E+03	2.7E+03	4.0E+03	8.0E+03
60297	Ethyl ether	X	NC	7.4E+02	1.0E+03	1.7E+03	2.6E+03	5.2E+03
141786	Ethylacetate	X	NC	8.0E+05	1.1E+06	1.9E+06	2.8E+06	5.6E+06
100414	Ethylbenzene		C	9.8E+02	1.4E+03	2.3E+03	3.4E+03	6.9E+03
75218	Ethylene oxide		C	1.5E+02	2.1E+02	3.6E+02	5.4E+02	1.1E+03
97632	Ethylmethacrylate	X	NC	1.3E+04	1.8E+04	3.0E+04	4.6E+04	9.1E+04
86737	Fluorene	X	NC	**	**	**	**	**
110009	Furan	X	NC	2.3E+01	3.2E+01	5.3E+01	7.9E+01	1.6E+02
58899	gamma-HCH (Lindane)	X	C	1.6E+03	2.3E+03	3.8E+03	5.7E+03	**
76448	Heptachlor		C	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †
87683	Hexachloro-1,3-butadiene		C	4.7E+01	6.6E+01	1.1E+02	1.7E+02	3.3E+02
118741	Hexachlorobenzene		C	**	**	**	**	**
77474	Hexachlorocyclopentadiene		NC	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †
67721	Hexachloroethane		C	5.5E+02	7.6E+02	1.3E+03	1.9E+03	3.8E+03

Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-4}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
110543	Hexane		NC	4.2E+00	5.9E+00	9.8E+00	1.5E+01	2.9E+01
74908	Hydrogen cyanide		NC	7.9E+02	1.1E+03	1.8E+03	2.8E+03	5.5E+03
78831	Isobutanol	X	NC	3.1E+06	4.4E+06	7.3E+06	1.1E+07	2.2E+07
7439976	Mercury (elemental)		NC	9.7E-01	1.4E+00	2.3E+00	3.4E+00	6.8E+00
126987	Methacrylonitrile		NC	9.9E+01	1.4E+02	2.3E+02	3.5E+02	6.9E+02
72435	Methoxychlor	X	NC	**	**	**	**	**
79209	Methyl acetate	X	NC	1.0E+06	1.4E+06	**	**	**
96333	Methyl acrylate	X	NC	2.0E+04	2.7E+04	4.6E+04	6.8E+04	1.4E+05
74839	Methyl bromide		NC	2.8E+01	3.9E+01	6.5E+01	9.8E+01	2.0E+02
74873	Methyl chloride (chloromethane)		NC	3.6E+02	5.0E+02	8.3E+02	1.2E+03	2.5E+03
108872	Methylcyclohexane		NC	1.0E+03	1.4E+03	2.4E+03	3.6E+03	7.1E+03
74953	Methylene bromide	X	NC	1.4E+03	2.0E+03	3.3E+03	5.0E+03	9.9E+03
75092	Methylene chloride		C	8.3E+03	1.2E+04	1.9E+04	2.9E+04	5.8E+04
78933	Methylethylketone (2-butanone)		NC	6.2E+05	8.7E+05	1.5E+06	2.2E+06	4.4E+06
108101	Methylisobutylketone		NC	2.0E+04	2.8E+04	4.7E+04	7.1E+04	1.4E+05
80626	Methylmethacrylate		NC	7.3E+04	1.0E+05	1.7E+05	2.5E+05	5.1E+05
91576	2-Methylnaphthalene	X	NC	4.7E+03	6.6E+03	1.1E+04	1.7E+04	**
1634044	MTBE		NC	1.7E+05	2.3E+05	3.9E+05	5.9E+05	1.2E+06
108383	m-Xylene	X	NC	3.3E+04	4.7E+04	7.8E+04	1.2E+05	**
91203	Naphthalene		NC	2.2E+02	3.0E+02	5.1E+02	7.6E+02	1.5E+03
104518	n-Butylbenzene	X	NC	3.7E+02	5.2E+02	8.7E+02	1.3E+03	**
98953	Nitrobenzene		NC	2.9E+03	4.1E+03	6.8E+03	1.0E+04	2.0E+04
79469	2-Nitropropane		C	2.6E+01	3.6E+01	6.0E+01	9.0E+01	1.8E+02
924163	N-Nitroso-di-n-butylamine		C	1.7E+01	2.4E+01	3.9E+01	5.9E+01	1.2E+02
103651	n-Propylbenzene	X	NC	4.6E+02	6.4E+02	1.1E+03	1.6E+03	3.2E+03
88722	o-Nitrotoluene	X	NC	9.8E+04	1.4E+05	2.3E+05	3.4E+05	**
95476	o-Xylene	X	NC	4.7E+04	6.6E+04	1.1E+05	1.6E+05	**
106423	p-Xylene	X	NC	3.2E+04	4.5E+04	7.4E+04	1.1E+05	**
129000	Pyrene	X	NC	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	3.5E+02	4.9E+02	8.2E+02	1.2E+03	2.5E+03
100425	Styrene		NC	1.3E+04	1.8E+04	3.0E+04	4.4E+04	8.9E+04
98066	tert-Butylbenzene	X	NC	4.1E+02	5.8E+02	9.6E+02	1.4E+03	2.9E+03
630206	1,1,1,2-Tetrachloroethane		C	4.7E+02	6.6E+02	1.1E+03	1.7E+03	3.3E+03

Table 3a - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-4}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
79345	1,1,2,2-Tetrachloroethane		C	4.2E+02	5.9E+02	9.9E+02	1.5E+03	3.0E+03
127184	Tetrachloroethylene		C	1.5E+02	2.2E+02	3.6E+02	5.4E+02	1.1E+03
108883	Toluene		NC	2.1E+03	2.9E+03	4.9E+03	7.4E+03	1.5E+04
156605	trans-1,2-Dichloroethylene	X	NC	2.6E+02	3.6E+02	6.1E+02	9.1E+02	1.8E+03
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	2.2E+03	3.1E+03	5.1E+03	7.7E+03	1.5E+04
120821	1,2,4-Trichlorobenzene		NC	4.9E+03	6.9E+03	1.1E+04	1.7E+04	3.4E+04
79005	1,1,2-Trichloroethane		C	5.8E+02	8.1E+02	1.4E+03	2.0E+03	4.1E+03
71556	1,1,1-Trichloroethane		NC	4.5E+03	6.3E+03	1.0E+04	1.6E+04	3.1E+04
79016	Trichloroethylene ^{††}	X	C	7.5E+00	1.1E+01	1.8E+01	2.6E+01	5.3E+01
75694	Trichlorofluoromethane		NC	2.5E+02	3.5E+02	5.9E+02	8.8E+02	1.8E+03
96184	1,2,3-Trichloropropane		NC	4.2E+02	5.9E+02	9.8E+02	1.5E+03	2.9E+03
95636	1,2,4-Trimethylbenzene		NC	3.4E+01	4.7E+01	7.9E+01	1.2E+02	2.4E+02
108678	1,3,5-Trimethylbenzene		NC	3.5E+01	4.9E+01	8.2E+01	1.2E+02	2.5E+02
108054	Vinyl acetate		NC	1.4E+04	1.9E+04	3.2E+04	4.8E+04	9.6E+04
75014	Vinyl chloride (chloroethene)		C	3.6E+01	5.0E+01	8.3E+01	1.3E+02	2.5E+02

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

† The target groundwater concentrations is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-5}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
83329	Acenaphthene	X	NC	**	**	**	**	**
75070	Acetaldehyde		NC	4.0E+03	5.6E+03	9.3E+03	1.4E+04	2.8E+04
67641	Acetone	X	NC	3.2E+05	4.4E+05	7.4E+05	1.1E+06	2.2E+06
75058	Acetonitrile		NC	6.1E+04	8.5E+04	1.4E+05	2.1E+05	4.2E+05
98862	Acetophenone	X	NC	1.1E+06	1.6E+06	2.7E+06	4.0E+06	**
107028	Acrolein		NC	5.7E+00	8.0E+00	1.3E+01	2.0E+01	4.0E+01
107131	Acrylonitrile		C	1.2E+02	1.7E+02	2.8E+02	4.2E+02	8.5E+02
309002	Aldrin		C	1.0E+00	1.4E+00	2.4E+00	3.6E+00	7.1E+00
319846	alpha-HCH (alpha-BHC)		C	4.5E+01	6.2E+01	1.0E+02	1.6E+02	3.1E+02
100527	Benzaldehyde	X	NC	5.1E+05	7.2E+05	1.2E+06	1.8E+06	**
71432	Benzene		C	2.0E+01	2.7E+01	4.6E+01	6.9E+01	1.4E+02
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**
100447	Benzylchloride	X	C	4.2E+01	5.9E+01	9.8E+01	1.5E+02	3.0E+02
91587	beta-Chloronaphthalene	X	NC	**	**	**	**	**
92524	Biphenyl	X	NC	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	1.4E+02	2.0E+02	3.3E+02	5.0E+02	1.0E+03
108601	Bis(2-chloroisopropyl)ether		C	7.3E+02	1.0E+03	1.7E+03	2.5E+03	5.1E+03
542881	Bis(chloromethyl)ether		C	6.4E-02	9.0E-02	1.5E-01	2.3E-01	4.5E-01
75274	Bromodichloromethane	X	C	3.0E+01	4.2E+01	7.0E+01	1.1E+02	2.1E+02
75252	Bromoform		C	1.2E-01	1.7E-01	2.8E-01	4.2E-01	8.3E-01
106990	1,3-Butadiene		C	4.1E-02	5.8E-02	9.6E-02	1.4E-01	2.9E-01
75150	Carbon disulfide		NC	8.1E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
56235	Carbon tetrachloride		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	6.5E+00	1.3E+01
57749	Chlordane		C	**	**	**	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
108907	Chlorobenzene		NC	5.6E+02	7.9E+02	1.3E+03	2.0E+03	3.9E+03
109693	1-Chlorobutane	X	NC	2.9E+03	4.0E+03	6.7E+03	1.0E+04	2.0E+04
124481	Chlorodibromomethane	X	C	4.5E+01	6.3E+01	1.1E+02	1.6E+02	3.2E+02
75456	Chlorodifluoromethane		NC	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	4.0E+04	5.5E+04	9.2E+04	1.4E+05	2.8E+05
67663	Chloroform		C	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †
95578	2-Chlorophenol	X	NC	1.6E+03	2.2E+03	3.6E+03	5.5E+03	1.1E+04
75296	2-Chloropropane		NC	2.4E+02	3.4E+02	5.7E+02	8.6E+02	1.7E+03

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-5}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
218019	Chrysene	X	C	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	3.0E+02	4.2E+02	7.0E+02	1.0E+03	2.1E+03
123739	Crotonaldehyde (2-butenal)	X	C	8.0E+01	1.1E+02	1.9E+02	2.8E+02	5.6E+02
98828	Cumene		NC	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
72559	DDE	X	C	**	**	**	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	4.8E+01	6.7E+01	1.1E+02	1.7E+02	3.3E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.2E+00	7.3E+00	1.2E+01	1.8E+01	3.6E+01
541731	1,3-Dichlorobenzene	X	NC	1.2E+03	1.7E+03	2.8E+03	4.1E+03	8.3E+03
95501	1,2-Dichlorobenzene		NC	3.7E+03	5.1E+03	8.6E+03	1.3E+04	2.6E+04
106467	1,4-Dichlorobenzene		NC	1.2E+04	1.6E+04	2.7E+04	4.1E+04	**
75718	Dichlorodifluoromethane		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
75343	1,1-Dichloroethane		NC	3.1E+03	4.4E+03	7.3E+03	1.1E+04	2.2E+04
107062	1,2-Dichloroethane		C	3.3E+01	4.7E+01	7.8E+01	1.2E+02	2.3E+02
75354	1,1-Dichloroethylene		NC	2.7E+02	3.7E+02	6.2E+02	9.4E+02	1.9E+03
78875	1,2-Dichloropropane		NC	5.0E+01	7.0E+01	1.2E+02	1.7E+02	3.5E+02
542756	1,3-Dichloropropene		C	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
60571	Dieldrin		C	1.2E+01	1.7E+01	2.9E+01	4.3E+01	8.6E+01
115297	Endosulfan	X	NC	**	**	**	**	**
106898	Epichlorohydrin		NC	1.1E+03	1.6E+03	2.7E+03	4.0E+03	8.0E+03
60297	Ethyl ether	X	NC	7.4E+02	1.0E+03	1.7E+03	2.6E+03	5.2E+03
141786	Ethylacetate	X	NC	8.0E+05	1.1E+06	1.9E+06	2.8E+06	5.6E+06
100414	Ethylbenzene		C	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †
75218	Ethylene oxide		C	1.5E+01	2.1E+01	3.6E+01	5.4E+01	1.1E+02
97632	Ethylmethacrylate	X	NC	1.3E+04	1.8E+04	3.0E+04	4.6E+04	9.1E+04
86737	Fluorene	X	NC	**	**	**	**	**
110009	Furan	X	NC	2.3E+01	3.2E+01	5.3E+01	7.9E+01	1.6E+02
58899	gamma-HCH (Lindane)	X	C	1.6E+02	2.3E+02	3.8E+02	5.7E+02	1.1E+03
76448	Heptachlor		C	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †
87683	Hexachloro-1,3-butadiene		C	4.7E+00	6.6E+00	1.1E+01	1.7E+01	3.3E+01
118741	Hexachlorobenzene		C	1.4E+00	2.0E+00	3.3E+00	4.9E+00	**
77474	Hexachlorocyclopentadiene		NC	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †
67721	Hexachloroethane		C	5.5E+01	7.6E+01	1.3E+02	1.9E+02	3.8E+02

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-5}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
110543	Hexane		NC	4.2E+00	5.9E+00	9.8E+00	1.5E+01	2.9E+01
74908	Hydrogen cyanide		NC	7.9E+02	1.1E+03	1.8E+03	2.8E+03	5.5E+03
78831	Isobutanol	X	NC	3.1E+06	4.4E+06	7.3E+06	1.1E+07	2.2E+07
7439976	Mercury (elemental)		NC	9.7E-01	1.4E+00	2.3E+00	3.4E+00	6.8E+00
126987	Methacrylonitrile		NC	9.9E+01	1.4E+02	2.3E+02	3.5E+02	6.9E+02
72435	Methoxychlor	X	NC	**	**	**	**	**
79209	Methyl acetate	X	NC	1.0E+06	1.4E+06	**	**	**
96333	Methyl acrylate	X	NC	2.0E+04	2.7E+04	4.6E+04	6.8E+04	1.4E+05
74839	Methyl bromide		NC	2.8E+01	3.9E+01	6.5E+01	9.8E+01	2.0E+02
74873	Methyl chloride (chloromethane)		C	9.6E+01	1.3E+02	2.2E+02	3.4E+02	6.7E+02
108872	Methylcyclohexane		NC	1.0E+03	1.4E+03	2.4E+03	3.6E+03	7.1E+03
74953	Methylene bromide	X	NC	1.4E+03	2.0E+03	3.3E+03	5.0E+03	9.9E+03
75092	Methylene chloride		C	8.3E+02	1.2E+03	1.9E+03	2.9E+03	5.8E+03
78933	Methylethylketone (2-butanone)		NC	6.2E+05	8.7E+05	1.5E+06	2.2E+06	4.4E+06
108101	Methylisobutylketone		NC	2.0E+04	2.8E+04	4.7E+04	7.1E+04	1.4E+05
80626	Methylmethacrylate		NC	7.3E+04	1.0E+05	1.7E+05	2.5E+05	5.1E+05
91576	2-Methylnaphthalene	X	NC	4.7E+03	6.6E+03	1.1E+04	1.7E+04	**
1634044	MTBE		NC	1.7E+05	2.3E+05	3.9E+05	5.9E+05	1.2E+06
108383	m-Xylene	X	NC	3.3E+04	4.7E+04	7.8E+04	1.2E+05	**
91203	Naphthalene		NC	2.2E+02	3.0E+02	5.1E+02	7.6E+02	1.5E+03
104518	n-Butylbenzene	X	NC	3.7E+02	5.2E+02	8.7E+02	1.3E+03	**
98953	Nitrobenzene		NC	2.9E+03	4.1E+03	6.8E+03	1.0E+04	2.0E+04
79469	2-Nitropropane		C	2.6E+00	3.6E+00	6.0E+00	9.0E+00	1.8E+01
924163	N-Nitroso-di-n-butylamine		C	1.7E+00	2.4E+00	3.9E+00	5.9E+00	1.2E+01
103651	n-Propylbenzene	X	NC	4.6E+02	6.4E+02	1.1E+03	1.6E+03	3.2E+03
88722	o-Nitrotoluene	X	NC	9.8E+04	1.4E+05	2.3E+05	3.4E+05	**
95476	o-Xylene	X	NC	4.7E+04	6.6E+04	1.1E+05	1.6E+05	**
106423	p-Xylene	X	NC	3.2E+04	4.5E+04	7.4E+04	1.1E+05	**
129000	Pyrene	X	NC	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	3.5E+02	4.9E+02	8.2E+02	1.2E+03	2.5E+03
100425	Styrene		NC	1.3E+04	1.8E+04	3.0E+04	4.4E+04	8.9E+04
98066	tert-Butylbenzene	X	NC	4.1E+02	5.8E+02	9.6E+02	1.4E+03	2.9E+03
630206	1,1,1,2-Tetrachloroethane		C	4.7E+01	6.6E+01	1.1E+02	1.7E+02	3.3E+02

Table 3b - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-5}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
79345	1,1,2,2-Tetrachloroethane		C	4.2E+01	5.9E+01	9.9E+01	1.5E+02	3.0E+02
127184	Tetrachloroethylene		C	1.5E+01	2.2E+01	3.6E+01	5.4E+01	1.1E+02
108883	Toluene		NC	2.1E+03	2.9E+03	4.9E+03	7.4E+03	1.5E+04
156605	trans-1,2-Dichloroethylene	X	NC	2.6E+02	3.6E+02	6.1E+02	9.1E+02	1.8E+03
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	2.2E+03	3.1E+03	5.1E+03	7.7E+03	1.5E+04
120821	1,2,4-Trichlorobenzene		NC	4.9E+03	6.9E+03	1.1E+04	1.7E+04	3.4E+04
79005	1,1,2-Trichloroethane		C	5.8E+01	8.1E+01	1.4E+02	2.0E+02	4.1E+02
71556	1,1,1-Trichloroethane		NC	4.5E+03	6.3E+03	1.0E+04	1.6E+04	3.1E+04
79016	Trichloroethylene ††	X	C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.3E+00
75694	Trichlorofluoromethane		NC	2.5E+02	3.5E+02	5.9E+02	8.8E+02	1.8E+03
96184	1,2,3-Trichloropropane		NC	4.2E+02	5.9E+02	9.8E+02	1.5E+03	2.9E+03
95636	1,2,4-Trimethylbenzene		NC	3.4E+01	4.7E+01	7.9E+01	1.2E+02	2.4E+02
108678	1,3,5-Trimethylbenzene		NC	3.5E+01	4.9E+01	8.2E+01	1.2E+02	2.5E+02
108054	Vinyl acetate		NC	1.4E+04	1.9E+04	3.2E+04	4.8E+04	9.6E+04
75014	Vinyl chloride (chloroethene)		C	3.6E+00	5.0E+00	8.3E+00	1.3E+01	2.5E+01

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

† The target groundwater concentrations is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-6}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
83329	Acenaphthene	X	NC	**	**	**	**	**
75070	Acetaldehyde		C	4.9E+02	6.9E+02	1.1E+03	1.7E+03	3.4E+03
67641	Acetone	X	NC	3.2E+05	4.4E+05	7.4E+05	1.1E+06	2.2E+06
75058	Acetonitrile		NC	6.1E+04	8.5E+04	1.4E+05	2.1E+05	4.2E+05
98862	Acetophenone	X	NC	1.1E+06	1.6E+06	2.7E+06	4.0E+06	**
107028	Acrolein		NC	5.7E+00	8.0E+00	1.3E+01	2.0E+01	4.0E+01
107131	Acrylonitrile		C	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.5E+01
309002	Aldrin		C	1.0E-01	1.4E-01	2.4E-01	3.6E-01	7.1E-01
319846	alpha-HCH (alpha-BHC)		C	4.5E+00	6.2E+00	1.0E+01	1.6E+01	3.1E+01
100527	Benzaldehyde	X	NC	5.1E+05	7.2E+05	1.2E+06	1.8E+06	**
71432	Benzene		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	6.9E+00	1.4E+01
205992	Benzo(b)fluoranthene	X	C	**	**	**	**	**
100447	Benzylchloride	X	C	4.2E+00	5.9E+00	9.8E+00	1.5E+01	3.0E+01
91587	beta-Chloronaphthalene	X	NC	**	**	**	**	**
92524	Biphenyl	X	NC	**	**	**	**	**
111444	Bis(2-chloroethyl)ether		C	1.4E+01	2.0E+01	3.3E+01	5.0E+01	1.0E+02
108601	Bis(2-chloroisopropyl)ether		C	7.3E+01	1.0E+02	1.7E+02	2.5E+02	5.1E+02
542881	Bis(chloromethyl)ether		C	6.4E-03	9.0E-03	1.5E-02	2.3E-02	4.5E-02
75274	Bromodichloromethane	X	C	3.0E+00	4.2E+00	7.0E+00	1.1E+01	2.1E+01
75252	Bromoform		C	1.2E-02	1.7E-02	2.8E-02	4.2E-02	8.3E-02
106990	1,3-Butadiene		C	4.1E-03	5.8E-03	9.6E-03	1.4E-02	2.9E-02
75150	Carbon disulfide		NC	8.1E+02	1.1E+03	1.9E+03	2.8E+03	5.6E+03
56235	Carbon tetrachloride		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †
57749	Chlordane		C	1.7E+01	2.4E+01	4.1E+01	**	**
126998	2-Chloro-1,3-butadiene (chloroprene)		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
108907	Chlorobenzene		NC	5.6E+02	7.9E+02	1.3E+03	2.0E+03	3.9E+03
109693	1-Chlorobutane	X	NC	2.9E+03	4.0E+03	6.7E+03	1.0E+04	2.0E+04
124481	Chlorodibromomethane	X	C	4.5E+00	6.3E+00	1.1E+01	1.6E+01	3.2E+01
75456	Chlorodifluoromethane		NC	**	**	**	**	**
75003	Chloroethane (ethyl chloride)		NC	4.0E+04	5.5E+04	9.2E+04	1.4E+05	2.8E+05
67663	Chloroform		C	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †	8.0E+01 †
95578	2-Chlorophenol	X	NC	1.6E+03	2.2E+03	3.6E+03	5.5E+03	1.1E+04
75296	2-Chloropropane		NC	2.4E+02	3.4E+02	5.7E+02	8.6E+02	1.7E+03

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-6}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
218019	Chrysene	X	C	**	**	**	**	**
156592	cis-1,2-Dichloroethylene	X	NC	3.0E+02	4.2E+02	7.0E+02	1.0E+03	2.1E+03
123739	Crotonaldehyde (2-butenal)	X	C	8.0E+00	1.1E+01	1.9E+01	2.8E+01	5.6E+01
98828	Cumene		NC	1.2E+01	1.7E+01	2.8E+01	4.2E+01	8.4E+01
72559	DDE	X	C	4.2E+01	5.8E+01	9.7E+01	**	**
132649	Dibenzofuran	X	NC	**	**	**	**	**
96128	1,2-Dibromo-3-chloropropane		NC	4.8E+01	6.7E+01	1.1E+02	1.7E+02	3.3E+02
106934	1,2-Dibromoethane (ethylene dibromide)		C	5.2E-01	7.3E-01	1.2E+00	1.8E+00	3.6E+00
541731	1,3-Dichlorobenzene	X	NC	1.2E+03	1.7E+03	2.8E+03	4.1E+03	8.3E+03
95501	1,2-Dichlorobenzene		NC	3.7E+03	5.1E+03	8.6E+03	1.3E+04	2.6E+04
106467	1,4-Dichlorobenzene		NC	1.2E+04	1.6E+04	2.7E+04	4.1E+04	**
75718	Dichlorodifluoromethane		NC	2.0E+01	2.9E+01	4.8E+01	7.1E+01	1.4E+02
75343	1,1-Dichloroethane		NC	3.1E+03	4.4E+03	7.3E+03	1.1E+04	2.2E+04
107062	1,2-Dichloroethane		C	5.0E+00 †	5.0E+00 †	7.8E+00	1.2E+01	2.3E+01
75354	1,1-Dichloroethylene		NC	2.7E+02	3.7E+02	6.2E+02	9.4E+02	1.9E+03
78875	1,2-Dichloropropane		NC	5.0E+01	7.0E+01	1.2E+02	1.7E+02	3.5E+02
542756	1,3-Dichloropropene		C	1.2E+00	1.7E+00	2.8E+00	4.2E+00	8.4E+00
60571	Dieldrin		C	1.2E+00	1.7E+00	2.9E+00	4.3E+00	8.6E+00
115297	Endosulfan	X	NC	**	**	**	**	**
106898	Epichlorohydrin		NC	1.1E+03	1.6E+03	2.7E+03	4.0E+03	8.0E+03
60297	Ethyl ether	X	NC	7.4E+02	1.0E+03	1.7E+03	2.6E+03	5.2E+03
141786	Ethylacetate	X	NC	8.0E+05	1.1E+06	1.9E+06	2.8E+06	5.6E+06
100414	Ethylbenzene		C	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †	7.0E+02 †
75218	Ethylene oxide		C	1.5E+00	2.1E+00	3.6E+00	5.4E+00	1.1E+01
97632	Ethylmethacrylate	X	NC	1.3E+04	1.8E+04	3.0E+04	4.6E+04	9.1E+04
86737	Fluorene	X	NC	**	**	**	**	**
110009	Furan	X	NC	2.3E+01	3.2E+01	5.3E+01	7.9E+01	1.6E+02
58899	gamma-HCH (Lindane)	X	C	1.6E+01	2.3E+01	3.8E+01	5.7E+01	1.1E+02
76448	Heptachlor		C	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †	4.0E-01 †
87683	Hexachloro-1,3-butadiene		C	4.7E-01	6.6E-01	1.1E+00	1.7E+00	3.3E+00
118741	Hexachlorobenzene		C	1.0E+00 †	1.0E+00 †	1.0E+00 †	1.0E+00 †	1.0E+00 †
77474	Hexachlorocyclopentadiene		NC	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †	5.0E+01 †
67721	Hexachloroethane		C	5.5E+00	7.6E+00	1.3E+01	1.9E+01	3.8E+01

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-6}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
110543	Hexane		NC	4.2E+00	5.9E+00	9.8E+00	1.5E+01	2.9E+01
74908	Hydrogen cyanide		NC	7.9E+02	1.1E+03	1.8E+03	2.8E+03	5.5E+03
78831	Isobutanol	X	NC	3.1E+06	4.4E+06	7.3E+06	1.1E+07	2.2E+07
7439976	Mercury (elemental)		NC	9.7E-01	1.4E+00	2.3E+00	3.4E+00	6.8E+00
126987	Methacrylonitrile		NC	9.9E+01	1.4E+02	2.3E+02	3.5E+02	6.9E+02
72435	Methoxychlor	X	NC	**	**	**	**	**
79209	Methyl acetate	X	NC	1.0E+06	1.4E+06	**	**	**
96333	Methyl acrylate	X	NC	2.0E+04	2.7E+04	4.6E+04	6.8E+04	1.4E+05
74839	Methyl bromide		NC	2.8E+01	3.9E+01	6.5E+01	9.8E+01	2.0E+02
74873	Methyl chloride (chloromethane)		C	9.6E+00	1.3E+01	2.2E+01	3.4E+01	6.7E+01
108872	Methylcyclohexane		NC	1.0E+03	1.4E+03	2.4E+03	3.6E+03	7.1E+03
74953	Methylene bromide	X	NC	1.4E+03	2.0E+03	3.3E+03	5.0E+03	9.9E+03
75092	Methylene chloride		C	8.3E+01	1.2E+02	1.9E+02	2.9E+02	5.8E+02
78933	Methylethylketone (2-butanone)		NC	6.2E+05	8.7E+05	1.5E+06	2.2E+06	4.4E+06
108101	Methylisobutylketone		NC	2.0E+04	2.8E+04	4.7E+04	7.1E+04	1.4E+05
80626	Methylmethacrylate		NC	7.3E+04	1.0E+05	1.7E+05	2.5E+05	5.1E+05
91576	2-Methylnaphthalene	X	NC	4.7E+03	6.6E+03	1.1E+04	1.7E+04	**
1634044	MTBE		NC	1.7E+05	2.3E+05	3.9E+05	5.9E+05	1.2E+06
108383	m-Xylene	X	NC	3.3E+04	4.7E+04	7.8E+04	1.2E+05	**
91203	Naphthalene		NC	2.2E+02	3.0E+02	5.1E+02	7.6E+02	1.5E+03
104518	n-Butylbenzene	X	NC	3.7E+02	5.2E+02	8.7E+02	1.3E+03	**
98953	Nitrobenzene		NC	2.9E+03	4.1E+03	6.8E+03	1.0E+04	2.0E+04
79469	2-Nitropropane		C	2.6E-01	3.6E-01	6.0E-01	9.0E-01	1.8E+00
924163	N-Nitroso-di-n-butylamine		C	1.7E-01	2.4E-01	3.9E-01	5.9E-01	1.2E+00
103651	n-Propylbenzene	X	NC	4.6E+02	6.4E+02	1.1E+03	1.6E+03	3.2E+03
88722	o-Nitrotoluene	X	NC	9.8E+04	1.4E+05	2.3E+05	3.4E+05	**
95476	o-Xylene	X	NC	4.7E+04	6.6E+04	1.1E+05	1.6E+05	**
106423	p-Xylene	X	NC	3.2E+04	4.5E+04	7.4E+04	1.1E+05	**
129000	Pyrene	X	NC	**	**	**	**	**
135988	sec-Butylbenzene	X	NC	3.5E+02	4.9E+02	8.2E+02	1.2E+03	2.5E+03
100425	Styrene		NC	1.3E+04	1.8E+04	3.0E+04	4.4E+04	8.9E+04
98066	tert-Butylbenzene	X	NC	4.1E+02	5.8E+02	9.6E+02	1.4E+03	2.9E+03
630206	1,1,1,2-Tetrachloroethane		C	4.7E+00	6.6E+00	1.1E+01	1.7E+01	3.3E+01

Table 3c - GW: Question 5 Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors (α)

Risk = 1×10^{-6}

Target Groundwater Concentrations at Different Attenuation Factors								
CAS No.	Chemical	Compounds with Provisional Toxicity Data Extrapolated From Oral Sources	Basis of Target Concentration C=cancer risk NC=noncancer risk	$\alpha = 7 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 5 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 3 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 2 \times 10^{-4}$ C_{gw} (ug/L)	$\alpha = 1 \times 10^{-4}$ C_{gw} (ug/L)
79345	1,1,2,2-Tetrachloroethane		C	4.2E+00	5.9E+00	9.9E+00	1.5E+01	3.0E+01
127184	Tetrachloroethylene		C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.4E+00	1.1E+01
108883	Toluene		NC	2.1E+03	2.9E+03	4.9E+03	7.4E+03	1.5E+04
156605	trans-1,2-Dichloroethylene	X	NC	2.6E+02	3.6E+02	6.1E+02	9.1E+02	1.8E+03
76131	1,1,2-Trichloro-1,2,2-trifluoroethane		NC	2.2E+03	3.1E+03	5.1E+03	7.7E+03	1.5E+04
120821	1,2,4-Trichlorobenzene		NC	4.9E+03	6.9E+03	1.1E+04	1.7E+04	3.4E+04
79005	1,1,2-Trichloroethane		C	5.8E+00	8.1E+00	1.4E+01	2.0E+01	4.1E+01
71556	1,1,1-Trichloroethane		NC	4.5E+03	6.3E+03	1.0E+04	1.6E+04	3.1E+04
79016	Trichloroethylene ††	X	C	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †	5.0E+00 †
75694	Trichlorofluoromethane		NC	2.5E+02	3.5E+02	5.9E+02	8.8E+02	1.8E+03
96184	1,2,3-Trichloropropane		NC	4.2E+02	5.9E+02	9.8E+02	1.5E+03	2.9E+03
95636	1,2,4-Trimethylbenzene		NC	3.4E+01	4.7E+01	7.9E+01	1.2E+02	2.4E+02
108678	1,3,5-Trimethylbenzene		NC	3.5E+01	4.9E+01	8.2E+01	1.2E+02	2.5E+02
108054	Vinyl acetate		NC	1.4E+04	1.9E+04	3.2E+04	4.8E+04	9.6E+04
75014	Vinyl chloride (chloroethene)		C	2.0E+00 †	2.0E+00 †	2.0E+00 †	2.0E+00 †	2.5E+00

* Health-based target breathing concentration exceeds maximum possible chemical vapor concentration (pathway incomplete)

** Target soil gas concentration exceeds maximum possible vapor concentration at this soil gas to indoor air attenuation factor (pathway incomplete)

† The target groundwater concentrations is the MCL. (The MCL for chloroform is the MCL for total Trihalomethanes. The MCL listed for m-Xylene, o-Xylene, and p-Xylene is the MCL for total Xylenes.

†† The target concentration for trichloroethylene is based on the upper bound cancer slope factor identified in EPA's draft risk assessment for trichloroethylene (US EPA, 2001). The slope factor is based on state-of-the-art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further. (See Appendix D.)

VOC Methods Analyte Lists

List 1 Office of Solid Waste SW 846 Method 8260 C	
Acetone Acetonitrile Acrolein (Propenal) Acrylonitrile Allyl alcohol Allyl chloride Benzene Benzyl chloride Bis(2-chloroethyl)sulfide Bromoacetone Bromochloromethane Bromodichloromethane Bromoform Bromomethane n-Butanol 2-Butanone (MEK) t-Butyl alcohol Carbon disulfide Carbon tetrachloride Chloral hydrate Chlorobenzene Chlorodibromomethane Chloroethane 2-Chloroethanol 2-Chloroethyl vinyl ether Chloroform Chloromethane Chloroprene 3-Chloropropionitrile Crotonaldehyde 1,2-Dibromo-3-chloropropane 1,2-Dibromoethane Dibromomethane 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene cis-1,4-Dichloro-2-butene trans-1,4-Dichloro-2-butene Dichlorodifluoromethane 1,1-Dichloroethane 1,2-Dichloroethane 1,1-Dichloroethene trans-1,2-Dichloroethene 1,2-Dichloropropane 1,3-Dichloro-2-propanol cis-1,3-Dichloropropene trans-1,3-Dichloropropene 1,2,3,4-Diepoxybutane Diethyl ether 1,4-Dioxane Epichlorohydrin	Ethanol Ethyl acetate Ethylbenzene Ethylene oxide Ethyl methacrylate Hexachlorobutadiene Hexachloroethane 2-Hexanone 2-Hydroxypropionitrile Iodomethane Isobutyl alcohol Isopropylbenzene Malononitrile Methacrylonitrile Methanol Methylene chloride Methyl methacrylate 4-Methyl-2-pentanone (MIBK) Naphthalene Bromobenzene 1,3-Dichloropropane n-Butylbenzene 2,2-Dichloropropane sec-Butylbenzene 1,1-Dichloropropene tert-Butylbenzene p-Isopropyltoluene Chloroacetonitrile Methyl acrylate 1-Chlorobutane Methyl-t-butyl ether 1-Chlorohexane Pentafluorobenzene 2-Chlorotoluene n-Propylbenzene 4-Chlorotoluene 1,2,3-Trichlorobenzene Dibromofluoromethane 1,2,4-Trimethylbenzene cis-1,2-Dichloroethene 1,3,5-trimethylbenzene

VOC Methods Analyte Lists (cont.)

List 2 EPA Office of Water Method 524.2	List 3 OERR (Superfund) CLP Statement of Work OLM04.2
Chloroform	1,1-Dichloroethane
Bromodichloromethane	1,1-Dichloroethene
Bromoform	1,1,1-Trichloroethane
Chlorodibromomethane	1,1,2-Trichloro-
Bromobenzene	1,1,2-Trichloroethane
Bromochloromethane	1,1,2,2-Tetrachloroethane
Bromomethane	1,2-Dibromo-3-chloropropane
n-Butylbenzene	1,2-Dibromoethane
tert-Butylbenzene	1,2-Dichlorobenzene
Chloroethane	1,2-Dichloroethane
Chloromethane	1,2-Dichloropropane
o-Chlorotoluene	1,2,2-trifluoroethane
p-Chlorotoluene	1,2,4-Trichlorobenzene
Dibromomethane	1,3-Dichlorobenzene
m-Dichlorobenzene	1,4-Dichlorobenzene
Dichlorodifluoromethane	2-Butanone [78-93-3]
1,1-Dichloroethane	2-Hexanone
1,3-Dichloropropane	4-Methyl-2-pentanone
2,2-Dichloropropane	Acetone
1,1-Dichloropropene	Benzene
1,3-Dichloropropene	Bromodichloromethane
Fluorotrchloromethane	Bromoform
Hexachlorobutadiene	Bromomethane
Isopropylbenzene	Carbon Disulfide
p-Isopropyltoluene	Carbon Tetrachloride [56-23-5]
Naphthalene	Chlorobenzene
n-Propylbenzene	Chloroethane
1,1,2,2-Tetrachloroethane	Chloroform [67-66-3]
1,1,1,2-Tetrachloroethane	Chloromethane
1,2,3-Trichlorobenzene	cis-1,2-Dichloroethene
1,2,3-Trichloropropane	cis-1,3-Dichloropropene
1,2,4-Trimethylbenzene	Cyclohexane [110-82-7]
1,3,5 -Trimethylbenzene	Dibromochloromethane
	Dichlorodifluoromethane
	Ethylbenzene
	Isopropylbenzene
	Methyl tert-Butyl Ether
	Methyl Acetate
	Methylcyclohexane
	Methylene Chloride
	Styrene
	Tetrachloroethene
	Toluene
	trans-1,2-Dichloroethene
	trans-1,3-Dichloropropene
	Trichloroethene
	Trichlorofluoromethane
	Vinyl Chloride
	Xylenes (total)

VOC Methods Analyte Lists (cont.)

List 4 OERR (Superfund) CLP Statement of Work OLC03.2	List 5 Office of Solid Waste SW 846 Method 5041
1,1-Dichloroethane 1,1-Dichloroethene 1,1,1-Trichloroethane 1,1,2-Trichloro-1,2,2-trifluoroethane 1,1,2-Trichloroethane 1,1,2,2-Tetrachloroethane 1,2-Dibromo-3-chloropropane 1,2-Dibromoethane 1,2-Dichlorobenzene 1,2-Dichloroethane 1,2-Dichloropropane 1,2,3-Trichlorobenzene 1,2,4-Trichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 2-Butanone 2-Hexanone 4-Methyl-2-pentanone Acetone Benzene Bromochloromethane Bromodichloromethane Bromoform Bromomethane Carbon Disulfide Carbon Tetrachloride Chlorobenzene Chloroethane Chloroform Chloromethane cis-1,2-Dichloroethene cis-1,3-Dichloropropene Cyclohexane Dibromochloromethane Dichlorodifluoromethane Ethylbenzene Isopropylbenzene Methyl Acetate Methyl tert-Butyl Ether Methylcyclohexane Methylene Chloride Styrene Tetrachloroethene Toluene trans-1,2-Dichloroethene trans-1,3-Dichloropropene Trichloroethene Trichlorofluoromethane Vinyl Chloride Xylenes (total)	Acetone Acrylonitrile Benzene Bromodichloromethane Bromoform Bromomethane Carbon disulfide Carbon tetrachloride Chlorobenzene Chlorodibromomethane Chloroethane Chloroform Chloromethane Dibromomethane 1,1-Dichloroethane 1,2-Dichloroethane 1,1-Dichloroethene trans-1,2-Dichloroethene 1,2-Dichloropropane cis-1,3-Dichloropropene trans-1,3-Dichloropropene Ethylbenzene Iodomethane Methylene chloride Styrene 1,1,2,2-Tetrachloroethane Tetrachloroethene Toluene 1,1,1-Trichloroethane 1,1,2-Trichloroethane Trichloroethene Trichlorofluoromethane 1,2,3-Trichloropropane Vinyl chloride Xylenes

VOC Methods Analyte Lists (cont.)

List 6 NIOSH Method 1003	List 7 NIOSH Method 1501
Benzyl chloride	1-tert-butyl-4-methylbenzene
Bromoform	a-methylstyrene
Carbon tetrachloride	benzene
Chlorobenzene	cumene
Chlorobromomethane	dimethylbenzene (p-xylene) (meta)
Chloroform	ethylbenzene
o-Dichlorobenzene	isopropenylbenzene
p-Dichlorobenzene	isopropylbenzene
1,1-Dichloroethane	methylbenzene
1,2-Dichloroethylene	methylstyrene
Ethylene dichloride	methylvinylbenzene (ortho)
Hexachloroethane	naphthalene
1,1,1-trichloroethane	p-tert-butyltoluene
Tetrachloroethylene	styrene
1,1,2-Trichloroethane	toluene
1,2,3-Trichloropropane	vinylbenzene
	xylene

VOC Methods Analyte Lists (cont.)

List 8 EPA Office of Air and Radiation TO-15 & TO-17	
<p>1,1-Dimethylhydrazine; 1,1,2-Trichloroethane; 1,1,2,2-Tetrachloroethane; 1,2-Dibromo-3-chloropropane; 1,2-Epoxybutane (1,2-butylene oxide); 1,2-Propyleneimine (2-methylazindine); 1,2,4-Trichlorobenzene; 1,3-Butadiene; 1,3-Dichloropropene; 1,3-Propane sultone; 1,4-Dichlorobenzene (p-); 1,4-Dioxane (1,4 Diethylene oxide); 2-Nitropropane; 2,2,4-Trimethyl pentane; Acetaldehyde (ethanal); Acetonitrile (cyanomethane); Acetophenone; Acrolein (2-propenal); Acrylamide; Acrylic acid; Acrylonitrile (2-propenenitrile); Allyl chloride (3-chloropropene); Aniline (aminobenzene); Benzene; Benzyl chloride (a-chlorotoluene); Beta-Propiolactone; Bis(2-Chloroethyl)ether; Bis(chloromethyl) ether; Bromoform (tribromomethane); Carbon tetrachloride; Carbon disulfide; Carbonyl sulfide; Catechol (o-hydroxyphenol); Chloroacetic acid; Chlorobenzene; Chloroform; Chloromethyl methyl ether; Chloroprene (2-chloro-1,3-butadiene); Cresylic acid (cresol isomer mixture); Cumene (isopropylbenzene); Diazomethane; Diethyl sulfate; Dimethyl sulfate; Dimethylcarbaryl chloride; Epichlorohydrin (1-chloro-2,3-epoxy propane); Ethyl acrylate; Ethyl carbamate (urethane); Ethyl chloride (chloroethane); Ethylbenzene; Ethylene dibromide (1,2-dibromoethane);</p>	<p>Ethylene dichloride (1,2-dichloroethane); Ethylene oxide; Ethyleneimine (aziridine); Ethylidene dichloride (1,1-dichloroethane); Formaldehyde; Hexachlorobutadiene; Hexachloroethane; Hexane; Isophorone; m-Xylene; Methanol; Methyl methacrylate; Methyl isobutyl ketone (hexone); Methyl chloride (chloromethane); Methyl bromide (bromomethane); Methyl ethyl ketone (2-butanone); Methyl isocyanate; Methyl iodide (iodomethane); Methyl chloroform (1,1,1 trichloroethane); Methyl tert-butyl ether; Methylene chloride; Methylhydrazine; N-Nitrosodimethylamine; N-Nitrosomorpholine; N-Nitroso-N-methylurea; Nitrobenzene; N,N-Dimethylaniline; N,N-Dimethylformamide; o-Cresol; o-Xylene; p-Xylene; Phenol; Phosgene; Propionaldehyde; Propylene dichloride (1,2-dichloropropane); Propylene oxide; Styrene oxide; Styrene; Tetrachloroethylene; Toluene; Trichloroethylene; Triethylamine; Vinyl acetate; Vinyl bromide (bromoethene); Vinyl chloride (chloroethene); Vinylidene chloride (1,1-dichloroethylene); Xylenes (isomer & mixtures);</p>

(1) The following provide more specific guidance for developing a CSM for cleanup programs:

Soil Screening Guidance: User's Guide, Part 2.1 and Attachment A; EPA-540-R-96-018. Office of Emergency and Remedial Response/EPA. July 1996.

Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites
Office of Emergency and Remedial Response/EPA

Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual, Part D - (Standardized Planning, Reporting, and Review of Superfund Risk Assessments), Final December 2001. Pub. # - 9285.7-47; *Chapter 2 - Risk Considerations in Project Scoping*; EPA - Office of Emergency and Remedial Response.

Site Conceptual Exposure Model Builder - User Manual - for PC (Windows version) application to assist in preparing a site model; U.S. Dept of Energy, RCRA/CERCLA Division; July 1997.

Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. EPA 540-G-89-004. Office of Emergency and Remedial Response/EPA . 1989.

Expedited Site Assessment Tools for Underground Storage Tank Sites: A Guide for Regulators. Chapter 2. EPA 510-B-97-001; Office of Underground Storage Tanks/EPA; March 1997.

(2) Selected risk assessment guidance and related documents that contain discussions concerning necessary problem formulation, and planning and scoping prior to conducting a risk assessment can provide some additional perspective to consider in preparation of a Conceptual Site Model.

Quality Assurance Guidance for Conducting Brownfields Site Assessments, EPA 540-R-98-038; OSWER 9230.0-83P; PB98-963307; September 1998.

Guidelines for Ecological Risk Assessment, EPA 630-R-95-002F, Federal Register Vol 63, pp.26846-26924; May 14, 1998.

Framework for Cumulative Risk Assessment - External Review Draft, EPA 630-P-02-001A; Risk Assessment Forum; April 23, 2002.

Risk Characterization Handbook, EPA 100-B-00-002, December 2000.

Guidance For The Data Quality Objectives Process - EPA QA/G-4; EPA-600-R-96-055; September 1994.

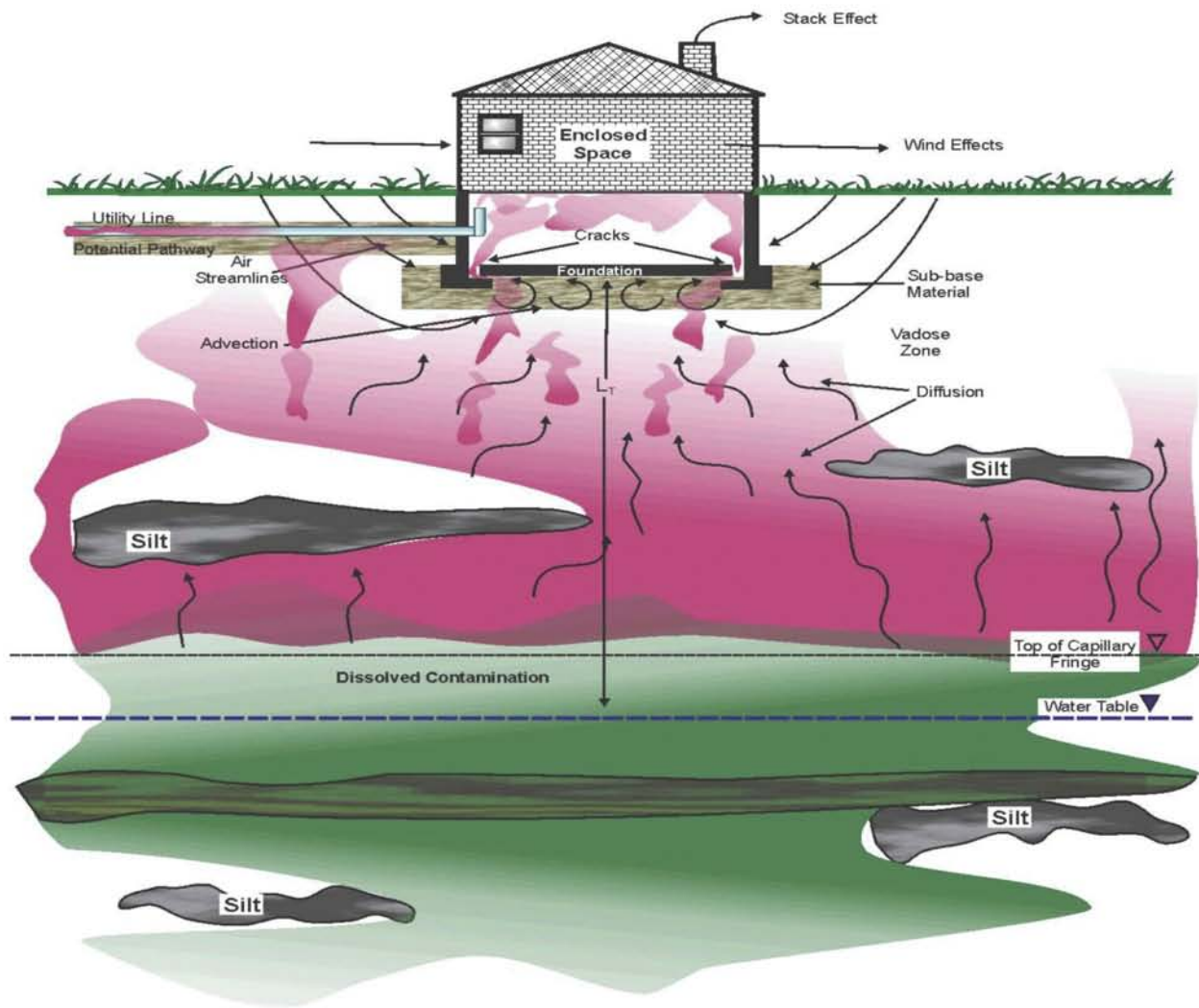
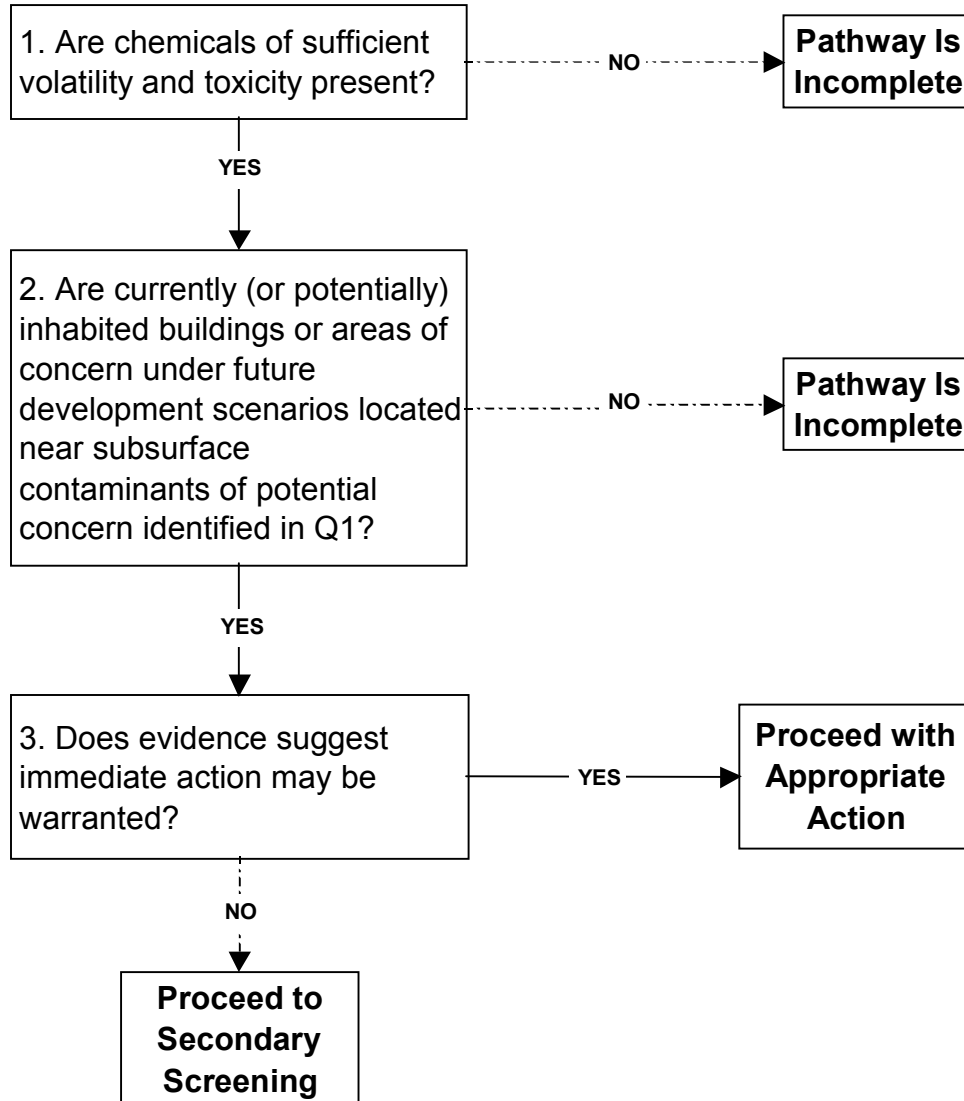


Figure B-1. Example of Conceptual Site Model cross section diagram illustrating potential subsurface vapor intrusion pathways

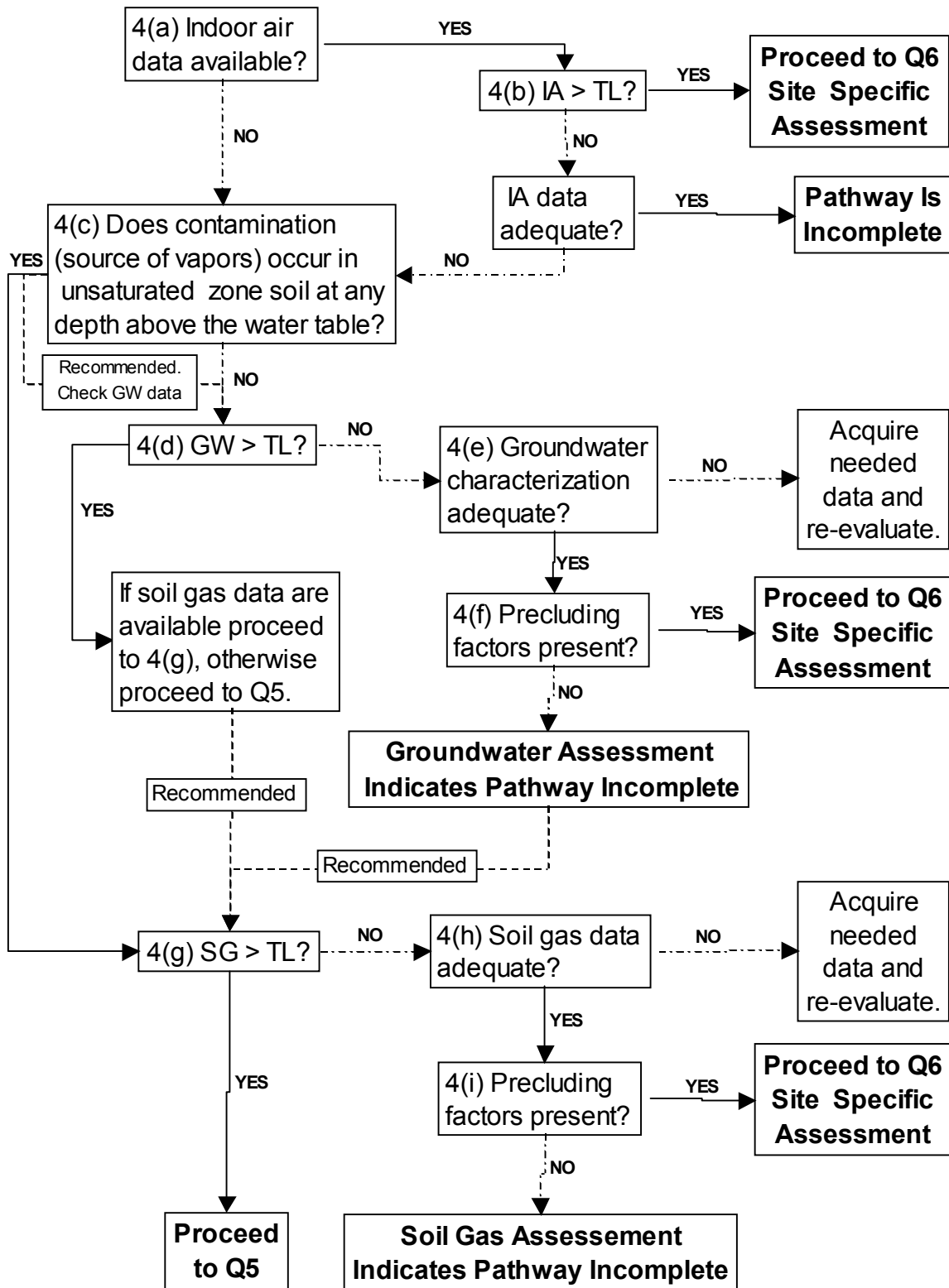
APPENDIX C

**DETAILED FLOW DIAGRAMS OF THE EVALUATION APPROACH
USED IN THE GUIDANCE**

PRIMARY SCREENING



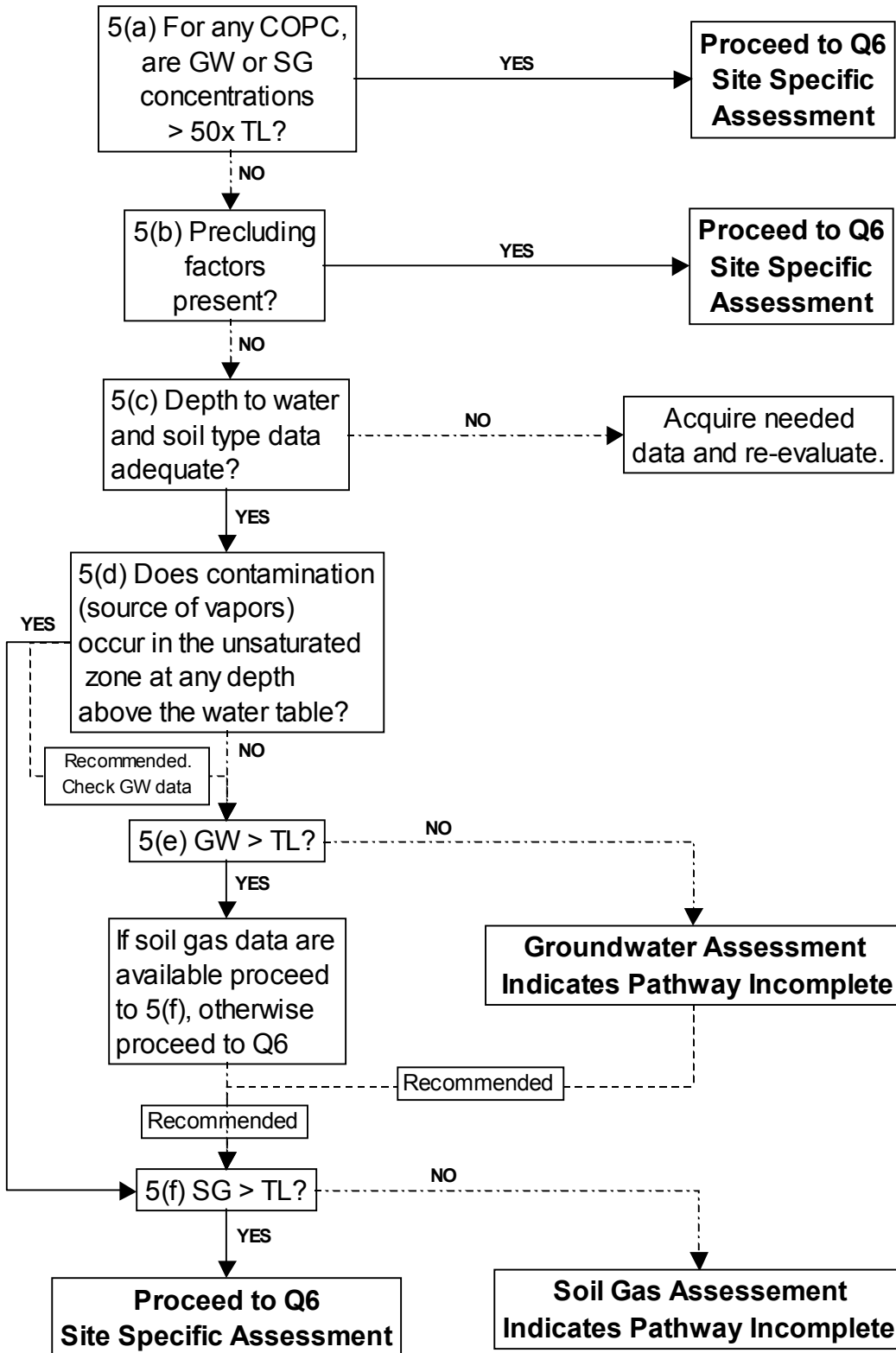
SECONDARY SCREENING
Question 4 – Generic Screening
(TL = appropriate media specific target level)



SECONDARY SCREENING

Question 5 – Semi-Site Specific Screening

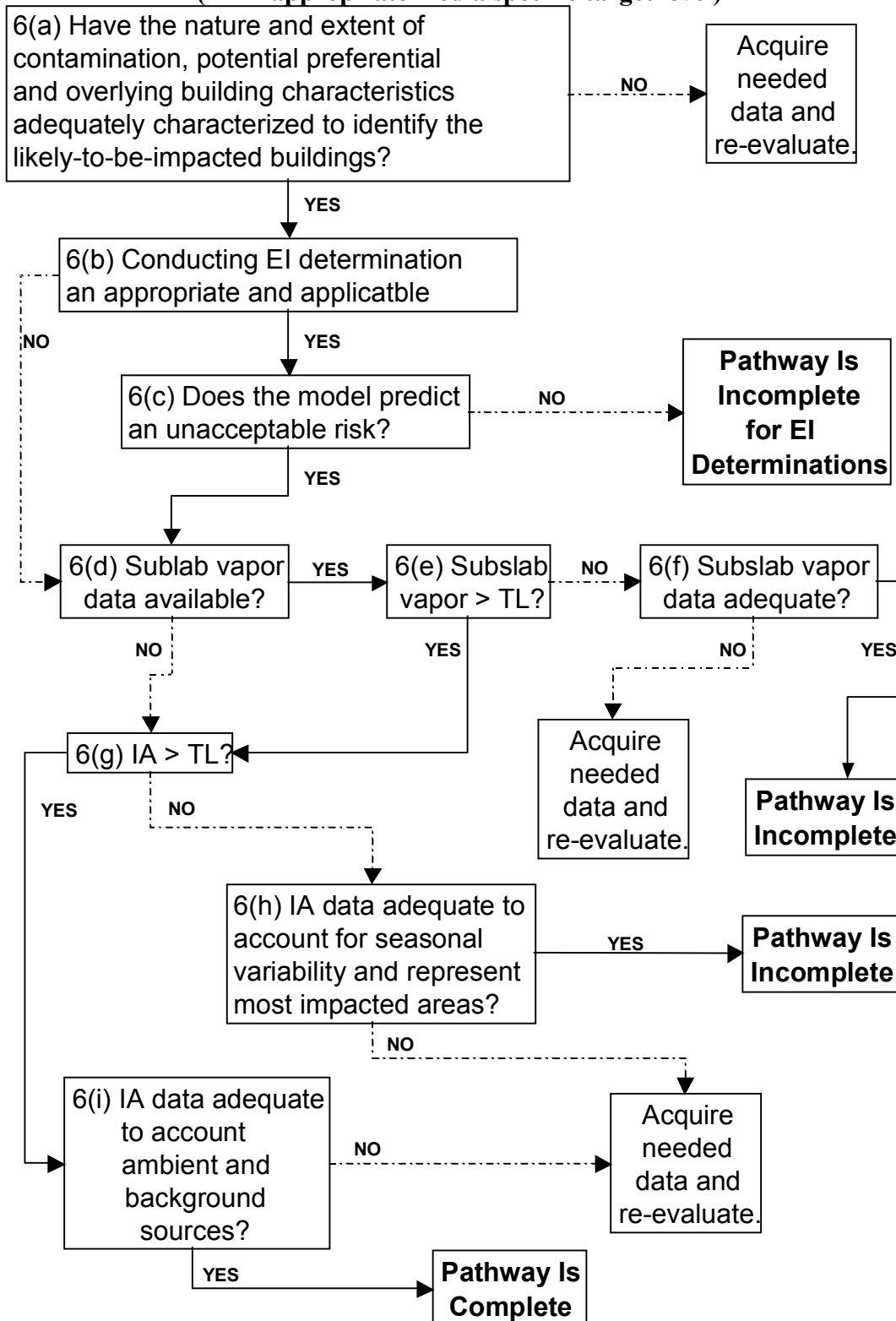
(TL = appropriate media specific target level)



SITE SPECIFIC SCREENING

Question 6

(TL = appropriate media specific target level)



LaBELLA
LaBella Associates, P.C.

300 State Street
Rochester, New York 14614

Appendix 5

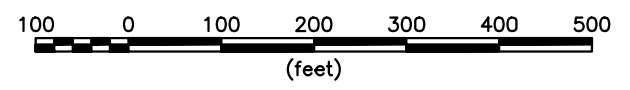
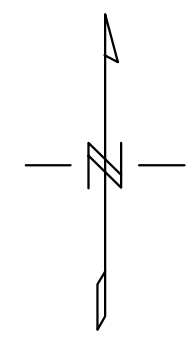
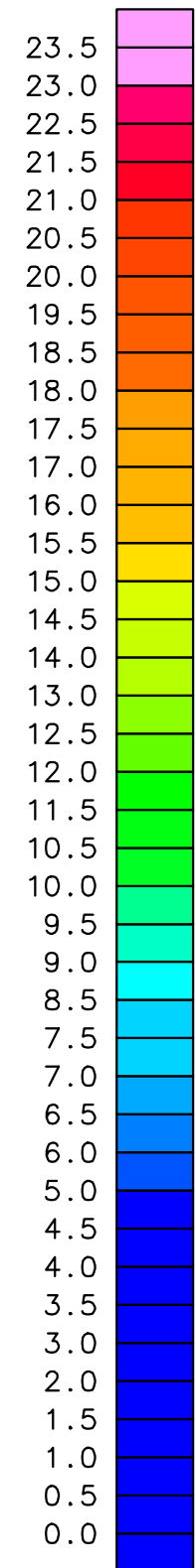
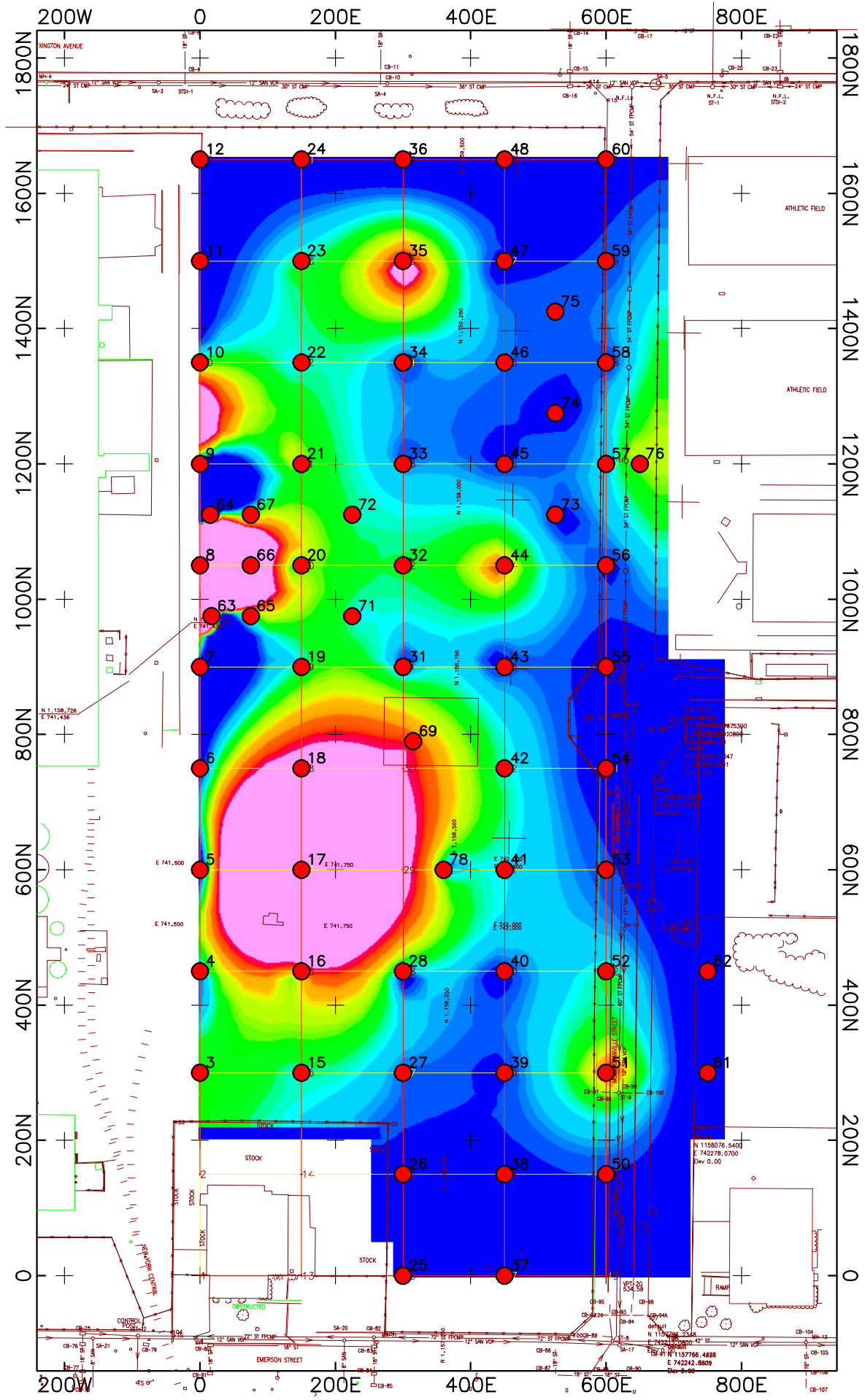
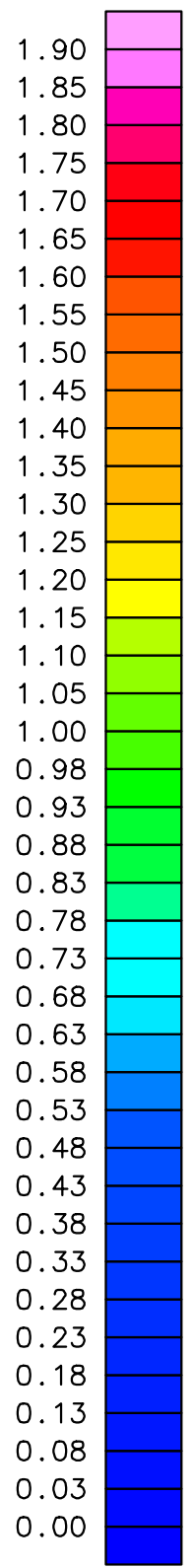
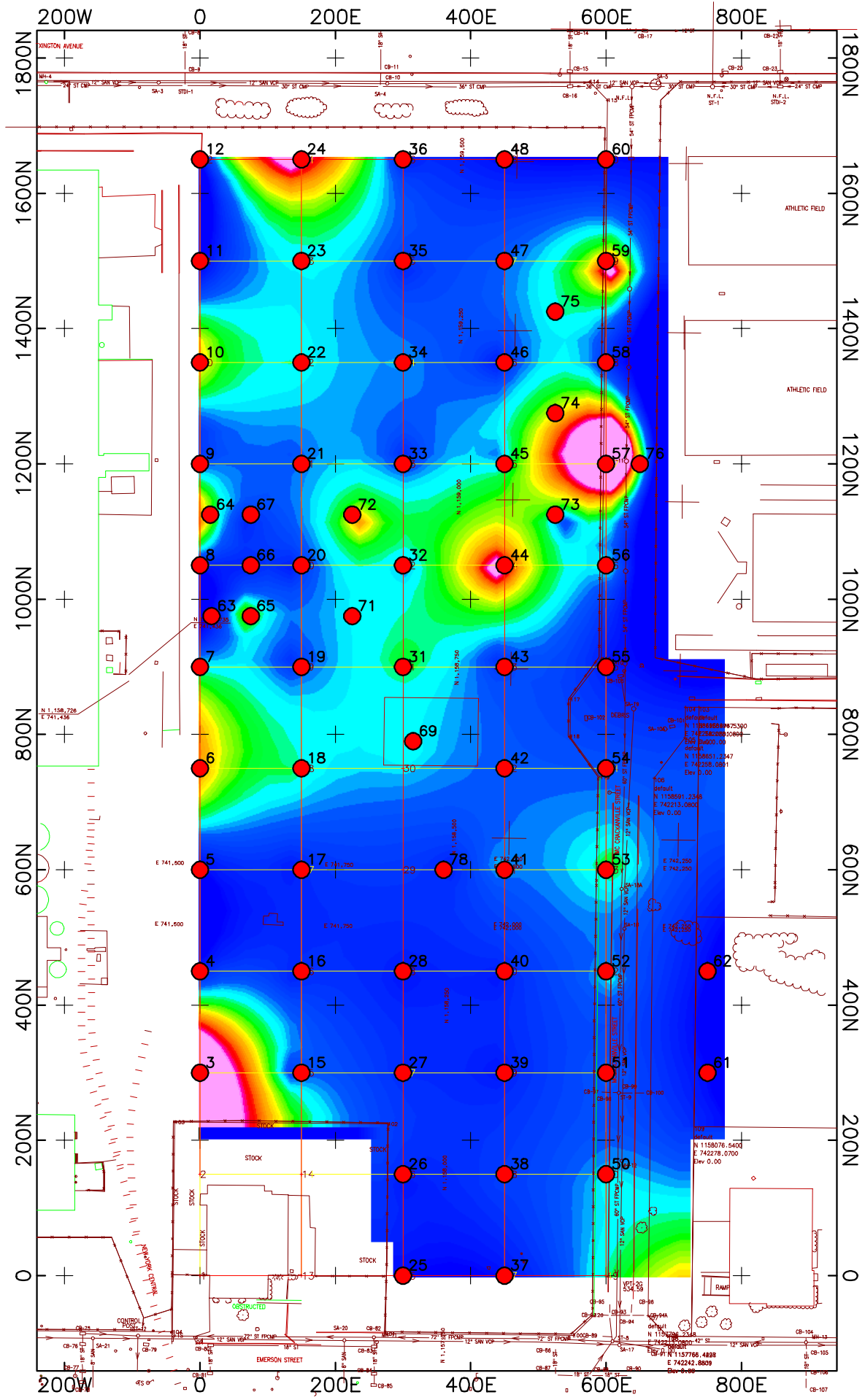


Figure 2
 Soil Gas Survey Results
 Emerson Street Landfill RI/FS
 Rochester, NY

BTEX
 (mg/m³)

Geomatrix Consultants, Inc.



Vinyl Chloride
(mg/m³)

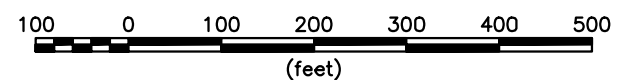
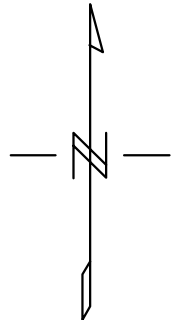
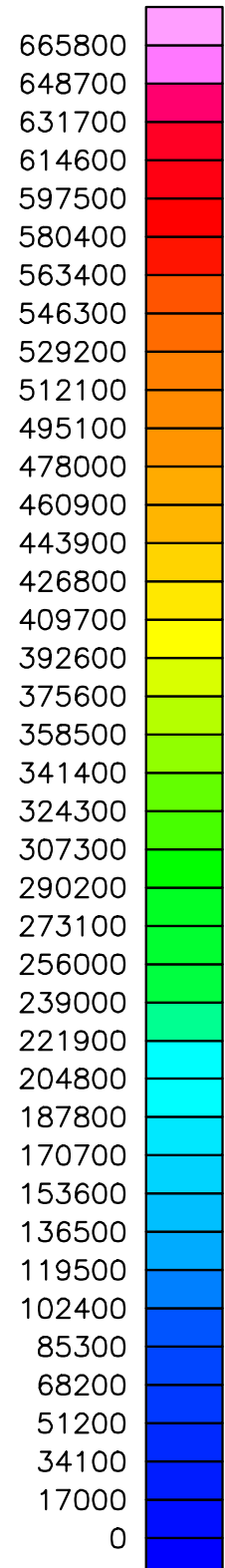
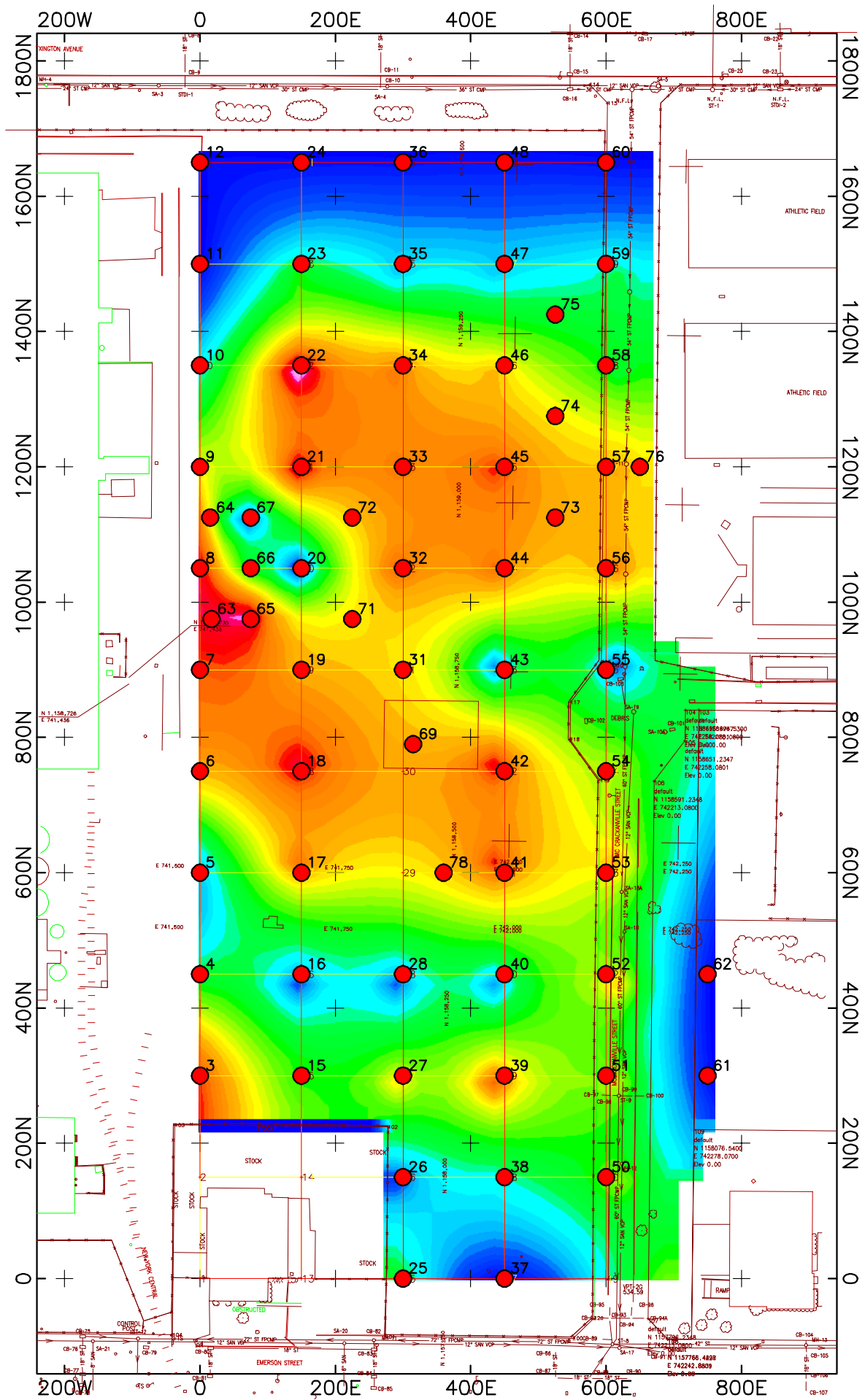


Figure 3
Soil Gas Survey Results
Emerson Street Landfill RI/FS
Rochester, NY
Vinyl Chloride
(mg/m³)
Geomatrix Consultants, Inc.



Methane
(ppm)

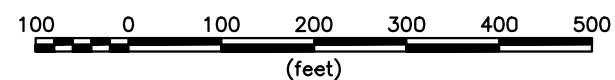
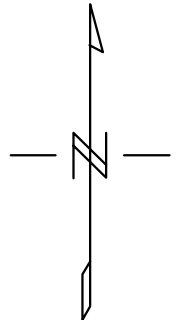


Figure 4
Soil Gas Survey Results
Emerson Street Landfill RI/FS
Rochester, NY

Methane
(ppm)

Geomatrix Consultants, Inc.