Vapor Intrusion Issues

Seminar

November 2, 2009

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Vapor Intrusion Issues
Presentation Team - Introduction

- **Steve Renninger** **EPA Region 5 OSC**
- **Kevin Turner** **EPA Region 5 OSC**

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Vapor Intrusion Issues – Agenda

Introduction	**Turner / Renninger**
Behr VOC Site - Example	**Renninger**
Health Issues	**Renninger / Turner**
Groundwater Issues	**Renninger / Turner**
Hartford Site – Example	**Turner**
Sampling Procedures	**Renninger / Turner**
Vapor Intrusion Toolbox	**Renninger**
Vapor Intrusion Guidance	**Renninger / Turner**
Questions/Discussion	

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Course Objectives

- **Course material is not EPA policy… lessons learned**
- **Material was prepared for OSCs (time critical component)**
- **Lessons learned from 5-10 vapor intrusion sites**
- **Present VOC and petroleum site examples**
- **Understand what screening levels are**
- **Discuss sample procedures and options**
- **Review Vapor Intrusion Guidance (EPA & ITRC)**

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What is Vapor Intrusion?

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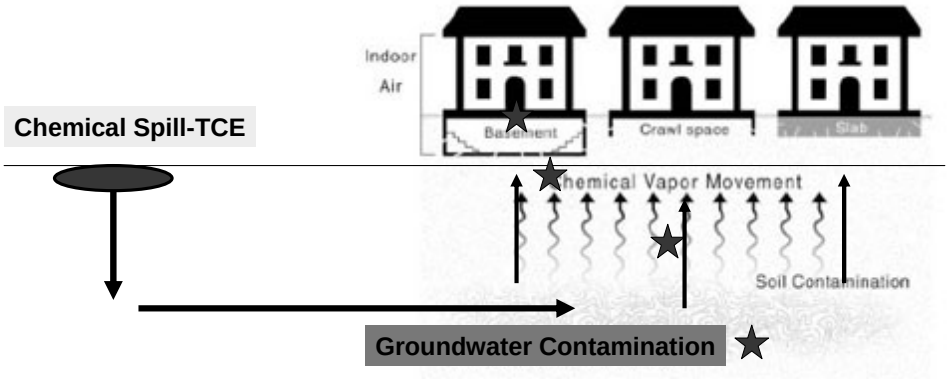
Definition: **Vapor Intrusion is the migration of volatile chemicals from the subsurface to overlying buildings**



Vapor Intrusion is a symptom of ignoring contaminated groundwater sites.
2000: Not drinking contaminated groundwater…no further action
2009: ……but you may be breathing contaminated groundwater

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Must Connect GW, SG, SS, IA

Vapor Intrusion Sites Across the U.S.

(Removal Program as of Feb 2009)

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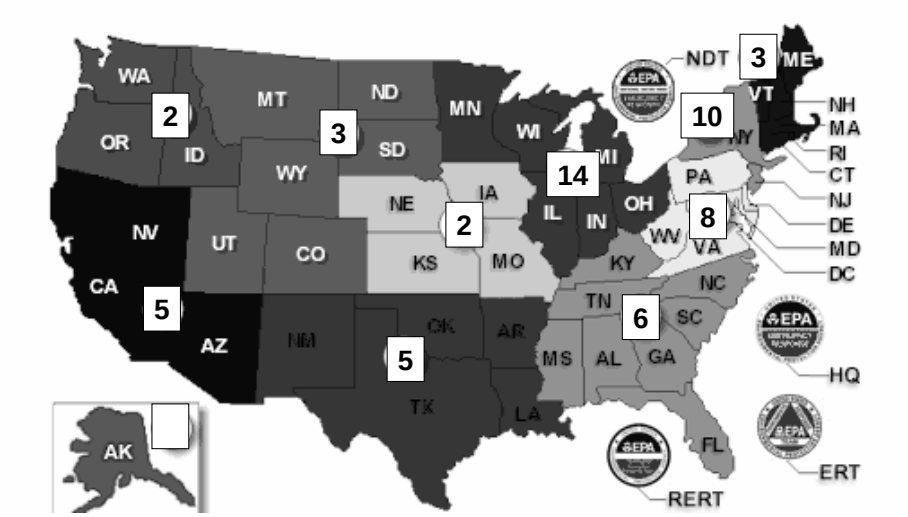

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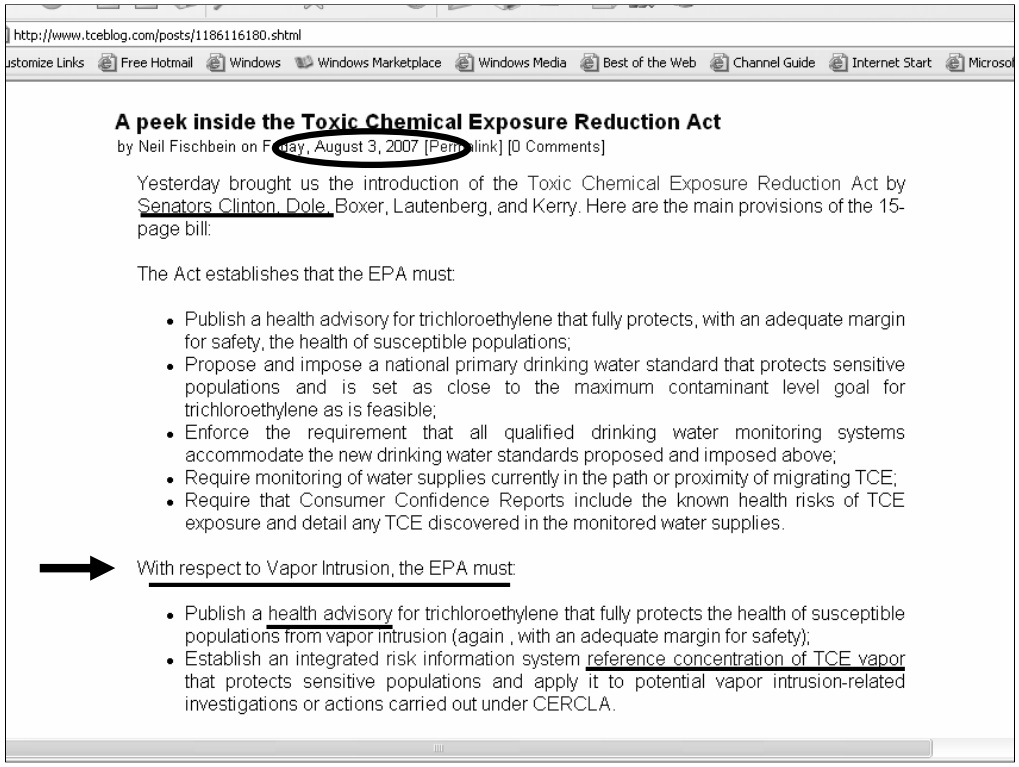

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A peek inside the Toxic Chemical Exposure Reduction Act

by Neil Fischbein on F day, August 3, 2007 [Perm link] [0 Comments]

Yesterday brought us the introduction of the Toxic Chemical Exposure Reduction Act by Senators Clinton, Dole, Boxer, Lautenberg, and Kerry. Here are the main provisions of the 15-page bill:

The Act establishes that the EPA must:

- Publish a health advisory for trichloroethylene that fully protects, with an adequate margin for safety, the health of susceptible populations;
- Propose and impose a national primary drinking water standard that protects sensitive populations and is set as close to the maximum contaminant level goal for trichloroethylene as is feasible;
- Enforce the requirement that all qualified drinking water monitoring systems accommodate the new drinking water standards proposed and imposed above;
- Require monitoring of water supplies currently in the path or proximity of migrating TCE;
- Require that Consumer Confidence Reports include the known health risks of TCE exposure and detail any TCE discovered in the monitored water supplies.

With respect to Vapor Intrusion, the EPA must:

- Publish a health advisory for trichloroethylene that fully protects the health of susceptible populations from vapor intrusion (again , with an adequate margin for safety);
- Establish an integrated risk information system reference concentration of TCE vapor that protects sensitive populations and apply it to potential vapor intrusion-related investigations or actions carried out under CERCLA.

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Senate committee approves bill to protect against TCE contamination

STAFF REPORTS • PUBLISHED JULY 31, 2008 3:40 PM

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WASHINGTON – A bill co-sponsored by Sen. Elizabeth Dole designed to protect people against the negative health effects of drinking water contaminated with trichloroethylene passed a senate committee today.

The bill, introduced by Sen. Hillary Clinton. would require the Enivronmental Protection Agency to establish a health advisory for TCE and a National Primary Drinking Water Regulation, a legally enforceable public water system standard, to limit TCE levels.

The legislation would also require EPA to prepare an electronic database with information on health effects that may result from exposure to chemicals in the environment and an inhalation reference concentration for TCE vapor exposure to provide an estimate of how much of vapor exposure would create a harmful effect.

TCE is a chemical commonly used in degreasing agents, paint and spot removers and adhesives. The government estimates that as many as one million people living and working at Camp

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Groundwater Issues	**Renninger / Turner**
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Vapor Intrusion Guidance	**Renninger / Turner**
Questions/Discussion	

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Vapor Intrusion Case Study

Behr VOC Site

Dayton, Ohio

TCE Case Study, Lessons Learned, Sample SOPs, Screening Levels, Mitigation

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Vapor Intrusion Sites in Dayton, Ohio

Common Denominator in 4 Dayton area sites:
Shallow groundwater (<25')
VOC groundwater contamination >200 ppb
Residential areas

2006: Springfield S… /PCE): 16 res systems installed, …ool. 80 sampled

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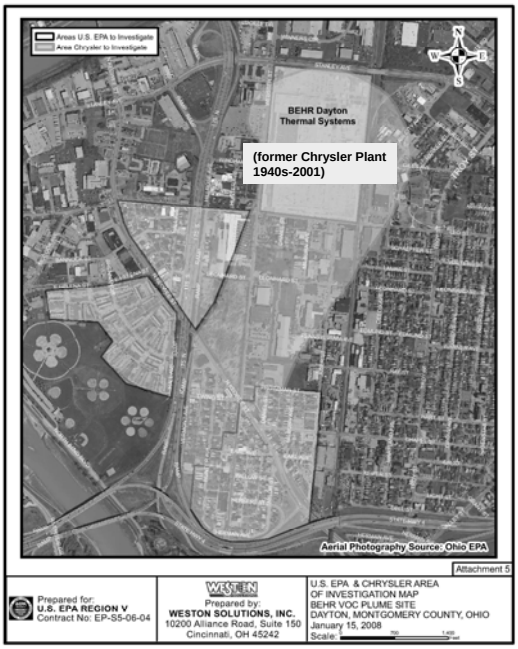
2008: Delphi Site (TCE/PCE/Chlor): 7 res systems installed. 30 sampled

2007-2008: Behr Site (TCE): 200+ res systems installed + 1 school. 350 sampled

7 Charateristics of Vapor Intrusion in Southwest Ohio

- **Shallow groundwater (<25')**
- **Sand & Gravel Aquifer**
- **VOC or petroleum groundwater contamination**
- **VOCs in GW > 200ppb**
- **Residential area over groundwater plume**
- **1940s factory complex…plant surrounded by houses**
- **Residential homes with basements (biggest variable)**



ATSDR Department of Health and Human Services
Agency for Toxic Substances & Disease Registry

What is Trichloroethylene (TCE)

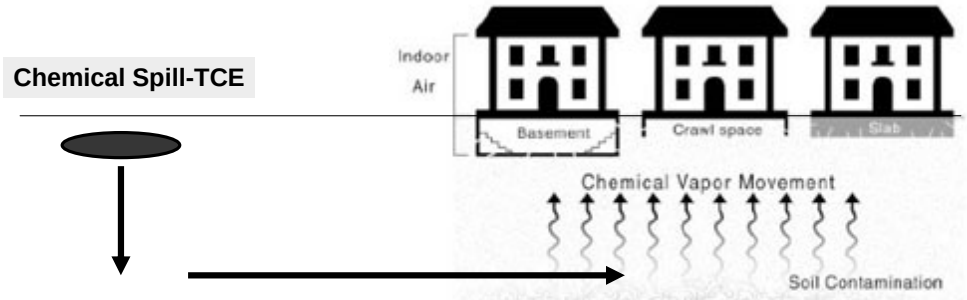
- **Man-made chemical, colorless liquid**
- **Used as a cleaner and degreaser**
- **Evaporates easily into the air**
- **Indoor air screening levels for TCE have been established by ATSDR and Ohio Department of Health (ODH)**

Ohio.gov So much to Discover.

Ohio Department of HEALTH ODH

ATSDR Department of Health and Human Services
Agency for Toxic Substances & Disease Registry

What are Screening Levels?



Screening levels provided by ODH and ATSDR. For TCE (residential):
Sub-Slab Screening Level = 4 ppb
Indoor Air Screening Level = 0.4 ppb

***Commercial levels also provided**

Ohio.gov So much to Discover
Ohio Department of HEALTH

DAIMLERCHRYSLER

2002 Human Health Risk Evaluation

- **Prepared for Daimler Chrysler by Earth Tech in Aug 2002**
- **Chrysler operated facility from 1938-2001 (auto parts production)**
- **TCE spill (SE) in mid 70s.**
- **Chrysler initiated groundwater pump & treat system in 2005**
- **Behr purchased facility in 2001, continued operations**
- **With respect to *Vapor Intrusion*, 2002 report noted that TCE and PCE "are the main contributors to the risk at the site"**
- **"The residential indoor air inhalation risks are *marginal…*" (based on modeling)**
- **No record of residential sub-slab or indoor air samples in the report**

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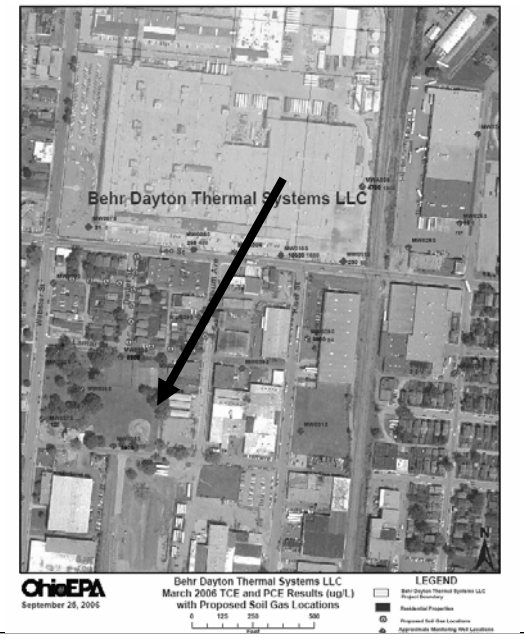
3 red flags *

2003 Groundwater Monitoring

- **Groundwater flow reported in SW direction**
- **Purple shaded areas = residential**



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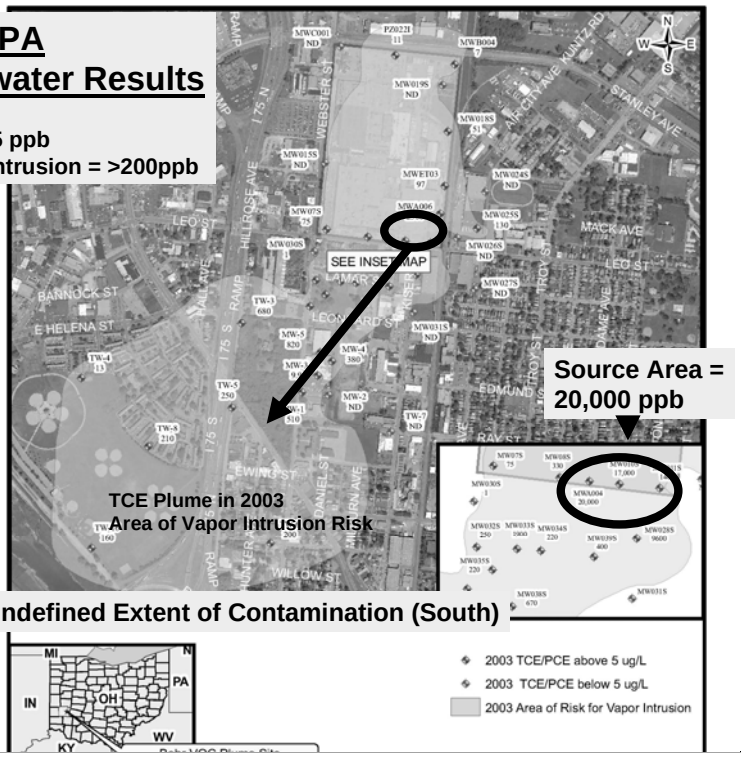
2003 OEPA Groundwater Results

TCE MCL = 5 ppb
TCE Vapor Intrusion = >200ppb



Note: Undefined Extent of Contamination (South)

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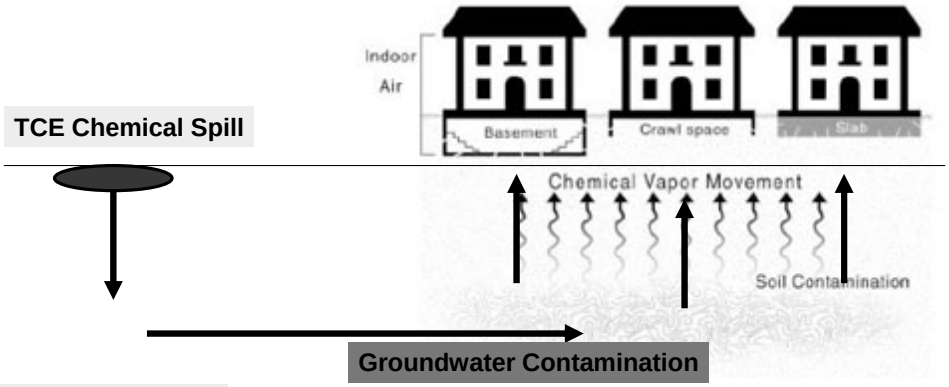
Vapor Intrusion



Groundwater TCE = 20,000 ppb

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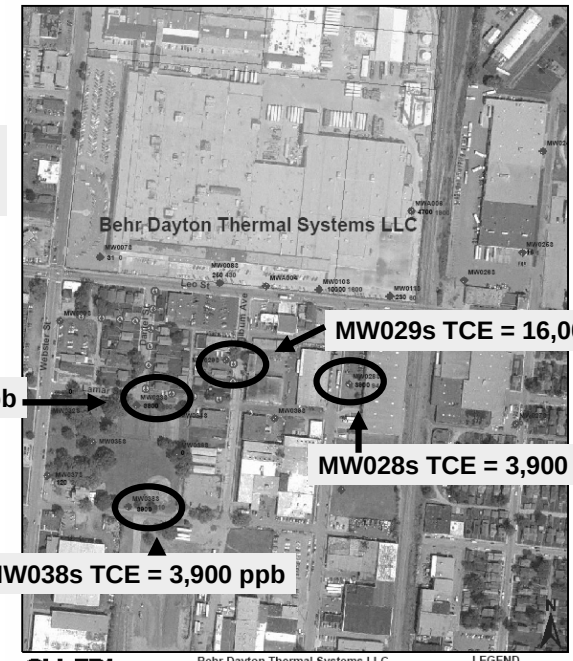
CHRYSLER

Groundwater Data 2003-2006



OhioEPA
September 25, 2006

Behr Dayton Thermal Systems LLC
March 2006 TCE and PCE Results (ug/L)
with Proposed Soil Gas Locations
0 125 250 500
Feet

LEGEND
Behr Dayton Thermal Systems LLC Project Boundary
Residential Properties
Proposed Soil Gas Locations
Approximate Monitoring Well Locations
TCE concentrations in black, PCE in blue

Vapor Intrusion > 200 ppb?

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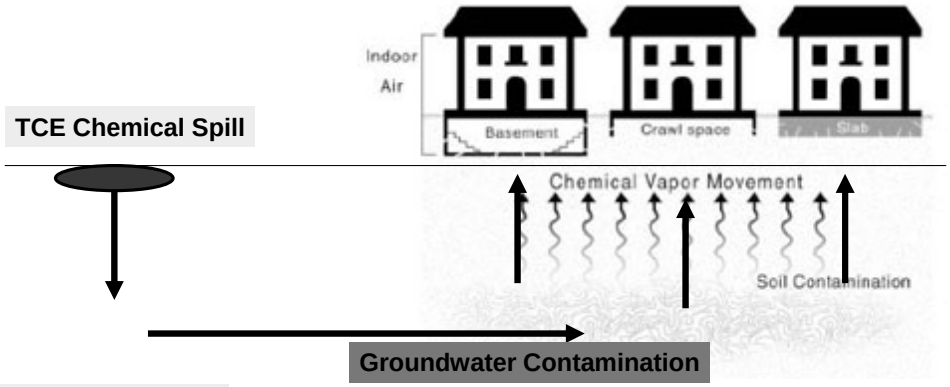
Vapor Intrusion



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Soil Gas Sampling Results - Oct 24, 2006

7 Vapor Probes installed & sampled utilizing Geopobe

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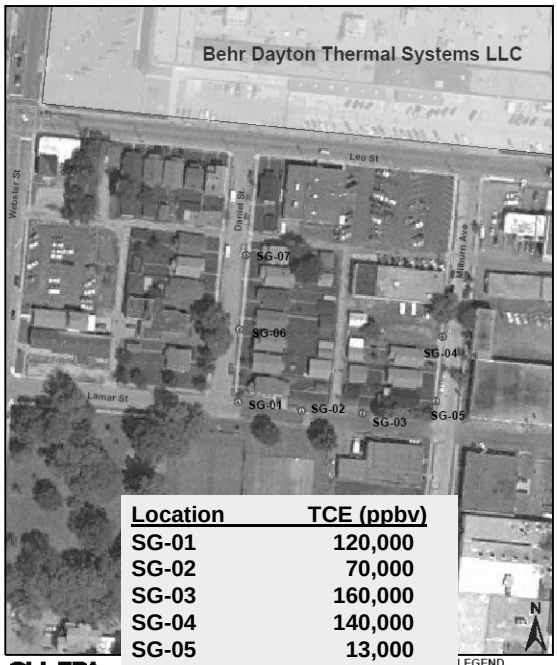
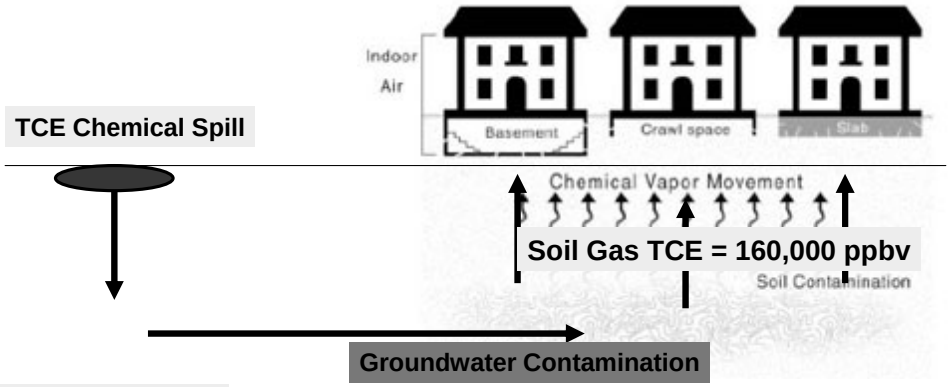


Location	TCE (ppbv)
SG-01	120,000
SG-02	70,000
SG-03	160,000
SG-04	140,000
SG-05	13,000
SG-06	16,000
SG-07	12,000

Vapor Intrusion



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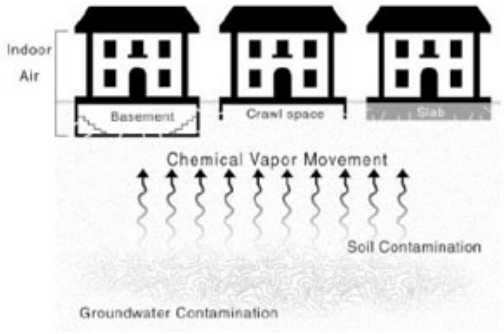
Request for Assistance



- **Ohio EPA requested assistance from U.S. EPA on November 6, 2006**
- **Noted elevated levels of TCE present in soil gas and groundwater.**
- **Evaluate potential for Vapor Intrusion into occupied structures.**

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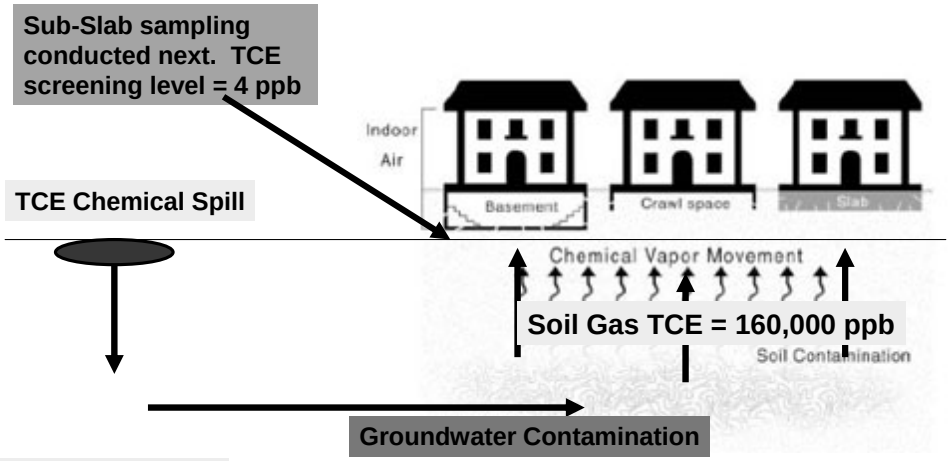
Sub-Slab Sampling



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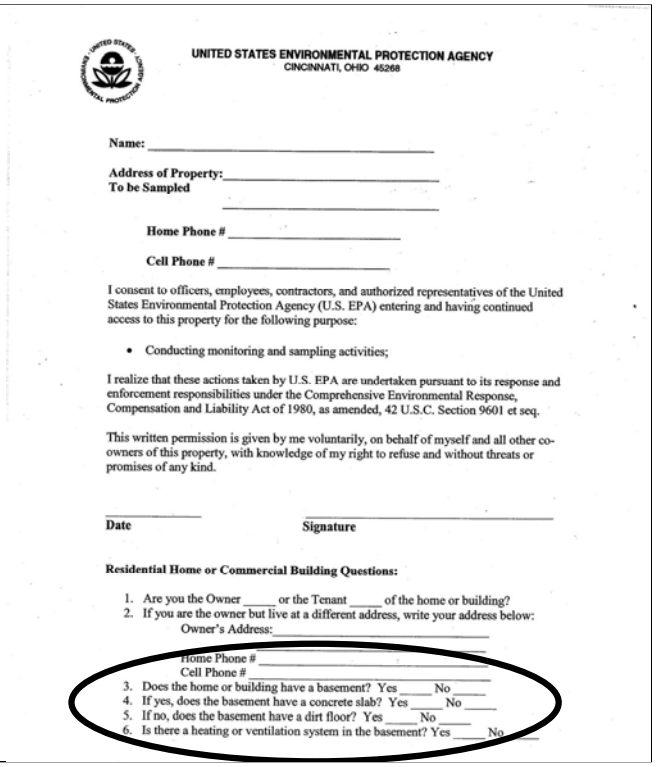
Access Form

- **Request owner (and tenant) to sign access form prior to sampling**
- **Follow up meeting to be scheduled to discuss sample results**



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

Name: _____

Address of Property: _____
To be Sampled
_____

Home Phone # _____

Cell Phone # _____

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

- Conducting monitoring and sampling activities;

I realize that these actions taken by U.S. EPA are undertaken pursuant to its response and enforcement responsibilities under the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended, 42 U.S.C. Section 9601 et seq.

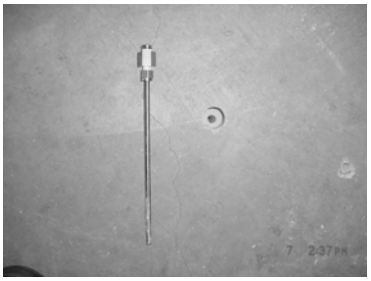
This written permission is given by me voluntarily, on behalf of myself and all other co-owners of this property, with knowledge of my right to refuse and without threats or promises of any kind.

_____ _____
Date **Signature**

Residential Home or Commercial Building Questions:

1. Are you the Owner _____ or the Tenant _____ of the home or building?
2. If you are the owner but live at a different address, write your address below:
   Owner's Address: _____
   _____
   Home Phone # _____
   Cell Phone # _____
3. Does the home or building have a basement? Yes _____ No _____
4. If yes, does the basement have a concrete slab? Yes _____ No _____
5. If no, does the basement have a dirt floor? Yes _____ No _____
6. Is there a heating or ventilation system in the basement? Yes _____ No _____

Sub Slab Air Sampling



EPA sampled sub-slab air in 8 residences in November 2006.

24 hour sample collected

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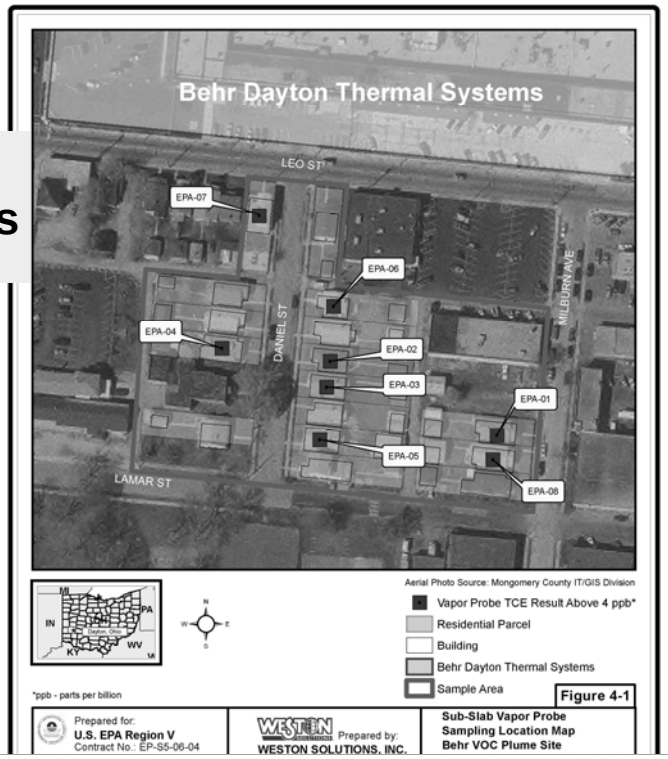
EPA Sub-Slab Sample Results

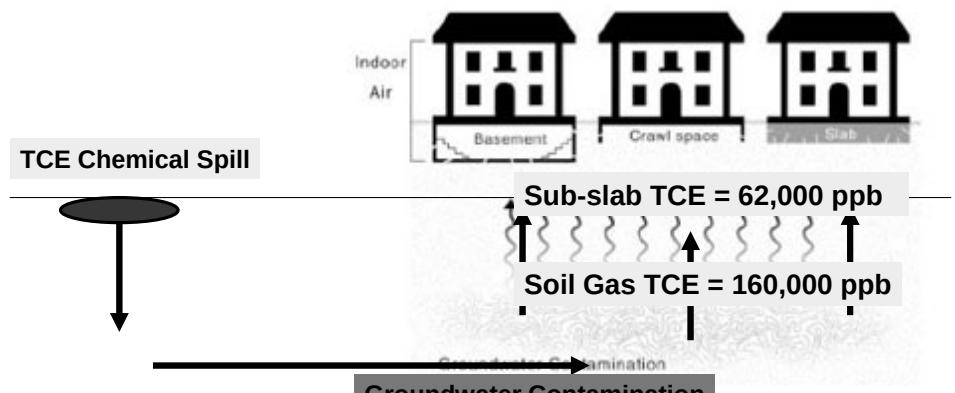
November 2006

Location	TCE (ppb)
EPA-01	980
EPA-02	18,000
EPA-03	16,000
EPA-04	260
EPA-05	62,000
EPA-06	3,700
EPA-07	49
EPA-08	62,000

ATSDR & ODH Sub-Slab Screening Level = 4 ppb



Vapor Intrusion



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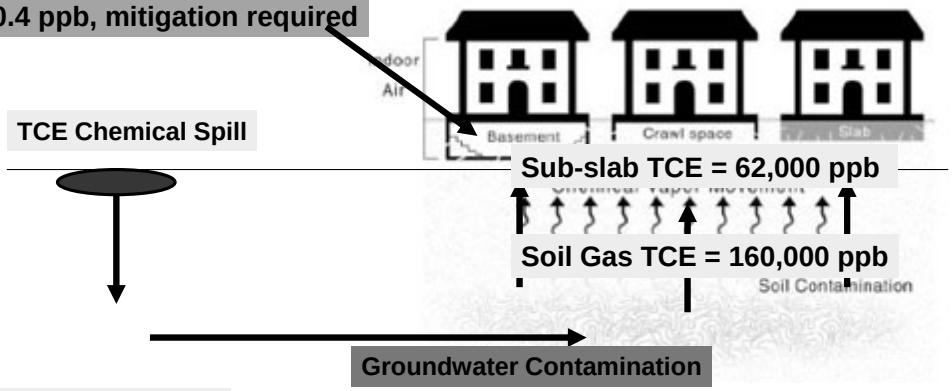
Indoor Air Sampling

If Indoor Air TCE Sample >0.4 ppb, mitigation required



TCE Chemical Spill

Groundwater Contamination

Groundwater TCE = 20,000 ppb

Groundwater TCE = 16,000 ppb

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Pre-Sample Residential Checklist

Screen indoor air prior to indoor air sampling to identify residential interferences

TAGA
ppb Rae

Remove paint cans, gas cans, dry cleaning

BUILDING CONSTRUCTION SECTION

	Single Family	Duplex	Condominium	Townhouse	Other
Type of Structure	☐	☐	☐	☐	☐

Structure Description:	
No. of Floors:	
Age of Structure:	

	Yes	No
Slab on grade? (*If yes, see slab section for additional description*)	☐	☐
Basement? (*If yes, see basement section for additional description*)	☐	☐
Finished ☐ Unfinished ☐		
Crawlspace? (*If yes, see crawlspace section for additional description*)	☐	☐
Under what % of structure: ____		
Approximate square footage of the structure: ____		

General aboveground construction (check all that apply):
Wood ☐ Brick ☐ Concrete ☐ Cement block ☐
Other ____

Foundation construction (check all that apply):
Concrete slab ☐ Fieldstone ☐ Concrete block ☐ Elevated above ground/grade ☐
Other ____

Integrity of structure (check all that apply):
Good ☐ Fair ☐ Poor ☐
Other ____

Has the structure been weatherized with any of the following? (check all that apply):
Insulation ☐ Storm Windows ☐ Energy-Efficient Windows ☐
Other ____

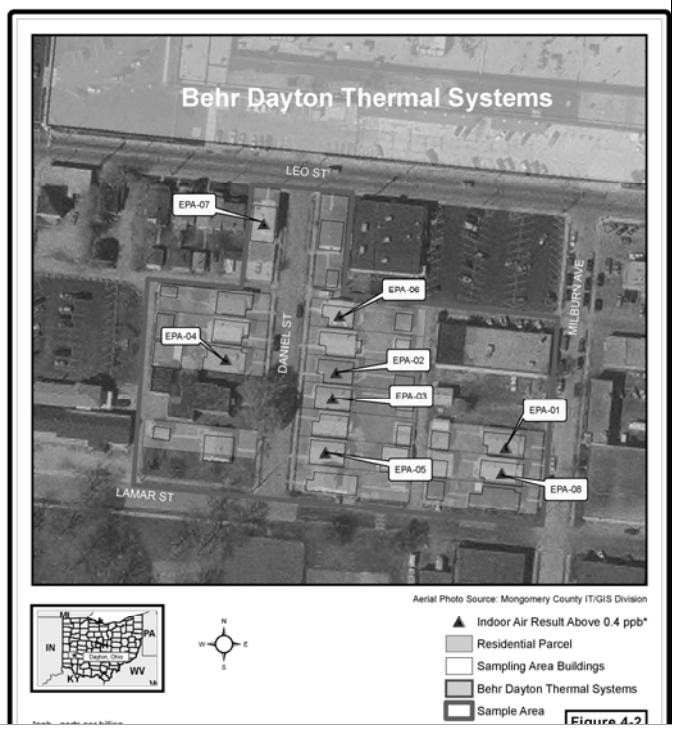
EPA Indoor Air Sample Results

November 2006

Location	TCE (ppb)
EPA-01	1.9
EPA-02	180
EPA-03	130
EPA-04	13
EPA-05	260
EPA-06	7.5
EPA-07	0.4
EPA-08	49

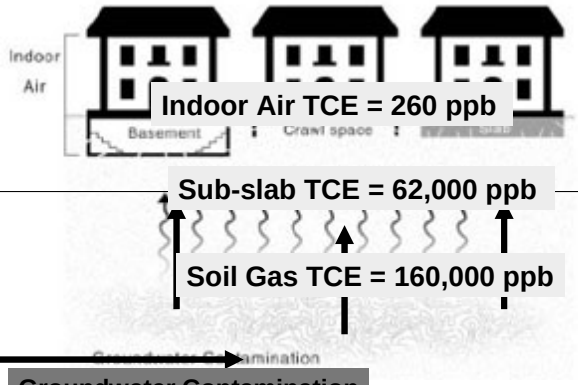
ATSDR & ODH Indoor Air Screening Level = 0.4 ppb (requiring mitigation)

3 residences > Immediate Action Level (100 ppb)



Vapor Intrusion

ATSDR & ODH: Completed Exposure Pathway



TCE Chemical Spill

Groundwater Contamination

Groundwater TCE = 20,000 ppb

Groundwater TCE = 16,000 ppb

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Consent Order Signed by EPA & Chrysler

Consent Order signed on Dec 19, 2006.
(Note: PRP negotiations – '02 Model vs '06 samples)
(Note: Cows?)

Work to be performed by Chrysler includes:

- ***Phase 1*** **: Residential sub-slab and indoor air sampling in 21 residences;**
- **if necessary install interior vapor abatement systems in structures.**

- ***Phase 2*** **includes an expanded Vapor Intrusion Investigation (south);**
- **if necessary mitigation.**
- **(Note: Phase 2 Problem in 2007)**

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Community Involvement

Public Meetings and Outreach

OSC and CIC at a public meeting

Ohio Dept of Health at a public meeting

- **Community Relations is critical to the public signing access agreements for sampling/mitigation.**
- **Most folks do not understand Vapor Intrusion and must be educated on the subject.**
- **"Breathing groundwater contamination" is like teaching a new language**

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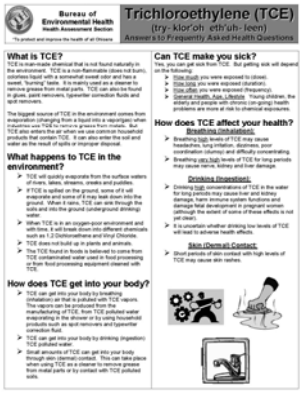
Ohio Department of Health Fact Sheets



Bureau of Environmental Health
Health Assessment Section

Trichloroethylene (TCE)
(try- klor'oh eth'uh- leen)
Answers to Frequently Asked Health Questions

What is TCE?

TCE is man-made chemical that is not found naturally in the environment. TCE is a non-flammable (does not burn), colorless liquid with a somewhat sweet odor and has a sweet, "burning" taste. It is mainly used as a cleaner to remove grease from metal parts. TCE can also be found in glues, paint removers, typewriter correction fluids and spot removers.

The biggest source of TCE in the environment comes from evaporation (changing from a liquid into a vapor/gas) when industries use TCE to remove grease from metals. But TCE also enters the air when we use common household products that contain TCE. It can also enter the soil and water as the result of spills or improper disposal.

What happens to TCE in the environment?

- TCE will quickly evaporate from the surface waters of rivers, lakes, streams, creeks and puddles.
- If TCE is spilled on the ground, some of it will evaporate and some of it may leak down into the ground. When it rains, TCE can sink through the soils and into the ground (underground drinking) water.
- When TCE is in an oxygen-poor environment and with time, it will break down into different chemicals such as 1,2-Dichloroethene and Vinyl Chloride.
- TCE does not build up in plants and animals.
- The TCE found in foods is believed to come from TCE contaminated water used in food processing or from food processing equipment cleaned with TCE.

How does TCE get into your body?

- TCE can get into your body by breathing (inhalation) air that is polluted with TCE vapors. This vapors can be produced from the manufacturing of TCE, from TCE polluted water evaporating in the shower or by using household products such as spot removers and typewriter correction fluid.
- TCE can get into your body by drinking (ingestion) TCE polluted water.
- Small amounts of TCE can get into your body through skin (dermal) contact. This can take place when using TCE as a cleaner to remove grease from metal parts or by contact with TCE polluted soils.

Can TCE make you sick?

Yes, you can get sick from TCE. But getting sick will depend on the following:

- How much you were exposed to (dose).
- How long you were exposed (duration).
- How often you were exposed (frequency).
- General Health, Age, Lifestyle. Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposures.

How does TCE affect your health?

Breathing (Inhalation):

- Breathing high levels of TCE may cause headaches, lung irritation, dizziness, poor coordination (clumsy) and difficulty concentrating.
- Breathing very high levels of TCE for long periods may cause nerve, kidney and liver damage.

Drinking (Ingestion):

- Drinking high concentrations of TCE in the water for long periods may cause liver and kidney damage, harm immune system functions and damage fetal development in pregnant women (although the extent of some of these effects is not yet clear).
- It is uncertain whether drinking low levels of TCE will lead to adverse health effects.

Skin (Dermal) Contact:

- Short periods of skin contact with high levels of TCE may cause skin rashes.

Bureau of Environmental Health
Health Assessment Section

Vapor Intrusion
Answers to Frequently Asked Health Questions

What is vapor intrusion?

Vapor intrusion refers to the vapors produced by a chemical spill/leak that make their way into indoor air. When chemicals are spilled on the ground or leak from an underground storage tank, they will seep into the soils and will sometimes make their way into the groundwater (underground drinking water). There are a group of chemicals called volatile organic compounds (VOCs) that easily produce vapors. These vapors can travel through soils, especially if the soils are sandy and loose or have a lot of cracks (fissures). These vapors can then enter a home through cracks in the foundation or into a basement with a dirt floor or concrete slab.

VOCs and vapors:

VOCs can be found in petroleum products such as gasoline or diesel fuels, in solvents used for industrial cleaning and are also used in dry cleaning. If there is a large spill or leak resulting in soil or groundwater contamination, vapor intrusion may be possible and should be considered a potential public health concern that may require further investigation.

Although large spills or leaks are a public health concern, other sources of VOCs are found in everyday household products and are a more common source of poor indoor air quality. Common products such as paint, paint strippers and thinners, hobby supplies (glues), solvents, stored fuels (gasoline or home heating fuel), aerosol sprays, new carpeting or furniture, cigarette smoke, moth balls, air fresheners and dry-cleaned clothing all contain VOCs.

Can you get sick from vapor intrusion?

You can get sick from breathing harmful chemical vapors. But getting sick will depend on:

How much you were exposed to (dose).
How long you were exposed (duration).
How often you were exposed (frequency).
How toxic the spill/leak chemicals are.
General Health, age, lifestyle. Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposures.

VOC vapors at high levels can cause a strong petroleum or solvent odor and some persons may experience eye and respiratory irritation, headache and/or nausea (upset stomach). These symptoms are usually temporary and go away when the person is moved to fresh air.

Lower levels of vapors may go unnoticed and a person may feel no health effects. A few individual VOCs are known carcinogens (cause cancer). Health officials are concerned with low-level chemical exposures that happen over many years and may raise a person's lifetime risk for developing cancer.

How is vapor intrusion investigated?

In most cases, collecting soil gas or groundwater samples near the spill site is done first to see if there is on-site contamination. If soil vapors or groundwater contamination are detected at a spill site, environmental protection and public health officials may then ask that soil vapor samples be taken from areas outside the immediate spill site and near any potential affected business or home. The Ohio Department of Health (ODH) does not usually recommend indoor air sampling for vapor intrusion before the on-site contamination is determined.

(continued on next page)

Bureau of Environmental Health
Health Assessment Section

Exposure to Toxic Chemicals
Answers to Frequently Asked Health Questions

How are we exposed to chemicals?

We come in contact with many different chemicals every day that are non-toxic and normally do not cause health problems. But any chemical could become toxic if a person comes in contact with high enough doses. For example: Aspirin will cure a headache but too much aspirin becomes toxic and can cause serious health problems. You can get sick from contact with chemicals but getting sick will depend on the following:

- How much you were exposed to (dose).
- How long you were exposed (duration).
- How often you were exposed (frequency).
- General Health, Age, Lifestyle.
  Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposures.

Other factors that increase health risks are:

- Current health status (if you are ill or healthy).
- Lifestyle, age, and weight.
- Smoking, drinking alcohol, or taking certain medicines or drugs.
- Allergies to certain chemicals.
- Past chemical exposure.
- Working in an industry/factory that makes or uses chemicals.

What is a completed exposure pathway?

Chemicals must have a way to get into a person's body to cause health problems. This process of those chemicals getting into our bodies is called an exposure pathway. A completed exposure pathway includes all of the following 5 links between a chemical source and the people who are exposed to that chemical.

(1) A Source of the chemical (where the chemical came from);
(2) Environmental Transport (the way the chemical moves from the source to the public. This can take place through the soil, air, underground drinking water or surface water);
(3) Point of Exposure (the place where there is physical contact with the chemical. This could be on-site as well as off-site);
(4) A Route of Exposure (how people came into the physical contact with the chemical. This can take place by drinking, eating, breathing or touching it);
(5) People Who Could be Exposed (people that live near a facility who are most likely to come into physical contact with the site-related chemical).

What are exposure routes?

There are three ways (routes) a person can come in contact with toxic chemicals. They include:

- Breathing (inhalation).
- Eating and drinking (ingestion).
- Skin contact (dermal contact).

Inhalation (breathing):
Chemicals can enter our body through the air we breathe. These chemicals can come in the form of dust, mist, or fumes. Some chemicals may stay in the lungs and damage lung cells. Other chemicals may pass through lung tissue, enter the bloodstream, and affect other parts of our body.

Ingestion (eating or drinking):
The body can absorb chemicals in the stomach from the foods we eat or the liquids we drink. Chemicals may also be in the dust or soil we swallow. These chemicals can enter our blood and affect other parts of our body.

Dermal (skin) Contact:
Chemicals can enter our body through our skin. We can come in contact with water polluted by chemicals or touch polluted soil. Some chemicals pass through our skin and enter our bloodstream, affecting other parts of our body.

For more information contact:

Ohio Department of Health
Health Assessment Section
246 North High Street, 8th Floor
Columbus OH 43215
Phone: 614-466-1390
Fax: 614-644-4556

ATSDR

The Ohio Department of Health is in cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Service, U.S. Department of Health and Human Services.

This pamphlet was created by the Ohio Department of Health, Health Assessment Section and supported in whole by funds from the Comprehensive Environmental Response, Compensation and Liability Act trust fund.

Ohio.gov
So much to Discover.

Ohio Department of HEALTH

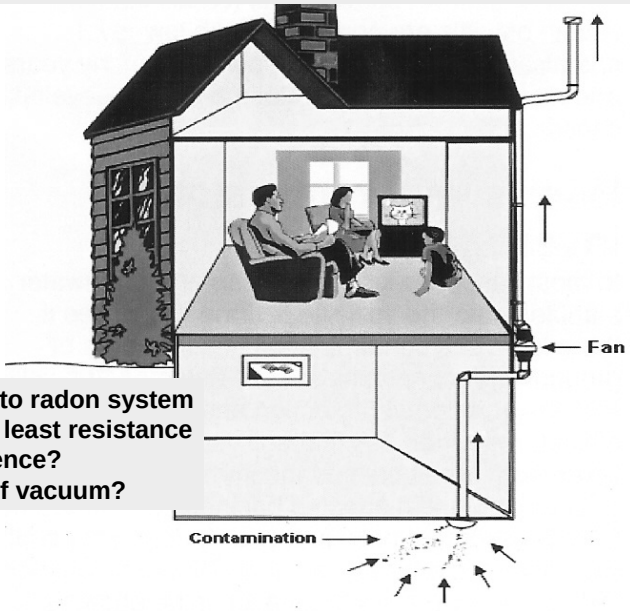
www.epaosc.net/behrvocplume

Web Site includes:

Reports
Photos
ODH Fact Sheets
Links to Articles

Vapor Abatement Mitigation System

(Sub-Slab Depressurization System or SSDS)



SSDS = similar to radon system
SSDS = Path of least resistance
Radius of Influence?
Least amount of vacuum?

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Vapor Abatement System Installation
Extraction Pipe into Slab

Based on radius of influence testing, multiple extraction points may be necessary
<u>Note:</u> Looking for entire slab to be under vacuum

38

Vapor Abatement System Installation
Outside Fan and Vent

Per local code, vent above highest window

39

Vapor Abatement System Installation
Outside Fan and Vent

Fan installed with electric on/off switch in a lockbox. Key provided to owner.
Electric cost = $75/year

VAS $ = average $1,500 installation (aka SSDS)

40

Vapor Abatement System Installation
Radius of Influence Testing

Radius of Influence testing = 96% success rate on initial installation at the Behr Site

Success = 30 & 90 day samples < IA screening level

41

Vapor Abatement System Installation
Crawl Space Application

42

Vapor Abatement System Installation
Dirt Basement (Test Case)

43

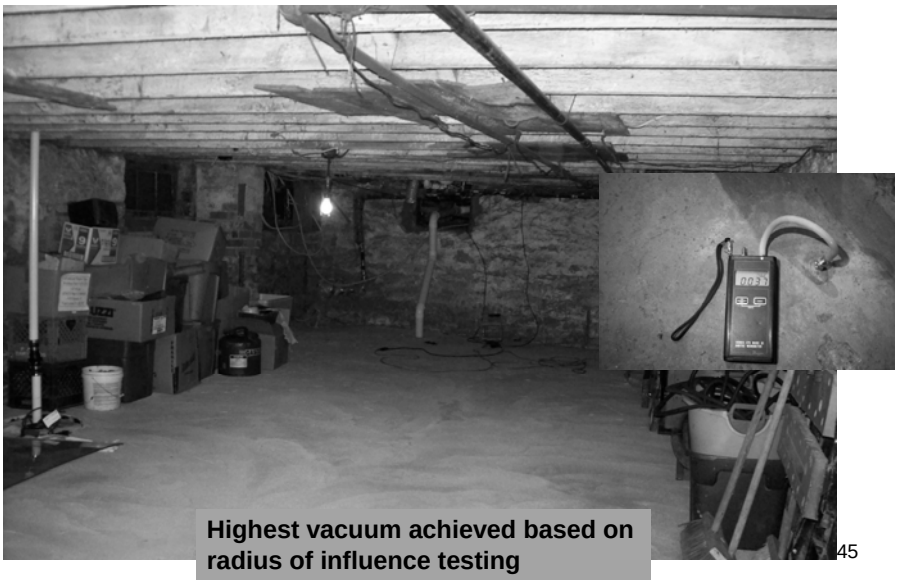
Vapor Abatement System Installation
Dirt Basement

Plastic netting applied under concrete to increase air flow to extraction pipe

Concrete creates impervious layer

44

Vapor Abatement System Installation
Dirt Basement



Highest vacuum achieved based on radius of influence testing

45

Vapor Abatement System Installation

U Tube Manometer on Extraction Pipe

1”- 2” vacuum applied to extraction point

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30 & 90 Day Performance Sampling

30 & 90 day sampling performed to confirm ATSDR screening levels have been achieved. 180 day sampling completed HD per request.

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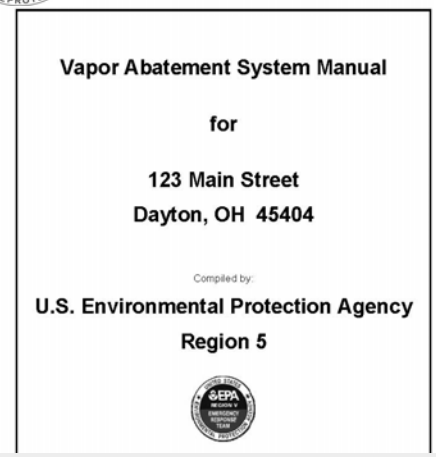
Vapor Abatement System Manual



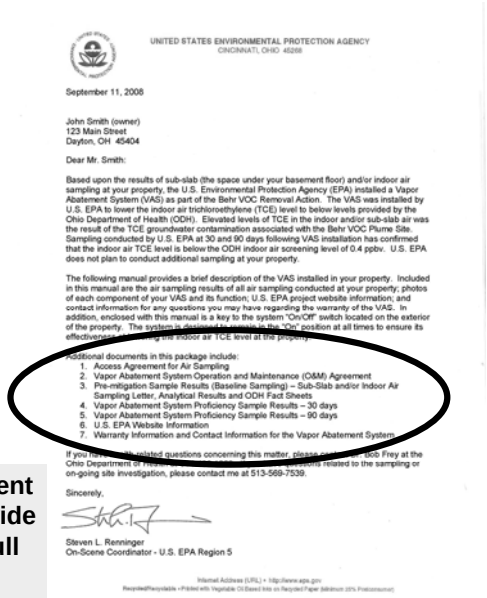
Vapor Abatement System Manual

for

123 Main Street
Dayton, OH 45404

Compiled by:

U.S. Environmental Protection Agency
Region 5



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

September 11, 2008

John Smith (owner)
123 Main Street
Dayton, OH 45404

Dear Mr. Smith:

Based upon the results of sub-slab (the space under your basement floor) and/or indoor air sampling at your property, the U.S. Environmental Protection Agency (EPA) installed a Vapor Abatement System (VAS) as part of the Behr VOC Removal Action. The VAS was installed by U.S. EPA to lower the indoor air trichloroethylene (TCE) level to below levels provided by the Ohio Department of Health (ODH). Elevated levels of TCE in the indoor and/or sub-slab air was the result of the TCE groundwater contamination associated with the Behr VOC Plume Site. Sampling conducted by U.S. EPA at 30 and 90 days following VAS installation has confirmed that the indoor air TCE level is below the ODH indoor air screening level of 0.4 ppbv. U.S. EPA does not plan to conduct additional sampling at your property.

The following manual provides a brief description of the VAS installed in your property. Included in this manual are the air sampling results of all air sampling conducted at your property; photos of each component of your VAS and its function; U.S. EPA project website information; and contact information for any questions you may have regarding the warranty of the VAS. In addition, enclosed with this manual is a key to the system "On/Off" switch located on the exterior of the property. The system is designed to remain in the "On" position at all times to ensure its effectiveness [illegible] the indoor air TCE level at the property.

Additional documents in this package include:

1. Access Agreement for Air Sampling
2. Vapor Abatement System Operation and Maintenance (O&M) Agreement
3. Pre-mitigation Sample Results (Baseline Sampling) – Sub-Slab and/or Indoor Air Sampling Letter, Analytical Results and ODH Fact Sheets
4. Vapor Abatement System Proficiency Sample Results – 30 days
5. Vapor Abatement System Proficiency Sample Results – 90 days
6. U.S. EPA Website Information
7. Warranty Information and Contact Information for the Vapor Abatement System

If you have [illegible] related questions concerning this matter, please contact [illegible] Bob Frey at the Ohio Department of [illegible] questions related to the sampling or on-going site investigation, please contact me at 513-569-7539.

Sincerely,

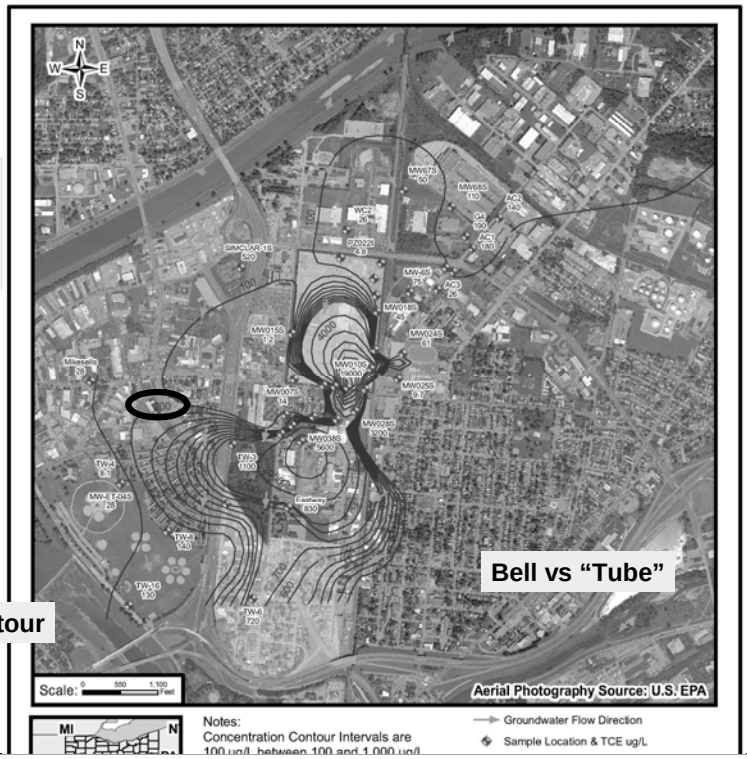
Steven L. Renninger
On-Scene Coordinator - U.S. EPA Region 5

Internet Address (URL) • http://www.epa.gov
Recycled/Recyclable • Printed with Vegetable Oil Based Inks on Recycled Paper (Minimum 25% Postconsumer)

Prior to installation, owners sign agreement accepting system. Owner agrees to provide electricity ($75/year). Following succesfull performance sampling (30 & 90 days), system manual is sent to owner

EPA Groundwater Contour Map

Sept 2007



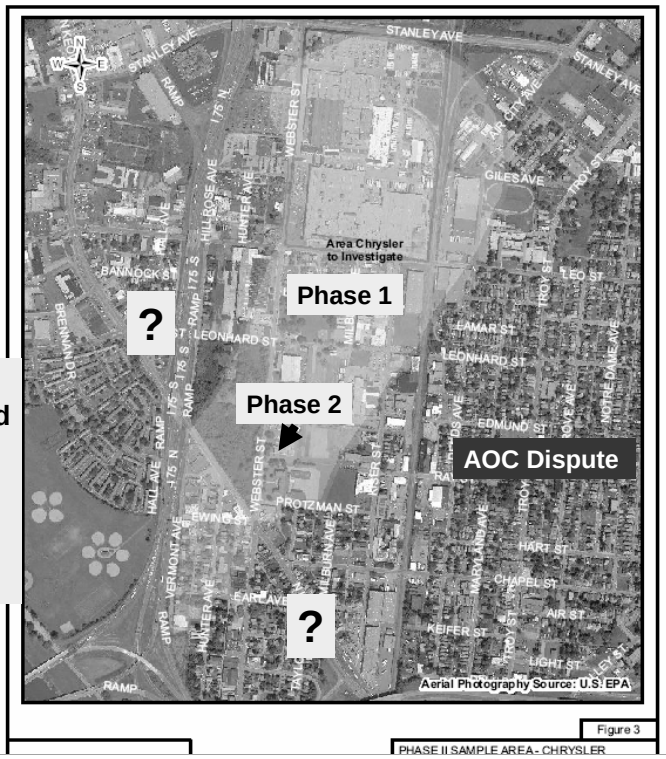
Note: 200 ppb contour

Phase 2 Area Plume Dispute

CHRYSLER

<u>Chrysler</u> will continue work in the blue shaded area including:

Sub-Slab Sampling
Indoor Air Sampling
Mitigation



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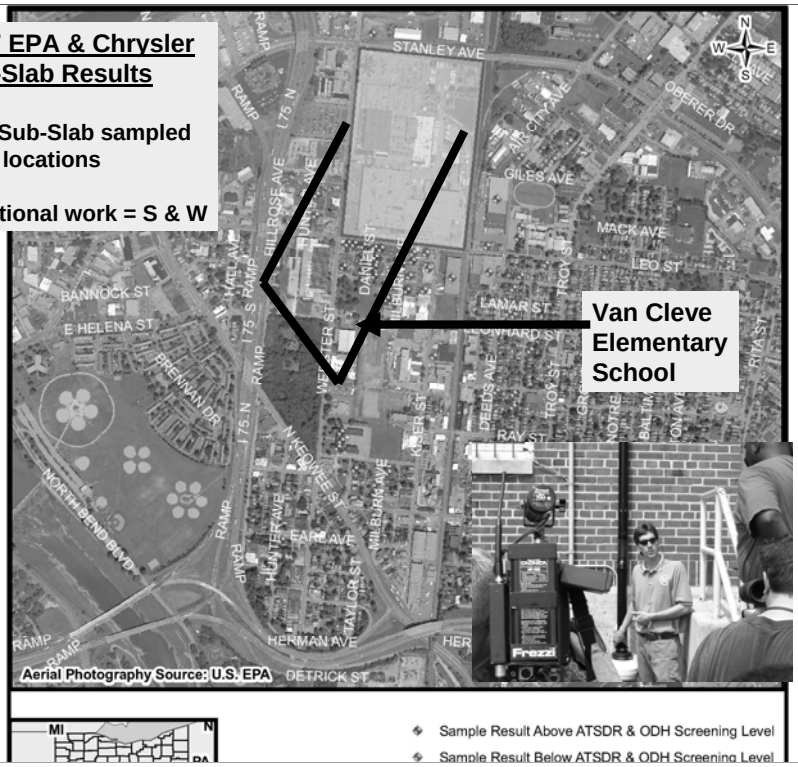
2007 EPA & Chrysler Sub-Slab Results

EPA Sub-Slab sampled at 30 locations

-additional work = S & W



- Sample Result Above ATSDR & ODH Screening Level
- Sample Result Below ATSDR & ODH Screening Level

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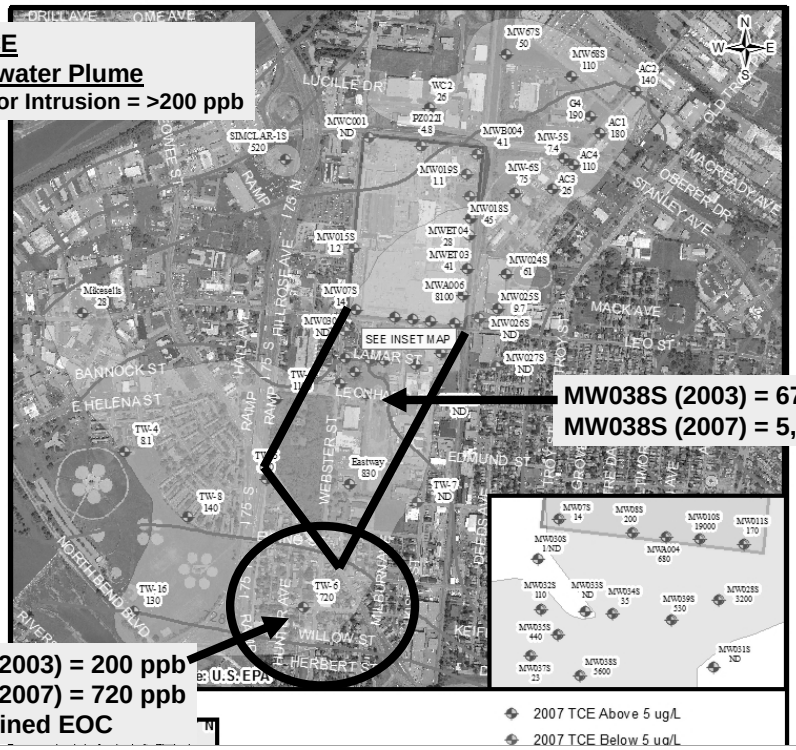
2007 TCE Groundwater Plume
TCE Vapor Intrusion = >200 ppb



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Behr VOC Site Summary Map Dec 2008

Chrysler area = blue

EPA area = yellow

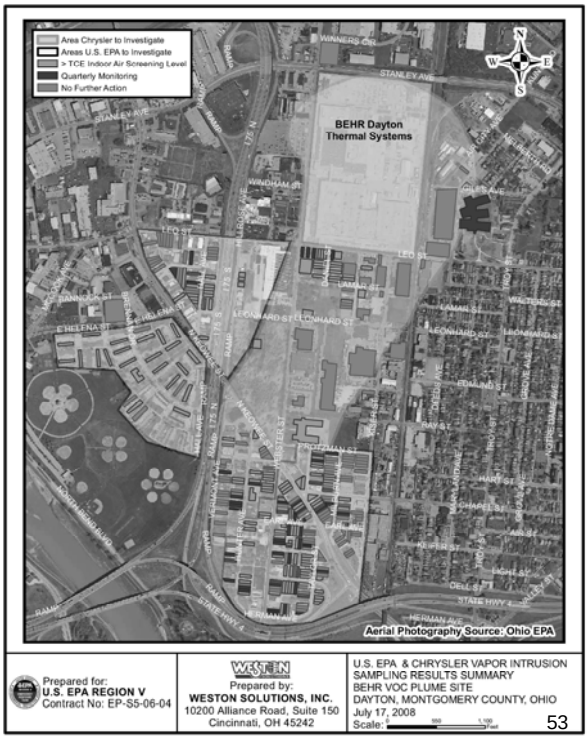
350 locations sampled to date

210 residences mitigated to date

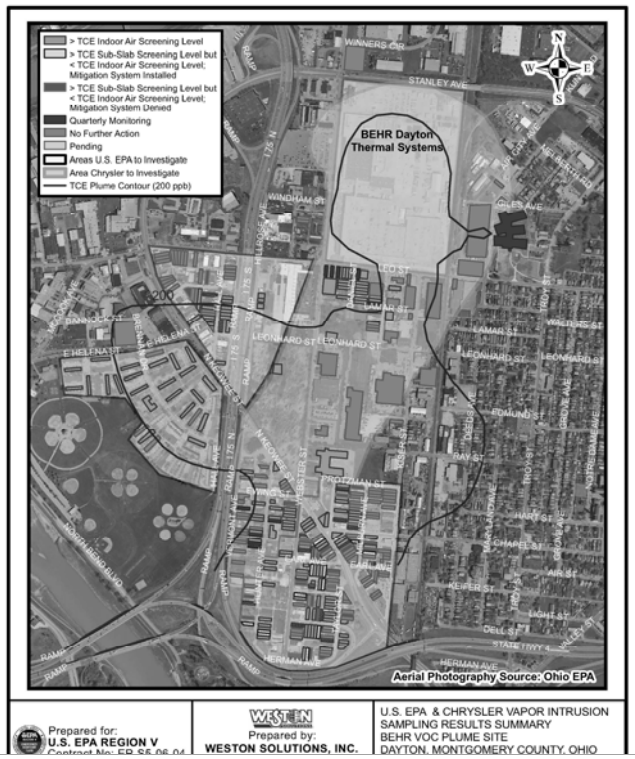
SVE system = Aug 2008

EPA Removal completion = Nov 2008

NPL listing = Sept 2008



Behr VOC Site Summary Map w/ 200 ppb GW contour



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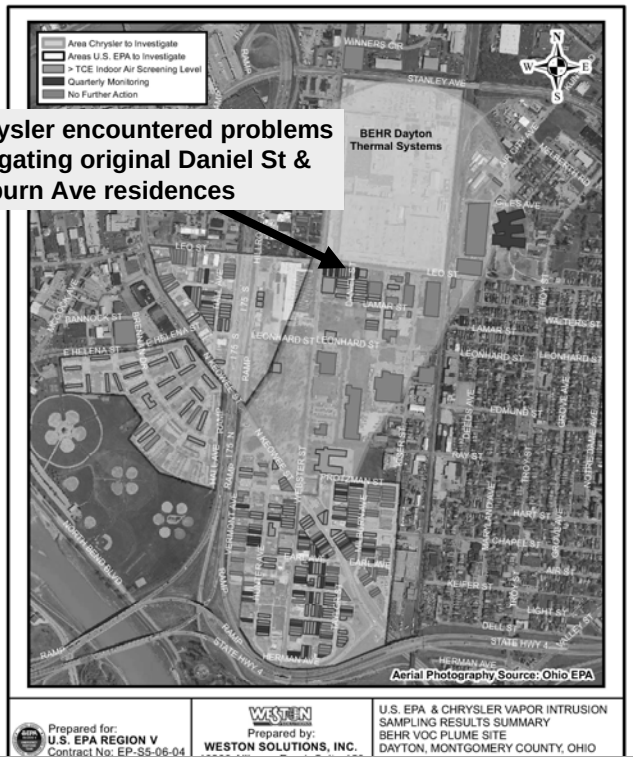
Chrysler encountered problems mitigating original Daniel St & Milburn Ave residences

Behr VOC Site
SVE System



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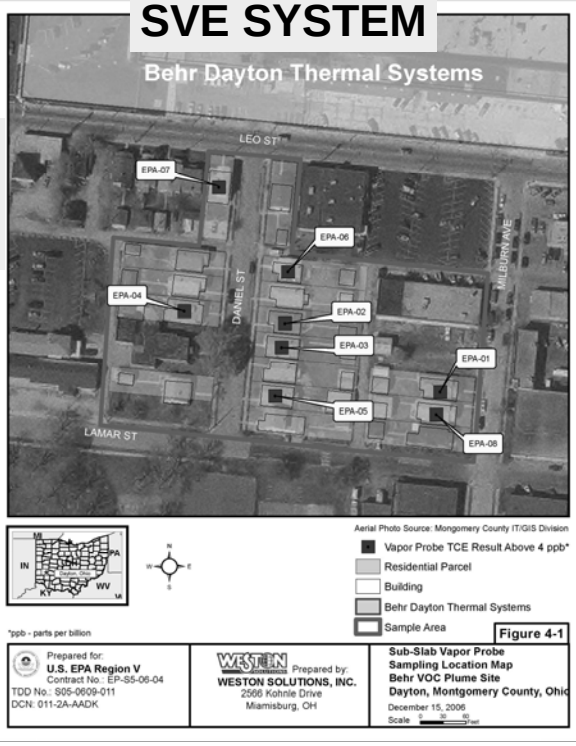
EPA Sub-Slab Sample Results

November 2006

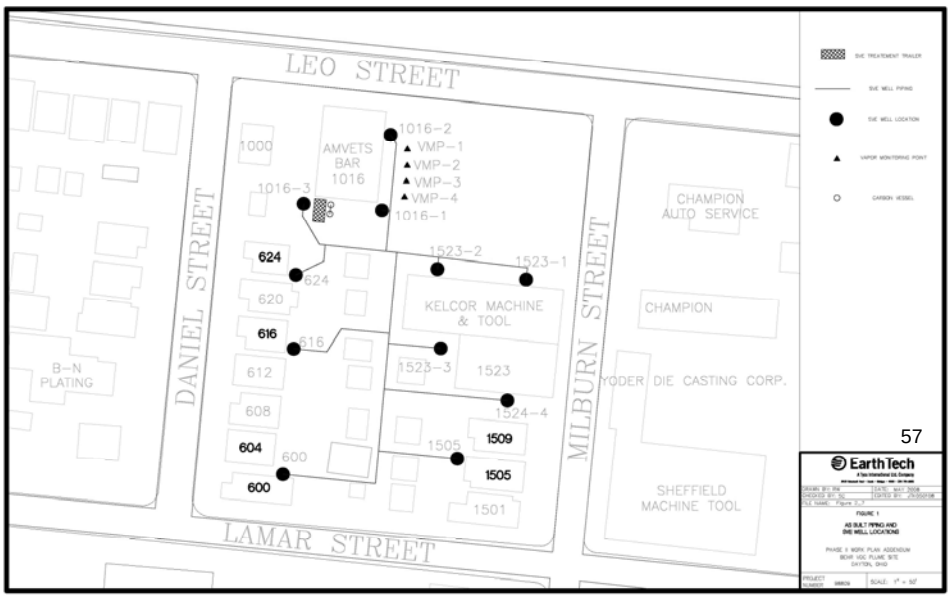
Location	TCE (ppb)
EPA-01	980
EPA-02	18,000
EPA-03	16,000
EPA-04	260
EPA-05	62,000
EPA-06	3,700
EPA-07	49
EPA-08	62,000

ATSDR & ODH Sub-Slab Screening Level = 4 ppb

SVE SYSTEM



SVE System – July 2008



SVE System

Sampling in August – December 2008 determined the SVE system is successful

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Some Behr Site Numbers…

- Highest **indoor air** TCE level = 460 ppbv (1,150 x IA)
- Highest **sub-slab** TCE level = 67,000 ppbv (1,675 x SS)

- EPA & Chrysler sampled 350 of 459 locations
  - **75% granted sampling access (Access is critical)**
  - **51% of residences sampled > IA screening level**

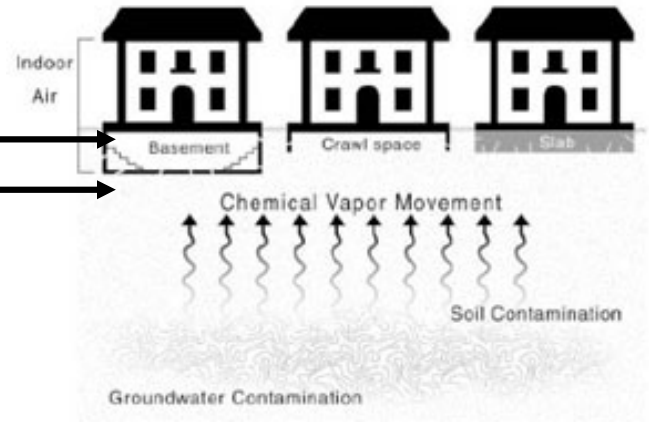
- For residences requiring mitigation (>SS & >IA)
  - **Average TCE Indoor Air result = 16.1 ppbv (40 x IA)**
  - **Average TCE Sub-Slab result = 3,758 ppbv (93 x SS)**

NCP Language

Actual vs Potential Threat

Indoor Air Sample > Screening Level = Actual Threat (needed in 2007)

Sub-Slab Sample > Screening Level = Potential Threat (ok in 2005)



NCP: "Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants"

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Vapor Intrusion Sample Decision Matrix

1. **SS < Screening Level = NFA (No Completed Pathway)**

2. **SS & IA > Screening Level = Mitigate (Completed Pathway)**

3. **SS > Screening Level & IA < Screening Level =**

   Quarterly Monitoring ($1,000 qtr x 3) vs Mitigation ($1,500)

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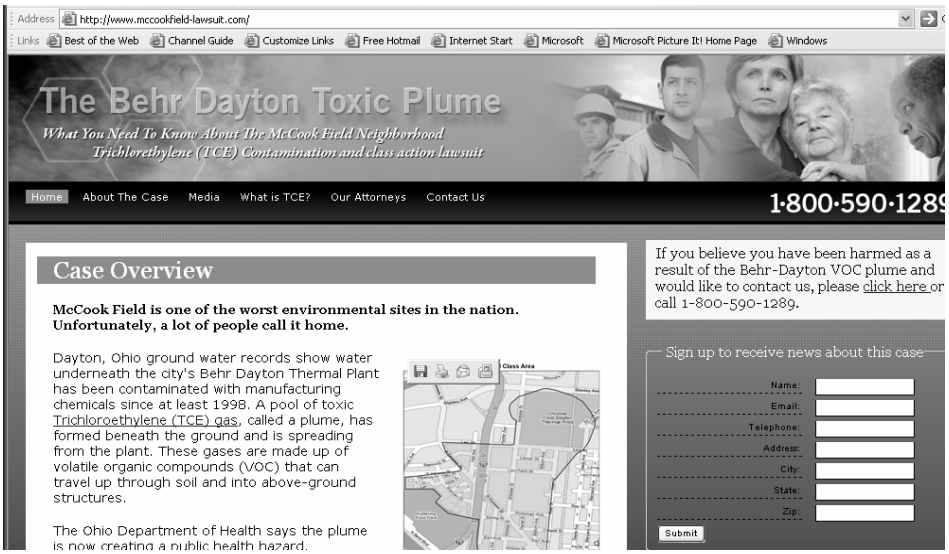

EPA = Mitigation to protect public health
PRP = Mitigation admits liability for class action lawsuit

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S/K

Vapor Intrusion Issues – Agenda

Introduction	**Turner / Renninger**
Behr VOC Site - Example	**Renninger**
Health Issues	**Renninger / Turner**
Groundwater Issues	**Renninger / Turner**
Hartford Site – Example	**Turner**
Sampling Procedures	**Renninger / Turner**
Vapor Intrusion Toolbox	**Renninger**
Vapor Intrusion Guidance	**Renninger / Turner**
Questions/Discussion	

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Considerations for establishing Health-based decision levels

S

- Best if decision levels and actions to be taken are established prior to sampling
- Partner with health department

- Environmental Media
  - Indoor air sampling
    - Sampling duration, seasonality
    - Impact of preferential pathways
    - Consider ambient and other indoor sources
  - Subslab air sampling
    - Attenuation factor
- Residential vs Commercial property

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Relationship of Health Issue to Decision Levels

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Health Issue	Decision Level
Acute health effects Intermediate health effects	Short-term
Chronic health effects Cancer	Long-term
Fire and explosion Asphyxiation, oxygen depletion	Immediate

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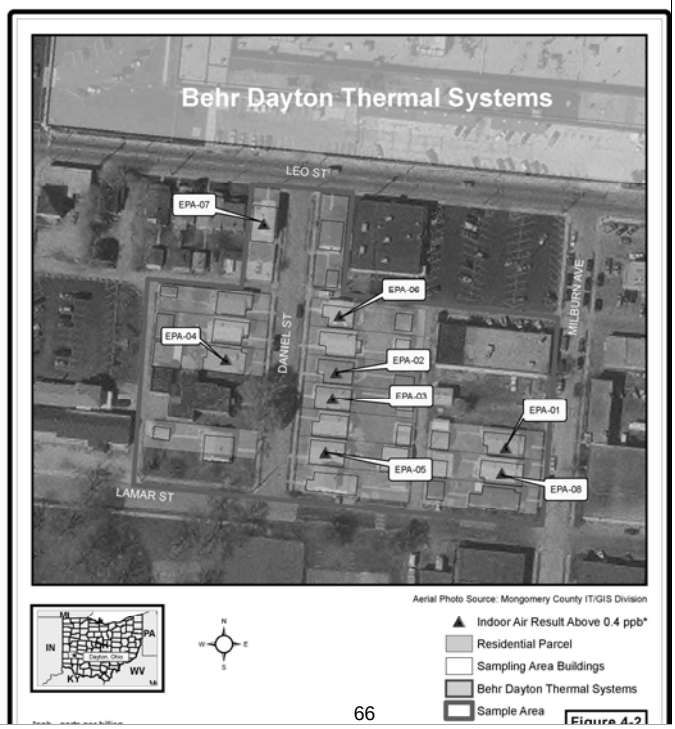
EPA Indoor Air Sample Results

November 2006

Location	TCE (ppb)
EPA-01	1.9
EPA-02	180
EPA-03	130
EPA-04	13
EPA-05	260
EPA-06	7.5
EPA-07	0.4
EPA-08	49

ATSDR & ODH Indoor Air Screening Level = 0.4 ppb (requiring mitigation)

3 residences > Immediate Action Level (100 ppb)



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"ACTION LEVELS" (Parts per billion per volume) FOR CHLORINATED SOLVENTS BEHR-DAYTON SITE, DAYTON, MONTGOMERY COUNTY S

Residential	Short-term Action Level[1]	Short-term Action Level	Long-term Screening Level[2]	Long-term Screening Level
Chemical	**Indoor Residential**	**Sub-slab Residential**	**Indoor Residential**	**Sub-slab Residential**
Trichloroethylene	100	1,000	0.4	4.0
Perchloroethylene	200	2,000	12	120
cis 1,2 DCE	200	2,000	8.8	88
trans 1,2 DCE	200	2,000	18	180
1,1,1 TCA	700	7,000	400	4,000
Vinyl chloride	30	300	11	110

[1] = ATSDR Intermediate Environmental Media Evaluation Guidance (EMEG)

[2] = US EPA Draft Vapor Intrusion Guidance document (2002)

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Resources for Health Information S on Toxic Substances

- ATSDR
  - Toxic Substances Portal
    http://www.atsdr.cdc.gov/substances/
  - ToxFAQ, ToxGuide, Public Health Statements
- State Health Departments
- EPA
  - Integrated Risk Information System (IRIS)

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Table 5-1 - Proposed Comparison Values (CVs)		
Compound	**Indoor Air ($\mu g/m^3$)[(a)]**	**Sub-Slab Vapor ($\mu g/m^3$)**
1,3-Butadiene	2	20
n-Hexane	200	2,000
Benzene - chronic	10	100
Benzene – acute	29	290
Methylcyclohexane	3,000	30,000
Toluene	300	3,000
Total Xylenes[(b)]	217	2170
Total Trimethylbenzenes[(b)]	6	60
Isopentane[(c)]	115	1,150
n-Butane[(c)]	115	1,150

(a) Indoor air CVs (ATSDR and IDPH, June 16,2006).
(b) CVs are for isomer totals.
(c) CVs are not health based.

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Non-Health Based screening levels

- Used as an ‘indicator’ chemical
  - Signals the presence of multiple chemicals that have not been specifically analyzed or evaluated
  - Allows for evaluation of potential health based effects of other chemicals when dilution of the sample is not technically possible
- Immediate health effects – fire and explosion hazards, oxygen depletion

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		Sample Method:	24-Hour 6-Liter Summa	K
		Sample Location:	Sub-Slab Monitoring Port 1	
		PID/FID Reading:	299 / 100000	
		Pressure Reading:	0	
		Sample Date:	5/2/2007	
Compound	**Comparison Value**	**Units**		
1,3-BUTADIENE	20	ug/m3	18000	U
HEXANE	2000	ug/m3	330000	
BENZENE	130	ug/m3	26000	U
METHYLCYCLOHEXANE	30100	ug/m3	51000	
TOLUENE	3000	ug/m3	30000	U
XYLENE	4300	ug/m3	35000	U
TRIMETHYLBENZENE	60	ug/m3	40000	U
ISOPENTANE	1150	ug/m3	4200000	
BUTANE	1150	ug/m3	6300000	
OXYGEN	NA	%	1.6	
METHANE	NA	%	3.9	
CARBON DIOXIDE	NA	%	11	72

Town is a time bomb!

It's sitting on sea of gasoline — and could blow up at any minute

It's a town that could explode at any minute!

The 1,700 residents of Hartford, Ill., are sitting on a ticking time bomb — because the whole town rests on an underground pool of close to four MILLION gallons of gasoline leaked from refinery pipes.

At any moment, a lit match or even a spark could ignite the ever-present gasoline fumes. The village has even put up street signs warning drivers not to leave their car motors running.

It's no empty threat — fires have already erupted at two homes when gas fumes ignited.

A year ago, the house that Harold and Norma Settles had built and lived in for 25 years caught fire and exploded, destroying the home and a lifetime of possessions.

"According to the fire department, the gas fumes entered the basement and were ignited by our furnace," said Norma, who now lives with her husband in a neighboring town, Wood River.

"It was a devastating sight. All the things I had saved for decades were gone. My husband and I are retired and had planned to live there the rest of our lives. But there was nothing left."

— Even the dirt burns

POWDER KEG: The town of Hartford, Ill., (above) is soaking in gasoline as Edwin Gallagher (below) shows — he got this jar full from a well.

partment of Public Health, says the gas fumes "are a terrible threat to public health" that can cause irritation of the eyes, nose and throat; headaches; nausea, and breathing difficulties.

Cindy Filson, a geologist with the Illinois Environmental Protection Agency, said the problem is espe-

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Safety Issues

- Explosion or Fire Hazard
- Asphyxiation, Oxygen depletion

URGENT public health hazard
- Contingency plan
- Fire department involvement
- Relocation

ATSDR/State and Local Health Department support to EPA

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- Development of health based screening levels for vapor intrusion sites
- Evaluation of sampling data
- Respond to citizen's health questions
- Provide health care provider education
- Support EPA at public meetings

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Vapor Intrusion Issues – Agenda

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Questions/Discussion	

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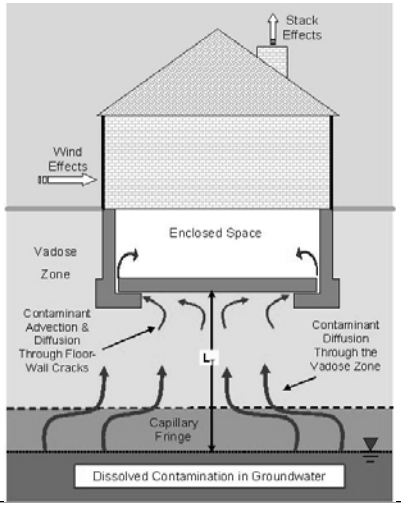
SITE HYDROGEOLOGY & URBAN FEATURES

- KEY TO DETERMINING IF VAPOR INTRUSION IS LIKELY.



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PERMANENT WELLS

- Provide a consistent data point.
- Repeat sampling events provide data for trend analysis.
- Installation of pressure transducers with data loggers provide water level measurements for ground water modeling.
- Wells must be maintained and eventually abandoned.

TEMPORARY WELLS

- Quickly installed by direct push method. Grab or vapor sample can be collected.
- An efficient way to get a ‘snapshot’ of the ground water and possibly the vapor plume.
- Temporary wells may help limit the number of permanent wells thus saving money.

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ANY SITE WITH VOC'S COULD BE A VAPOR INTRUSION SITE

- No site is the same
- There is no boiler plate for hydrogeological implications on vapor intrusion sites
- The hydrogeology of a site must be evaluated to determine the likelihood of vapor intrusion
- Don't assume without adequate data; otherwise,……..

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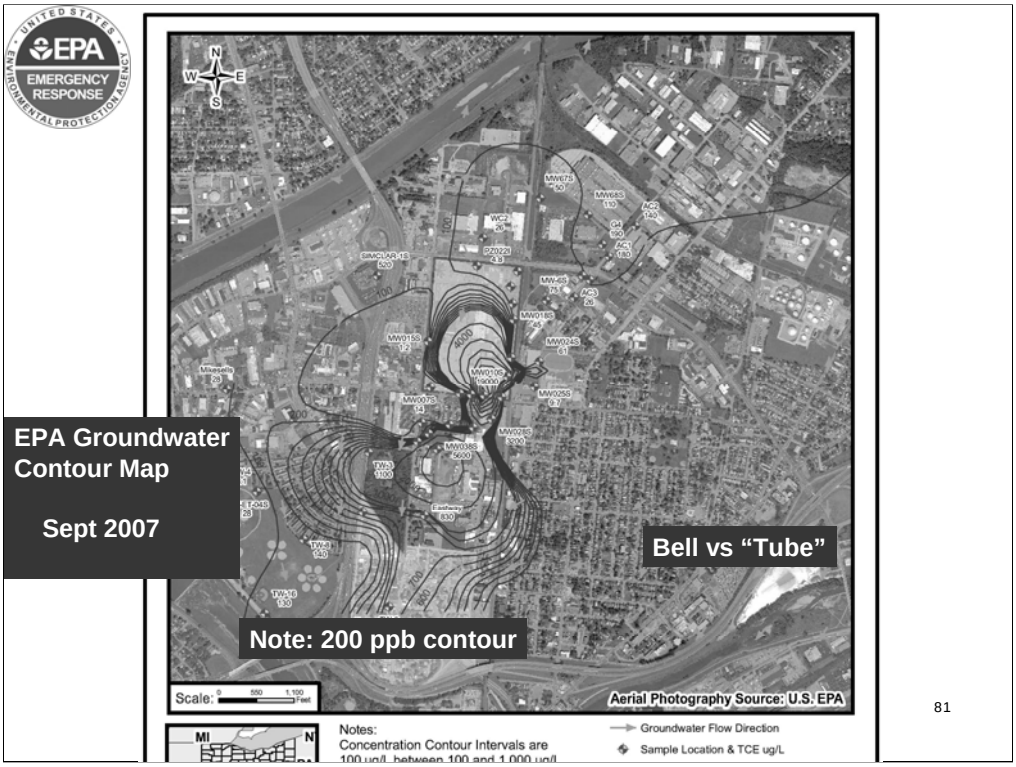
EPA
EMERGENCY RESPONSE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
N
W
E
S
EPA Groundwater Contour Map
Sept 2007
Bell vs "Tube"
Note: 200 ppb contour
Scale:
Aerial Photography Source: U.S. EPA
MI
Notes:
Concentration Contour Intervals are
100 ug/L between 100 and 1,000 ug/L
Groundwater Flow Direction
Sample Location & TCE ug/L

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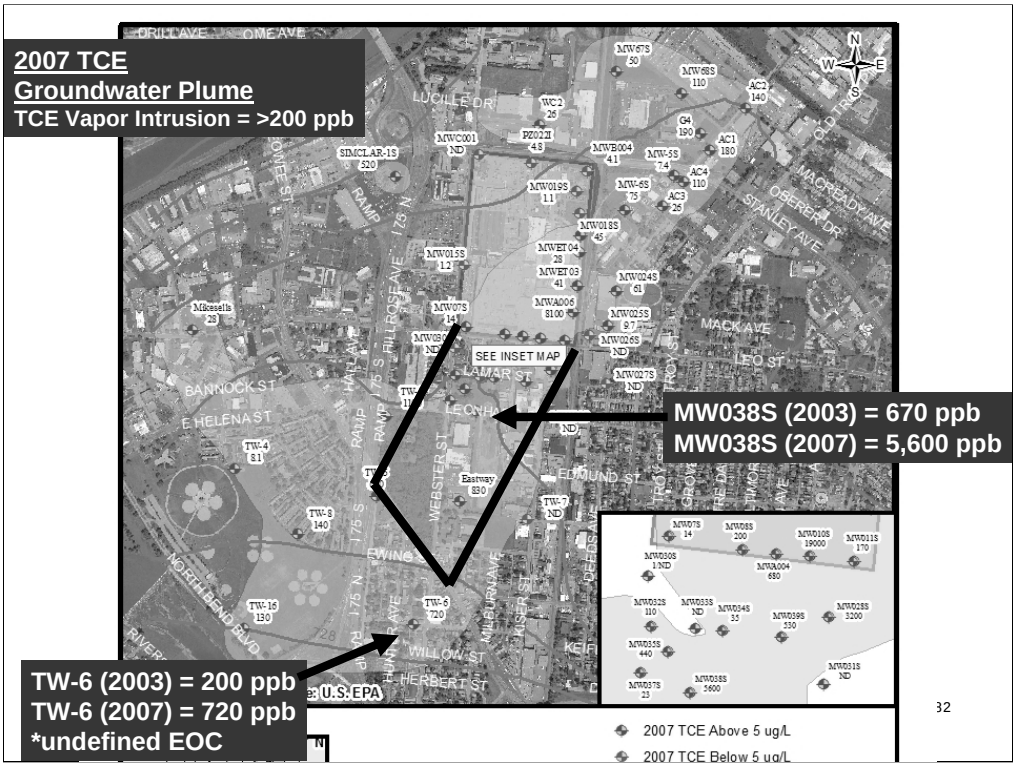
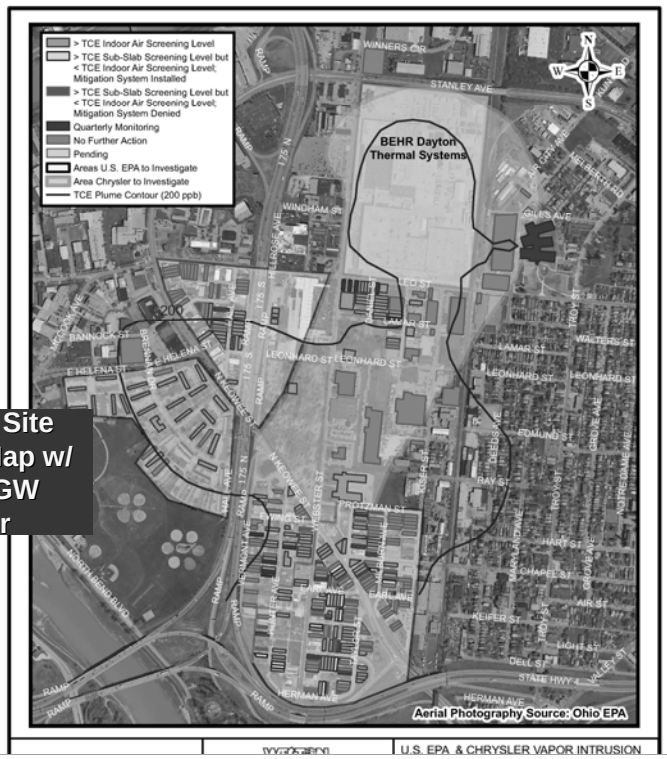

2007 TCE
Groundwater Plume
TCE Vapor Intrusion = >200 ppb
MW038S (2003) = 670 ppb
MW038S (2007) = 5,600 ppb
TW-6 (2003) = 200 ppb
TW-6 (2007) = 720 ppb
*undefined EOC
SEE INSET MAP
U.S. EPA
2007 TCE Above 5 ug/L
2007 TCE Below 5 ug/L

Behr VOC Site Summary Map w/ 200 ppb GW contour



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S/K

Vapor Intrusion Issues – Agenda

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Behr VOC Site - Example	**Renninger**
Health Issues	**Renninger / Turner**
Groundwater Issues	**Renninger / Turner**
Hartford Site – Example	**Turner**
Sampling Procedures	**Renninger / Turner**
Vapor Intrusion Toolbox	**Renninger**
Vapor Intrusion Guidance	**Renninger / Turner**
Questions/Discussion	

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Vapor Intrusion Case Study

Hartford Hydrocarbon Site

North Hartford, Illinois

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Hartford Project Description

- 10+ million gallons of gasoline, diesel and unrefined products released from buried pipelines and from the surrounding refineries over a 40+ year period
- 211 homes and businesses located over a thick layer of refined products plume
- Protecting the Village of Hartford public drinking water supply
- Seasonal vapor intrusion into homes and business building structures

86

Circa 1972

Significant Field Actions and Studies

- Multiple Work Plan submittals
  - Free Product, Dissolved, Vapors, Residuals, Pipeline corridors
- Pilot Test Studies
  - Interim Measures
  - Multi-Phase - Bio-slurp - Hi-Vac
  - Soil Vapor Extraction (SVE)
  - Skimming and pump testing
  - Cone of Depression??

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Details of Interim Measures

- Conduct “Needs Assessment” of each structure
- Make a Sub-Slab Depressuration System or Ventilation Fan available to all
- Emergency Response and Contingency Plan programs

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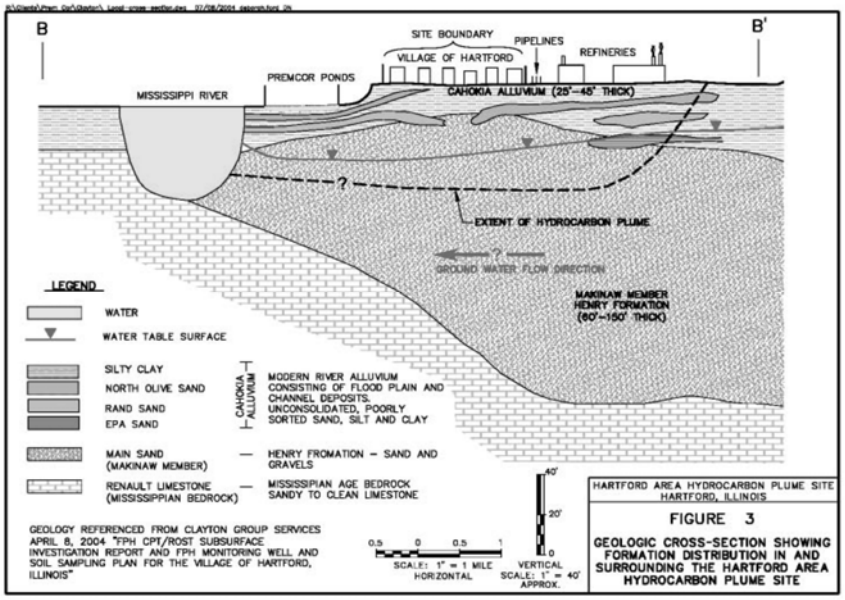
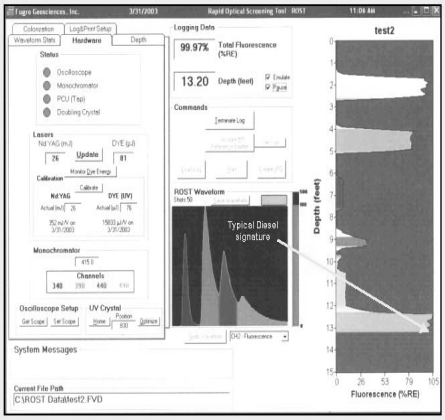
Located in Alluvial Deposits



ROST Investigation

Real Time Monitoring



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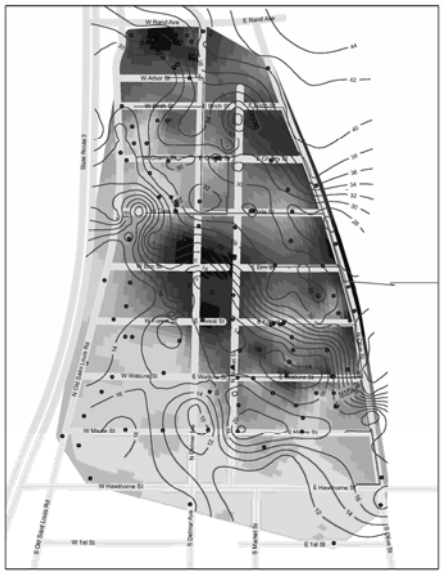
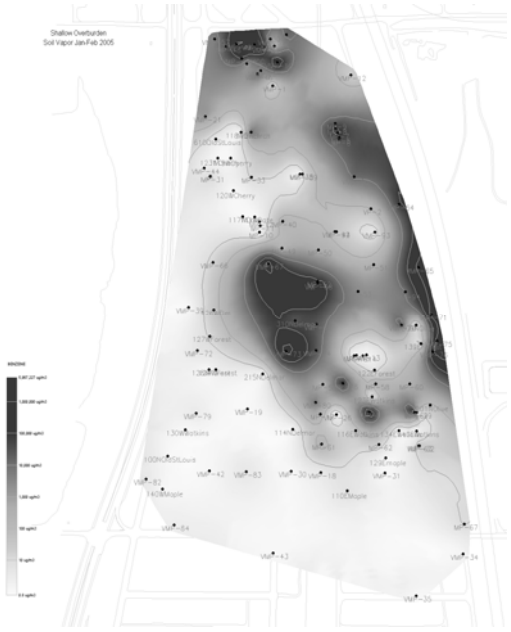
ROST LNAPL Extent – Main Stratum



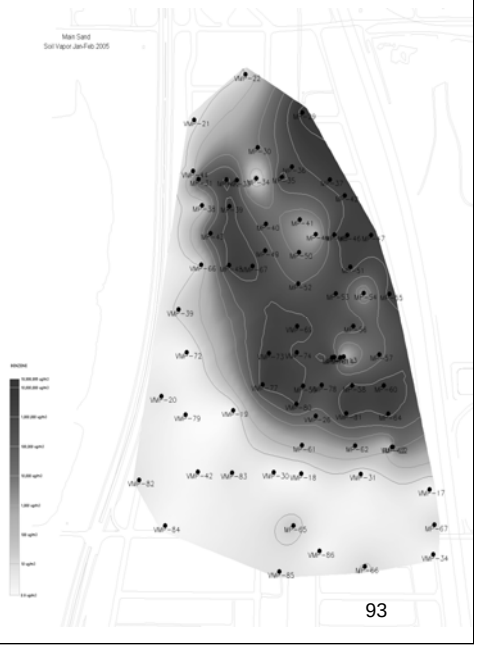
92

SVE Design Approach

Vapor Occurrence – Shallow



Vapor Occurrence – Deep



93

119 West Date

- Since 2004, a soil vapor extraction well had been located approximately 30 feet from the home.
- A needs assessment was completed at the home in July 2004, and a mitigation package was installed as an interim measure.
- Sub-slab monitoring at the home began in June 2006, and the three sub-slab results between June 2006 and February 2007 were low and unremarkable.

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May 2007 Event

- Hydrocarbon vapors were measured in routine quarterly sub-slab monitoring at the home in early May 2007:
  - Isopentane was detected at levels as high as 17,000,000 µg/m3 and hexane was detected at up to 1,300,000 µg/m3.
  - Sub-slab vapors were at 90% of the lower explosive limit on May 2, 2007 and they were “over range” on May 14, 2007.

95

Action levels of chemicals of interest are listed below.

Comparison Values for Hartford Air Samples			
Compound	Indoor Air Comparison Value		Sub Slab Comparison Value (in $\mu g/m^3$)
	ppb	$\mu g/m^3$	
1,3-butadiene	1	2	20
n-Hexane	55	200	2,000
Benzene	4	13	130
Methylcyclohexane	750	3,010	30,100
Toluene	80	300	3,000
Ethylbenzene	230	1,000	10,000
Xylenes	100	430	4,300
Isopentane	39	115	1,150
n-Butane	48	115	1,150
n-Propylbenzene	30	140	1,400
Trimethylbenzenes	1.3	6	60
Methyl-tert-butyl ether	700	2,500	25,000

Hartford Hydrocarbon Site

- Several gasoline constituents were measured at high levels on the first floor of the home and the same compounds were measured at even higher levels in the basement. For example, on May 14:

	Isopentane ug/m3	Hexane ug/m3
1st Floor	2,500	280
Basement	13,000	1,600

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Hartford Hydrocarbon Site

- Mabel Edwards agreed to leave the home and stay with her daughter until her home was cleared for occupancy. By late May 2007, the levels of sub-slab and indoor hydrocarbon vapors at the home subsided.

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Investigation

- Geoprobe test borings near the home showed that there was a comparatively thin layer of about 5 feet of clayey-silts beneath the home, with more porous sandy layers above and below those less permeable soils.
- Groundwater levels rose a total of 3.56 feet during April and May 2007, with the most significant daily rises in groundwater levels occurring on April 28 and May 10.
- Vapor data showed that pressure build-up from the groundwater rise in the Main Sand stratum forced gases upward into shallower soil layers near the home.

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DRAFT Assessment of Vapor Intrusion at 119 W. Date Street (May 2007)

The following provides an assessment of vapor intrusion at 119 W. Date Street during May 2007. This information is used to support the decision on placement and screen intervals for Soil Vapor Extraction well HSVE-5R.

I. **PROPERTY LOCATION**

119 W. Date Street
Hartford IL

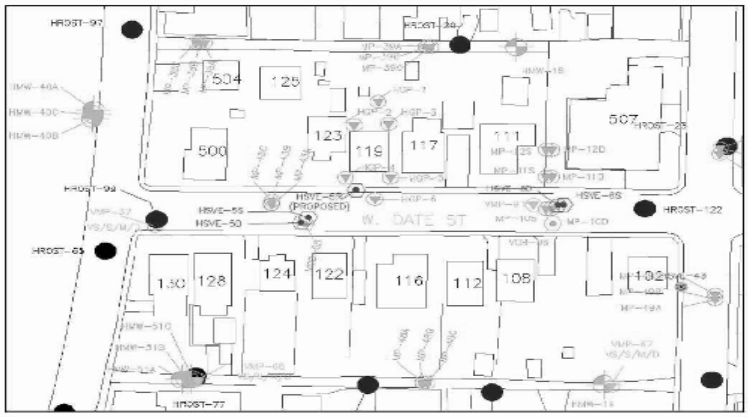


Figure 1 - Monitoring Points / Proposed Location of HSVE-5R

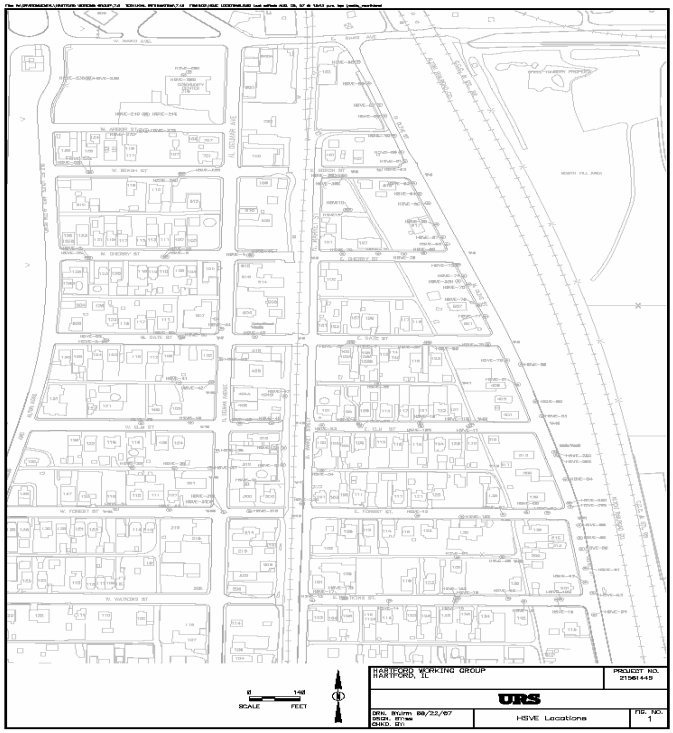
Conclusion

- Rapidly-rising groundwater levels in the area during late April and early May 2007 had forced hydrocarbons in the Main Sand stratum through a relatively thin layer of clays and silts beneath the home.

- The upward migration of vapors could not be controlled or captured by the existing Vapor Control System because the positive pressure exerted by the rising groundwater overwhelmed the negative pressure created by soil vapor extraction wells in the area.

Hartford Hydrocarbon Site

SVE Well Locations Dec 2008



Hartford Hydrocarbon Site

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Evaluate Broader Than BTEX Contamination

	Location ID	Sample ID	Sample Date	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	1,3-BUTADIENE	BENZENE	ETHYL BENZENE	HEXANE	ISOPENTANE	M,P-XYLENE	M
2		Subslab Comparison Value (ug/m3)		60	60	20	130	10,000	2,000	1,150	4,300	25,00
3			Units	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m
4	100NOldStLouis	013105 100NOldStLouis SS-1	1/31/2005	< 3.6	< 3.6	< 6.4	< 2.3	< 3.2	< 2.6	130	3.3	< 10
5		013105 100NOldStLouis SS-2	1/31/2005	11	11	< 6.6	< 2.4	< 3.2	6	130	4.7	< 11
6		013105 100NOldStLouis SS-3	1/31/2005	< 4.0	< 4.0	< 7.1	< 2.6	< 3.5	< 2.8	98	< 3.5	< 12
7	110EMaple	012405 110 E Maple SS1	1/24/2005	4.6	< 3.5	< 1.6	8.1	3.8	< 10	98	12	-
8		012405 110 E Maple SS2	1/24/2005	< 3.9	< 3.9	< 1.7	7.4	< 3.4	< 11	42	9	-
9		012405 110 E Maple SS3	1/24/2005	< 3.5	< 3.5	< 1.6	5.4	< 3.1	< 10	16	8.7	-
10	111WDate	022305 111 W Date SS1	2/23/2005	< 3.5	< 3.5	< 6.4	< 2.3	< 3.1	< 2.5	< 8.5	< 3.1	< 10
11		022305 111 W Date SS2	2/23/2005	< 3.6	< 3.6	< 6.4	< 2.3	< 3.2	< 2.6	< 8.6	< 3.2	< 10
12		022305 111 W Date SS3	2/23/2005	< 3.5	< 3.5	< 6.2	< 2.2	< 3.1	< 2.5	10	< 3.1	< 10
13	112WBirch	021005 112 W Birch SS1	2/10/2005	< 1,200	< 1,200	< 1,100J	**290**	< 25	[illegible]	**260,000**	< 25	< 3,50
14		021005 112 W Birch SS2	2/10/2005	< 46,000	< 46,000	< 20,000J	**12,000**	< 260	**490,000**	**10,000,000**	< 260	< 150,0
15		021005 112 W Birch SS3	2/10/2005	< 65,000	< 65,000	< 29,000J	**9,200**	< 270	**310,000**	**11,000,000**	< 270	< 320,0
16		021005 112 W Birch SS4	2/10/2005	< 72,000	< 72,000	< 32,000J	**14,000**	< 250	**410,000**	**16,000,000**	< 250	< 300,0
17	114NDelmar	021505 114 N Delmar SS1	2/15/2005	< 4.1	< 4.1	< 7.4	< 2.7	< 3.6	< 3.0	< 9.9	< 3.6	< 12
18		021505 114 N Delmar SS1 Dup	2/15/2005	< 3.5	< 3.5	< 6.4	< 2.3	< 3.1	< 2.5	< 8.5	< 3.1	< 10
19		021505 114 N Delmar SS2	2/15/2005	< 4.3	< 4.3	< 7.7	< 2.8	< 3.8	< 3.[illegible]	[illegible]	< 3.8	< 13
20	116EWatkins	020705116EWATKINS SS1	2/7/2005	< 3.2	< 3.2	< 5.8	< 2.1	< 2.9	< 2.3	8	< 2.9	< 9.4
21		020705116EWATKINS SS2	2/7/2005	< 4.0	< 4.0	< 7.1	94	< 3.5	< 2.8	< 9.5	9	< 12
22		020705116EWATKINS SS3	2/7/2005	< 3.7	< 3.7	< 6.7	< 2.4	< 3.3	< 2.7	62	< 3.3	< 11
23	117WDate	032205 117 W Date SS1	3/22/2005	< 3.7	< 3.7	< 6.6	< 2.4	< 3.2	< 2.6	< 8.8	< 3.2	< 11
24		032205 117 W Date SS2	3/22/2005	< 3.5	< 3.5	< 6.4	< 2.3	< 3.1	< 2.5	< 8.5	< 3.1	< 10
25		032205 117 W Date SS2 Dupe	3/22/2005	< 3.7	< 3.7	< 6.7	< 2.4	< 3.3	< 2.7	< 9.0	4	< 11
26		032205 117 W Date SS3	3/22/2005	< 3.5	< 3.5	< 6.2	< 2.2	< 3.1	< 2.5	< 8.3	< 3.1	< 10
27	118WBirch	031705 118 W Birch SS1	3/17/2005	< 4.0	< 4.0	< 7.2	< 2.6	< 3.6	< 2.9	< 9.7	9.4	< 12
28		031705 118 W Birch SS2	3/17/2005	< 3.7	< 3.7	< 6.6	< 2.4	< 3.2	< 2.6	< 8.8	8.4	< 11

ppbv units | ug-m3 units

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COMMON INDOOR AIR CHEMICAL SOURCES

CHEMICAL NAME	SOURCES
1,1,1-Trichloroethane	Used as a degreaser, in solvents, and as an aerosol propellant
1,2,4-Trimethylbenzene	Used to make drugs and dyes, in gasoline and certain paints and cleaners.
1,3,5-Trimethylbenzene	Component in diesel exhaust.
2-Butanone	Found in paints, coatings, glues, cleaning agents, and cigarette smoke. It occurs naturally in some fruit and trees. Also known as Methyl Ethyl Ketone or MEK.
4-Ethyltoluene	Used as a solvent, found in kerosene and light vapor oil.
Acetone	Used as a common solvent.
Acetonitrile	Found in certain lithium batteries. Used to make plastics, synthetic rubber, and acrylic fibers. Used as a common solvent in laboratories.
Acrolein	Used in plastics, perfumes, aquatic herbicides. Also found in cigarette smoke and automobile exhaust.
Benzene	Found in cigarette smoke, gasoline, crude oil, and used as a solvent. May be an ingredient of household products such as glues, paints, furniture wax, and detergents.
Carbon Disulfide	Used in the manufacturing of rayon, in soil disinfectants, and in solvents.
Chlorobenzene	Used as a solvent for paints, pesticides.
Chloroethane	Used as a refrigerant, solvent. Also used in making cellulose, dyes, medicinal drugs.
Chloromethane	Byproduct of burning grasses, wood, cigarettes, charcoal, or plastic. Found in styrofoam insulation, aerosol propellants, and chlorinated swimming pools.
cis-1,2-Dichloroethene	Found in perfumes, dyes, lacquers, solvents, and products made from natural rubber
Dichlorodifluoromethane	Used as a refrigerant, aerosol propellant, and solvent. Also known as Freon 12.
Ethylbenzene	Used as a common solvent, and found in gasoline, inks, insecticides, and paints. Also found in cigarette smoke.
Heptane/Hexane	Found in petroleum products, is often mixed with other solvents, and is used as a filling for thermometers.
Isooctane	Found in petroleum, gasoline, solvents, and thinners. A component of the "odor" of gasoline.
Methyl t-Butyl Ether	Used as an additive in unleaded gasoline.
Pentane	Found in petroleum, gasoline.
Propene	A flammable propellant, produced from petroleum cracking.
Styrene	Found in synthetic rubbers, resins, insulators
tert-Butyl Alcohol	Found as flavors, in perfumes, in paint remover, as a gasoline booster, and in solvents.
Tetrachloroethene	Used in dry cleaning and as a degreaser. When clothes are brought home from the drycleaners, they often release small amounts of tetrachloroethylene into the air.
Toluene	Used as a common solvent, and found in gasoline, paints and lacquers. Also found in cigarette smoke.
Trichloroethene	Used as a degreasing agent. It is also a common ingredient in cleaning agents, paints, adhesives, varnishes, and inks.
Trichlorofluoromethane	Used as refrigerant, aerosol propellant, and solvent. Also known as Freon 11.
Xylenes	Used as a solvent, cleaning agent, and thinner for paints, and in fuels and gasoline.

Note: Gasoline components may be listed in the ingredients of household products as petroleum distillates or solvents.

S/K

Vapor Intrusion Issues – Agenda

Introduction	**Turner / Renninger**
Behr VOC Site - Example	**Renninger**
Health Issues	**Renninger / Turner**
Groundwater Issues	**Renninger / Turner**
Hartford Site – Example	**Turner**
Sampling Procedures	**Renninger / Turner**
Vapor Intrusion Toolbox	**Renninger**
Vapor Intrusion Guidance	**Renninger / Turner**
Questions/Discussion	

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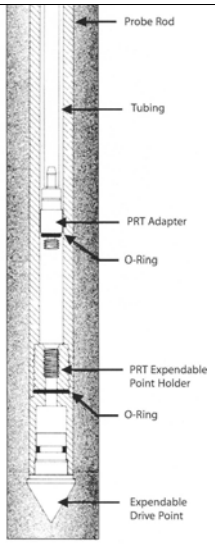
Direct Push Probes



Direct-push sampling methods likely create the least vapor concentration disturbance since sampling can often be accomplished without removal of soil.

Alternate ‘Sub Slab’ Implant Installation – Angle Drilling

Sampling Implant Installation

Soil Vapor and Sub Slab Vapor Investigation

- Step-wise approach

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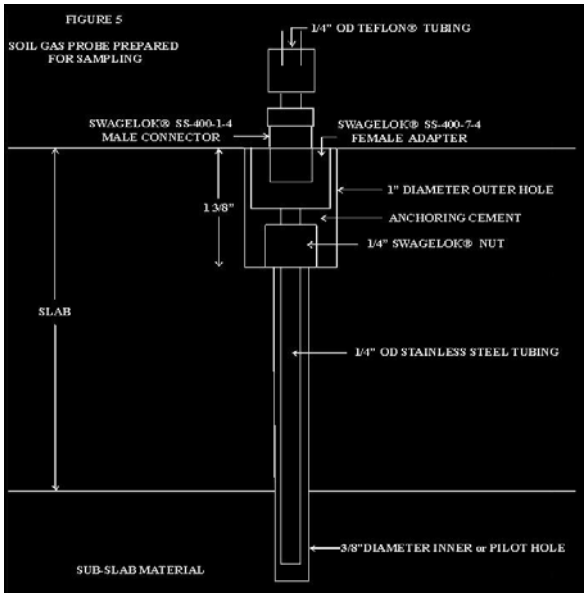
Subslab Sampling Port



Drilling Through Slab

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Placement and Cementing of the Probe

Installing Inert Sample Collection Line

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Collecting an Indoor Air Sample using a SUMMA Canister

116

Collecting an Ambient Air Sample Using a SUMMA Canister

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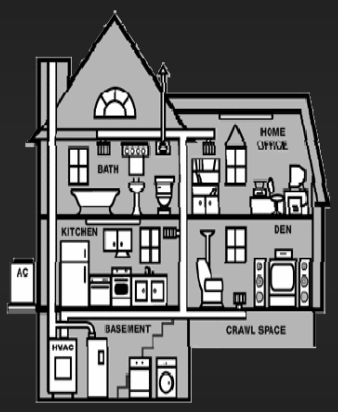
Sources of Background IA Contamination

- Consumer Activities
- Household Products
- Building Materials & Furnishings
- Ambient (outside) Air
- Laboratory Contaminants



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TAGA Pre-Screening

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Trace Atmospheric Gas Analyzer (TAGA) Mobile Laboratory

Gas Chromatograph with Concentrator for Volatiles

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Hey, did you want all of the sources removed???

What does your data tell you???

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Site Profile - Microsoft Internet Explorer
File Edit View Favorites Tools Help
www.epaosc.net/vaporintrusion
On-Scene Coordinator
United States Environmental Protection Agency EPA
profile bulletins images documents POLREPs contacts links logout profile
Vapor Intrusion ToolBox
Cincinnati, OH - EPA Region V
Delete Site
Site Contact:
Steven Renninger/Kevin Turner
On-Scene Coordinator
renninger.steven@epa.gov
www.epaosc.net/vaporintrusion
Cincinnati, OH
Edit Site Info
area map | bookmark
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
EPA
EMERGENCY RESPONSE
The Vapor Intrusion Toolbox will be used to post documents for OSCs to use in response to Vapor Intrusion Sites. Vapor intrusion is the migration of volatile chemicals from the subsurface into overlying buildings.
See Documents Section for:
Vapor Intrusion Fact Sheet
Exposure to Toxic Chemicals Fact Sheet
TCE Fact Sheet
EPA Access Agreement for Sampling
124
Internet
start
Steven Renning...
Chevron Hooven
Presentation1
Site Profile - Micr...
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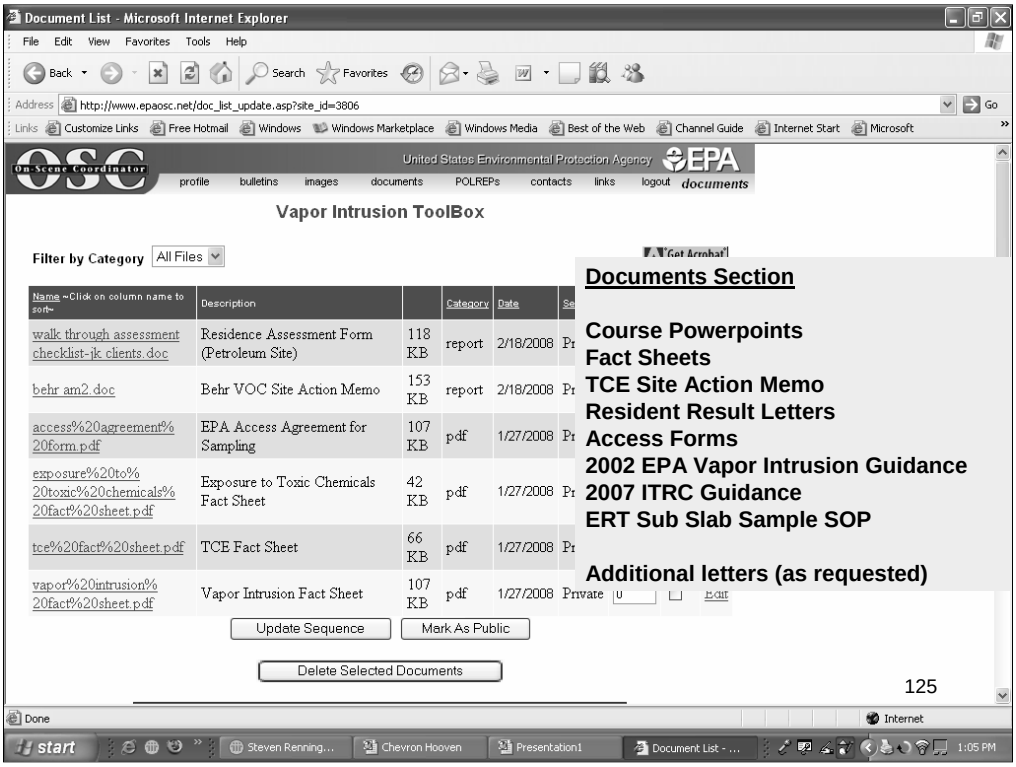
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On-Scene Coordinator
United States Environmental Protection Agency EPA
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Vapor Intrusion ToolBox
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Residence Assessment Form (Petroleum Site)
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report
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Behr VOC Site Action Memo
153 KB
report
2/18/2008
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Vapor Intrusion Fact Sheet
107 KB
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Update Sequence
Mark As Public
Delete Selected Documents
Documents Section
Course Powerpoints
Fact Sheets
TCE Site Action Memo
Resident Result Letters
Access Forms
2002 EPA Vapor Intrusion Guidance
2007 ITRC Guidance
ERT Sub Slab Sample SOP
Additional letters (as requested)
125
Done
Internet
start
Steven Renning...
Chevron Hooven
Presentation1
Document List - ...
1:05 PM

S/K

Vapor Intrusion Issues – Agenda

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Vapor Intrusion Guidance	**Renninger / Turner**
Questions/Discussion	

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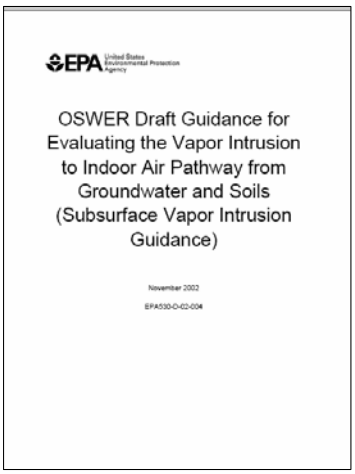
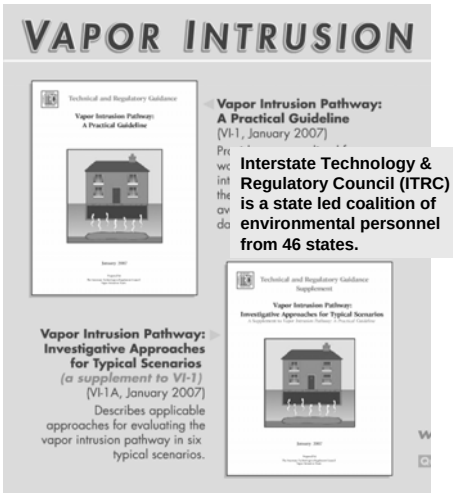
Vapor Intrusion Guidance



2002 EPA Guidance



Interstate Technology & Regulatory Council (ITRC) is a state led coalition of environmental personnel from 46 states.

2007 ITRC Guidance

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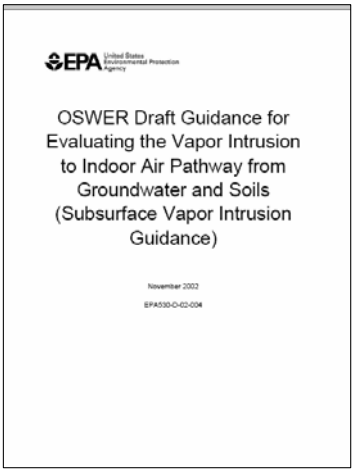
S

EPA Vapor Intrusion Guidance - 2002



Overview of Guidance: Where to find answers, definitions, etc

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EPA Vapor Intrusion Guidance – 2002

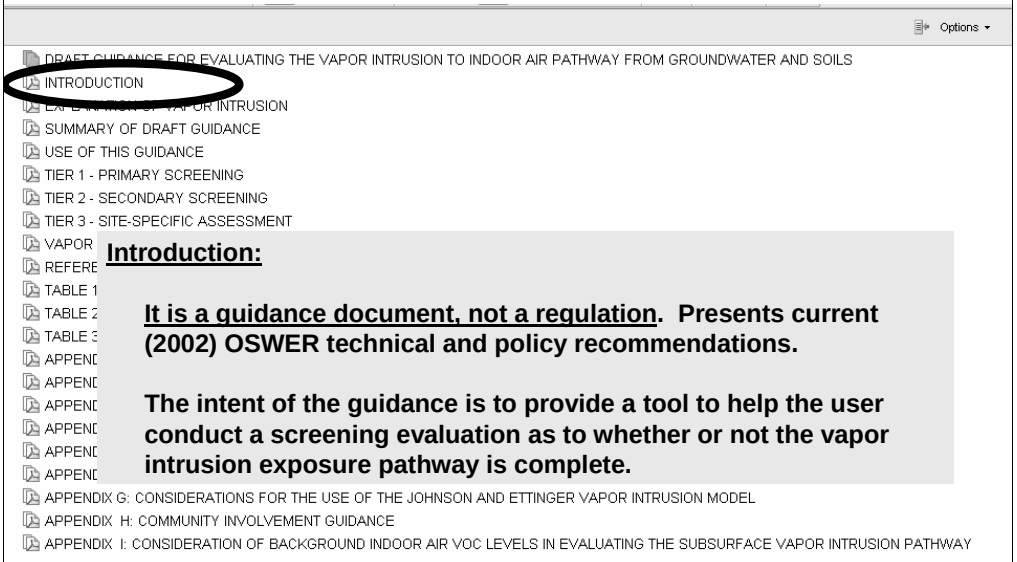
Table of Contents

Options

S

EPA Vapor Intrusion Guidance – 2002

Introduction



Introduction:

It is a guidance document, not a regulation. Presents current (2002) OSWER technical and policy recommendations.

The intent of the guidance is to provide a tool to help the user conduct a screening evaluation as to whether or not the vapor intrusion exposure pathway is complete.

K

EPA Vapor Intrusion Guidance – 2002

Explanation of Vapor Intrusion

Options

DRAFT GUIDANCE FOR EVALUATING THE VAPOR INTRUSION TO INDOOR AIR PATHWAY FROM GROUNDWATER AND SOILS

EXPLANATION OF VAPOR INTRUSION

USE OF THIS GUIDANCE

TIER 1 -

TIER 2 -

TIER 3 -

VAPOR

REFERE

TABLE 1: QUESTION 1 SUMMAY SHEET

TABLE 2: QUESTION 4 GENERIC SC

TABLE 3: QUESTION 5 SOIL GAS S

APPENDIX A: DATA QUALITY ASSU

APPENDIX B: DEVELOPMENT OF A

APPENDIX C: DETAILED FLOW DIA

APPENDIX D: DEVELOPMENT OF T

APPENDIX E: RELEVANT METHODS

APPENDIX F: EMPIRICAL ATTENUA

APPENDIX G: CONSIDERATIONS FC

APPENDIX H: COMMUNITY INVOLV

APPENDIX I: CONSIDERATION OF

Explanation of Vapor Intrusion:

Vapor Intrusion is migration of volatile chemicals from the subsurface to overlying buildings

FACTORS (α)

OR INTRUSION PATHWAY

ODEL

URFACE VAPOR INTRUSION PATHWAY

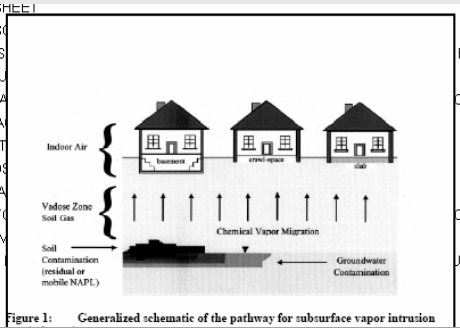
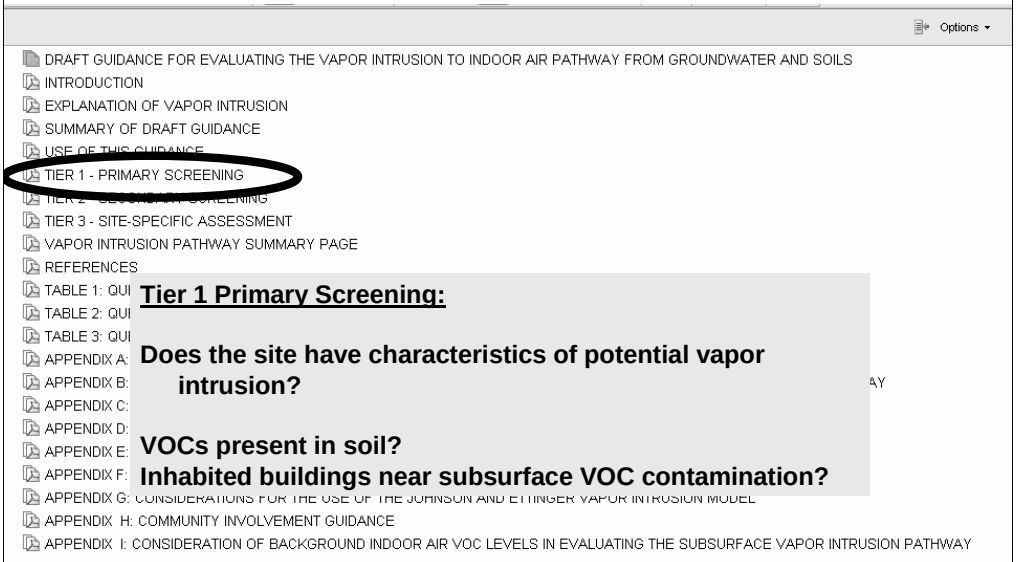


Figure 1: Generalized schematic of the pathway for subsurface vapor intrusion

S

EPA Vapor Intrusion Guidance – 2002

Primary Screening



Tier 1 Primary Screening:

Does the site have characteristics of potential vapor intrusion?

VOCs present in soil?

Inhabited buildings near subsurface VOC contamination?

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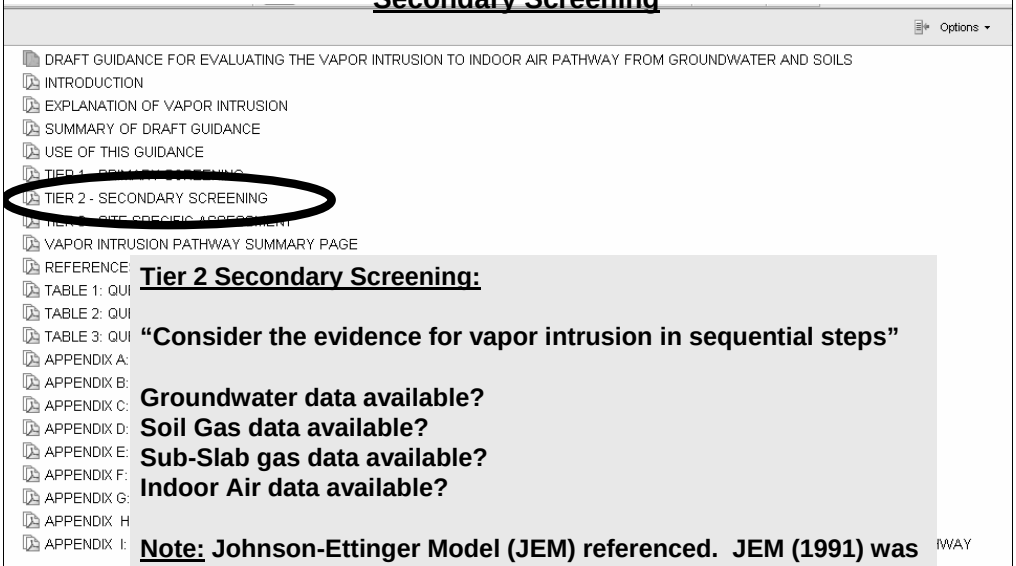
Secondary Screening



Tier 2 Secondary Screening:

"Consider the evidence for vapor intrusion in sequential steps"

Groundwater data available?
Soil Gas data available?
Sub-Slab gas data available?
Indoor Air data available?

Note: Johnson-Ettinger Model (JEM) referenced. JEM (1991) was developed for use as a screening model based on a number of oversimplifying assumptions about contaminant distribution

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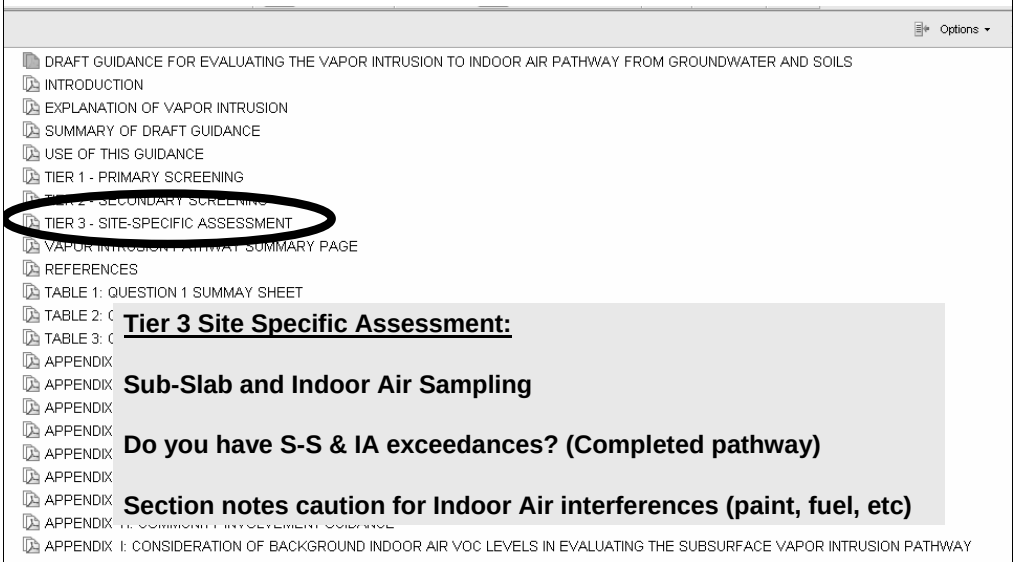
Site Specific Screening



Tier 3 Site Specific Assessment:

Sub-Slab and Indoor Air Sampling

Do you have S-S & IA exceedances? (Completed pathway)

Section notes caution for Indoor Air interferences (paint, fuel, etc)

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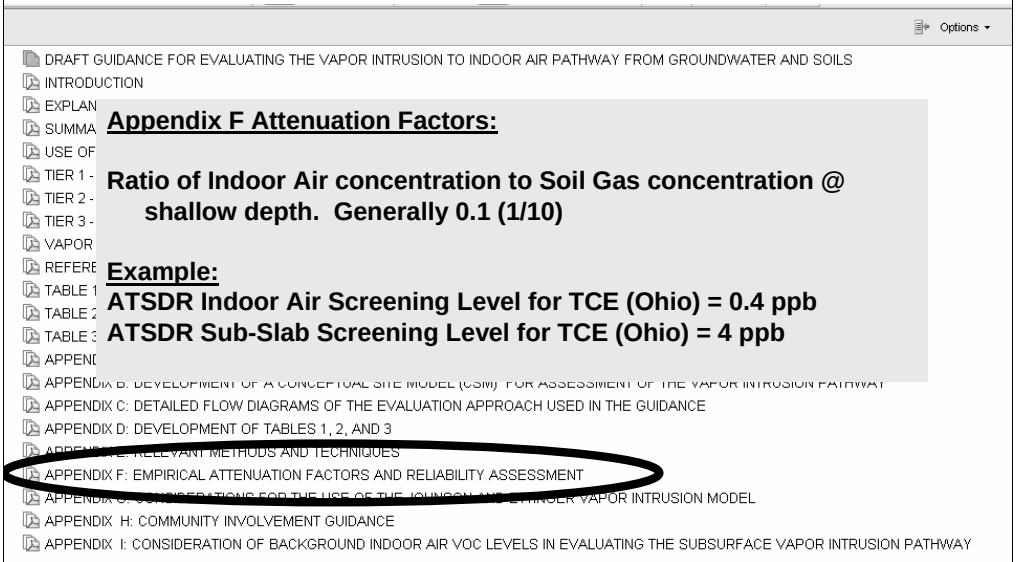
Appendix F



Appendix F Attenuation Factors:

Ratio of Indoor Air concentration to Soil Gas concentration @ shallow depth. Generally 0.1 (1/10)

Example:

ATSDR Indoor Air Screening Level for TCE (Ohio) = 0.4 ppb

ATSDR Sub-Slab Screening Level for TCE (Ohio) = 4 ppb

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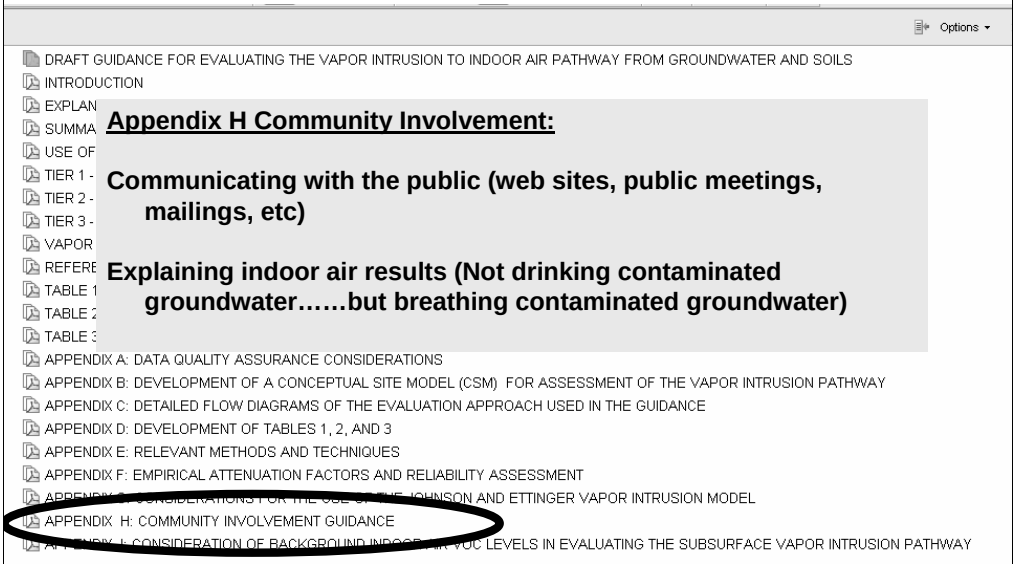
Appendix H



Appendix H Community Involvement:

Communicating with the public (web sites, public meetings, mailings, etc)

Explaining indoor air results (Not drinking contaminated groundwater……but breathing contaminated groundwater)

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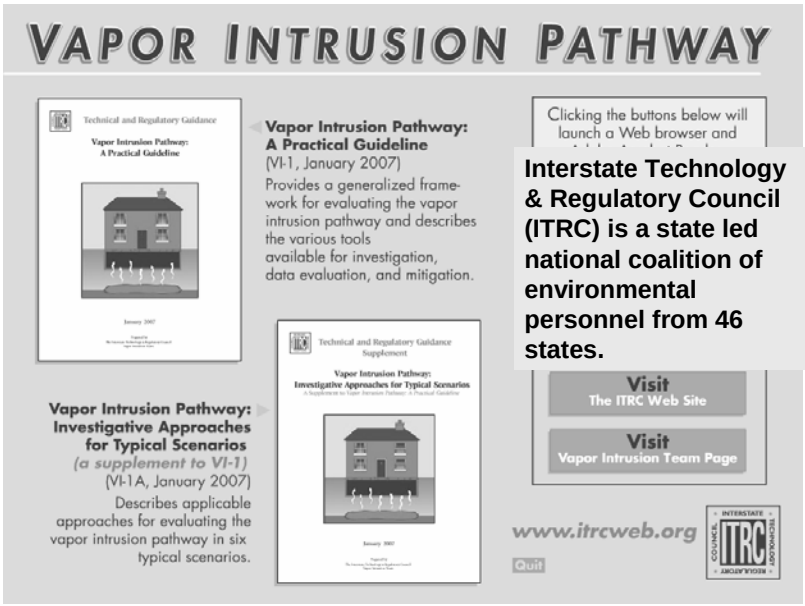

Interstate Technology & Regulatory Council (ITRC) is a state led national coalition of environmental personnel from 46 states.

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Conceptual Model

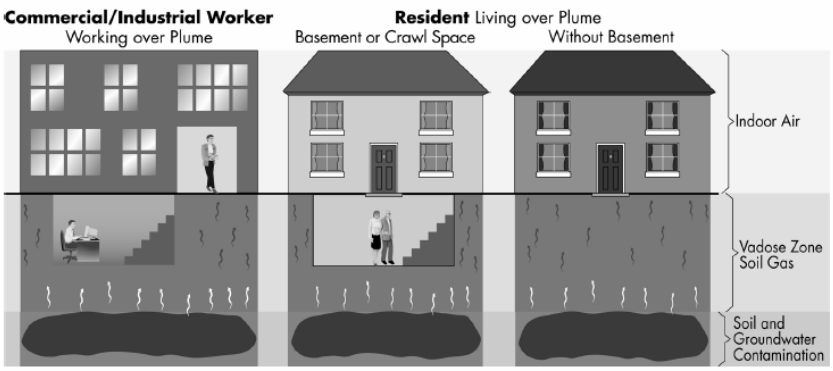

Figure 1-1. Typical conceptual model of vapor intrusion.

Note: Hartford Site volumes of data

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Soil Gas & Soil Vapor

ed approach, it is recommended
g., analytical results, building
tes) be used in making a
er vapor intrusion is occurring
ıtial health concerns as a result.
vill likely be some uncertainty
assessment, regardless of the
e considered. Decisions should
vith the regulatory agency and
ɔnal judgment deems to be
he specific site.

Soil Gas and Soil Vapor
In many vapor intrusion guidance documents, "soil gas" and "soil vapor" are used interchangeably. In this document, "soil gas" refers to the gaseous elements and compounds in the small spaces between particles of soil. Once the gaseous elements or compounds migrate into a structure, they are referred to as "vapor."

Soil Gas = gaseous elements between soil particles
Soil Vapor = gaseous elements in a structure

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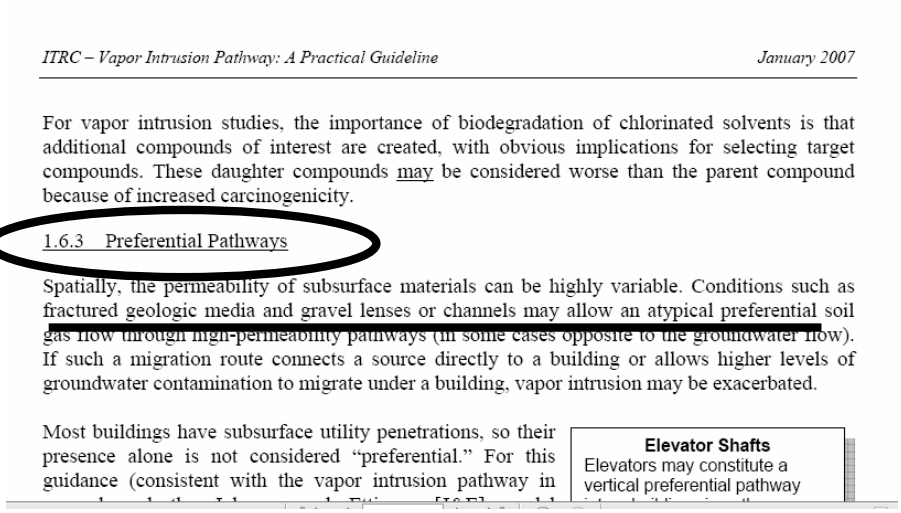
Preferential Pathways



ITRC – Vapor Intrusion Pathway: A Practical Guideline *January 2007*

For vapor intrusion studies, the importance of biodegradation of chlorinated solvents is that additional compounds of interest are created, with obvious implications for selecting target compounds. These daughter compounds may be considered worse than the parent compound because of increased carcinogenicity.

1.6.3 Preferential Pathways

Spatially, the permeability of subsurface materials can be highly variable. Conditions such as fractured geologic media and gravel lenses or channels may allow an atypical preferential soil gas flow through high-permeability pathways (in some cases opposite to the groundwater flow). If such a migration route connects a source directly to a building or allows higher levels of groundwater contamination to migrate under a building, vapor intrusion may be exacerbated.

Most buildings have subsurface utility penetrations, so their presence alone is not considered "preferential." For this guidance (consistent with the vapor intrusion pathway in

Elevator Shafts
Elevators may constitute a vertical preferential pathway

Example preferential pathways: underground utilities, sewers

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Screening Levels (Residential, Commercial, Standardizing?)

The approach in the USEPA draft VI guidance (2002b) is designed primarily to ensure protection of the public in residential settings but may be adjusted to evaluate nonresidential human exposures which occur in commercial, industrial, and recreational settings. Most state agencies are now making that distinction in their screening levels. According to the Vapor Intrusion Survey (ITRC 2004b), of those states that have developed vapor intrusion screening levels, 69% differentiate between residential and nonresidential values.

It is important to note that exposure to the "general public" in public buildings is usually not the most significant risk driver if there are any full-time workers in the building. USEPA's draft VI

In Ohio, schools = residential screening levels

Standardize Screening Levels?
Minnesota = IA Screening Level for TCE (0.5 ppb)

Ohio = IA Screening Level for TCE (0.4 ppb)

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Mitigation

3.9 Step 13: Is Mitigation Warranted?

If the vapor intrusion investigation is complete, the review of the data must be made to determine whether some form of remedial action is appropriate at the site. Step 13 is the final decision point in the assessment of the vapor intrusion pathway. The investigator must reach a conclusion on the status of the site—no further action, additional monitoring, or mitigation. This decision is often left to the regulatory agency. Mitigation is discussed further in Chapter 4.

4. REMEDIATION

Remediation of v…sults of the site investigation phase…olatile compounds exceed screening l…g levels in future buildings. When r…remedies must be selected, implemen…por intrusion until the source of the va…

Is Mitigation Warranted?

NFA: SS< SL & IA < SL

Mitigation: SS > SL & IA > SL

Quarterly Monitoring: SS> SL & IA < SL
Additional Monitoring $ vs Mitigation $?

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Chapter 4 Mitigation Options

Used @ Behr Site = +
Used @ Hartford = (-)

Used @ Behr Site = +

Used @ Behr Site = (-)

Technology	Typical applications	Challenges	Range of installed costs*
Subslab depressurization (SSD)	• New and existing structures • Sumps, drain tiles, and block wall foundations may also be depressurized if present	• Low permeability and wet soils may limit performance • Otherwise, highly effective systems	• $1–$5/ft^2 • Residential systems typically in the $1–2/ft^2 range
Submembrane depressurization	• Existing structures • Crawl spaces	• Sealing to foundation wall, pipe penetrations • Membranes may be damaged by occupants or trades people accessing crawl space	• $1–$6/ft^2 • Residential systems typically in the $1.50–2/ft^2 range
Subslab pressurization	• Same as SSD • Most applicable to highly permeable soils	• Higher energy costs and less effective than SSD • Potential for short-circuiting through cracks	• $1–$5/ft^2
Building pressurization	• Large commercial structures, new or existing • Sensitive receptors	• Requires regular air balancing and maintenance • May not maintain positive pressure when building is unoccupied	• $1–$15/ft^2 • Heavily dependent on size and complexity of structure
Indoor air treatment	• Specialized cases only	• Typically generates a waste disposal stream • Effective capture of air contaminants may be difficult	• $15K–$25K per application not atypical • Actual costs heavily dependent upon type of

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Chapter 4 Mitigation Options (SDS)

4.3.1.3 Subslab (Active) Depressurization

Subslab depressurization (SSD) is widely considered the most practical vapor intrusion mitigation strategy for most existing and new structures, including those with basement slabs or slab-on-grade foundations (see USEPA 1993b). SSD systems function by creating a pressure differential across the slab that favors movement of indoor air down into the subsurface. This is accomplished by pulling soil gases from beneath the slab and venting them to the atmosphere at a height well above the outdoor breathing zone and away from windows and air supply intakes (Figure 4-3). In new construction, SSD systems are similar to passive venting systems except that a fan is used to draw soil gas through the subslab venting layer prior to discharging it to the atmosphere. In existing structures, SSD systems entail the cutting of one or more holes in the existing slab, the removal of a quantity of soil from beneath the slab to create an open hole or "suction pit" (6–18 inch radius), and the placement of vertical suction pipes into the holes. These pipes are then manifolded together and connected to a fan, which draws soil gas from the subslab

Figure 4-3. Active subslab depressurization system.
Courtesy Kansas Department of Health

Good Overview of SDS
Behr Site = $1,500 average install (TCE)
Hartford = $15,000 average install (Hydrocarbon)

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Appendix D - Tools

cut at a length to either float in the slab or to extend just to the base of the slab (Figure D-4). If repeated sampling is anticipated, surface completions may need to be flush with the surface (trip-proof) and cosmetically clean, especially in residences.

Special considerations for subslab soil gas samples include:

- Subslab samples should be avoided in areas where groundwater might intersect the slab.
- Underground utilities (e.g., electric, gas, water, tension rods or sewer lines) should be located and avoided.
- If a vapor barrier already exists under the slab, subslab sampling might puncture the barrier, so the hole must be carefully resealed after monitoring is complete.
- For basements, primary entry points for vapors might be through the sidewalls rather than

Figure D-4. Installation of subslab soil gas sample port. Courtesy Kansas Department of Health and Environment

Good overview of SS sample procedure
Avoid utilities, water

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Appendix D - Tools

Collection of Samples in an Evacuated Canister

The sampling canister (Figure D-5) is a passivated or specially lined inert container (e.g., Summa, Silco®) sent to the field under vacuum and certified clean and leak-free. The canister fills with air at a fixed flow rate over a preset period of time with use of a flow controller calibrated and set in the laboratory. Initial and final vacuums are recorded for each canister. The main advantages of canister sample collection are the capability of analyzing multiple samples from the same canister and the ease of deployment and retrieval. Canister methods are most commonly employed in North America. To ensure the canisters are filling at the proper rate, they should be rechecked after deployment. Canisters with dedicated vacuum gauges facilitate this effort and are strongly recommended. The canister must be retrieved prior to being completely filled (with some residual vacuum remaining) to ensure proper collection period.

Figure D-5. Stainless steel canisters.

Good overview of Summa Canisters
Behr Site = $275/canister for TO-15 lab analytical costs

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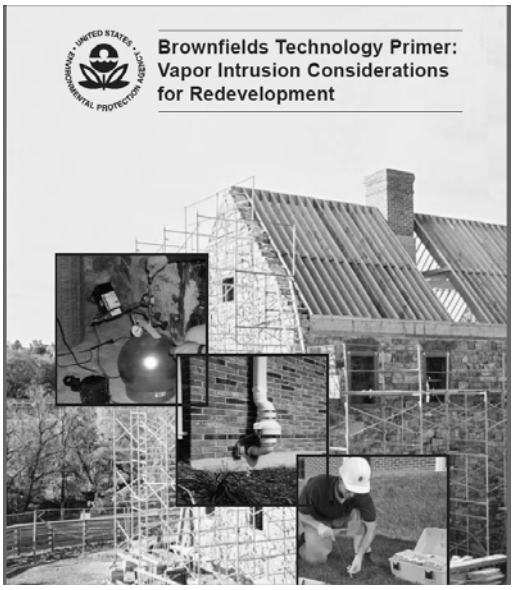
Good introduction to Vapor Intrusion



http://www.brownfieldstsc.org
See New Publications

(EPA 542-R-08-001, 2008)

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HQ "Roadmap" for Vapor Intrusion

- EPA is drafting a 'roadmap' to existing guidance and the latest technical tools available:
- Use ITRC 2007 (v.1) to frame investigations (sampling)
- Evaluate data (make decisions) using regulatory guidance
  - Also consider recent evidence:
    - Vapor Intrusion Database (Observed Attenuation)
  - And improved theories (to help selecting buildings for indoor sampling)
    - Johnson & Ettinger Model Updates

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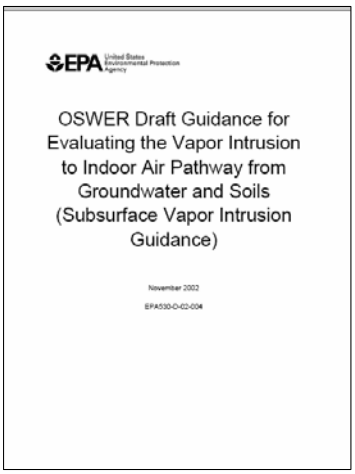
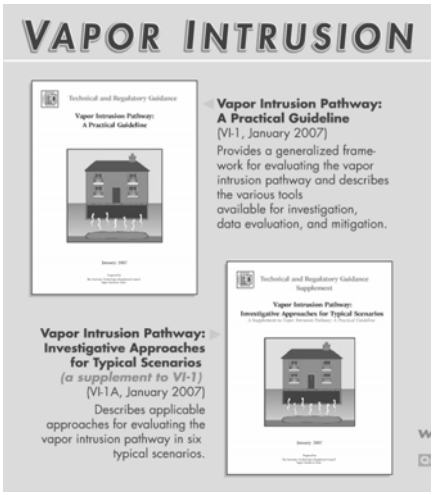
Vapor Intrusion Guidance





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Vapor Intrusion Issues – Agenda

Introduction	**Turner / Renninger**
Behr VOC Site - Example	**Renninger**
Health Issues	**Renninger / Turner**
Groundwater Issues	**Renninger / Turner**
Hartford Site – Example	**Turner**
Sampling Procedures	**Renninger / Turner**
Vapor Intrusion Toolbox	**Renninger**
Vapor Intrusion Guidance	**Renninger / Turner**
Questions/Discussion	

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Vapor Intrusion Issues

Seminar

November 2, 2009

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Links to Additional Resources

Feedback Form

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