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

2

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	

3

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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)

4

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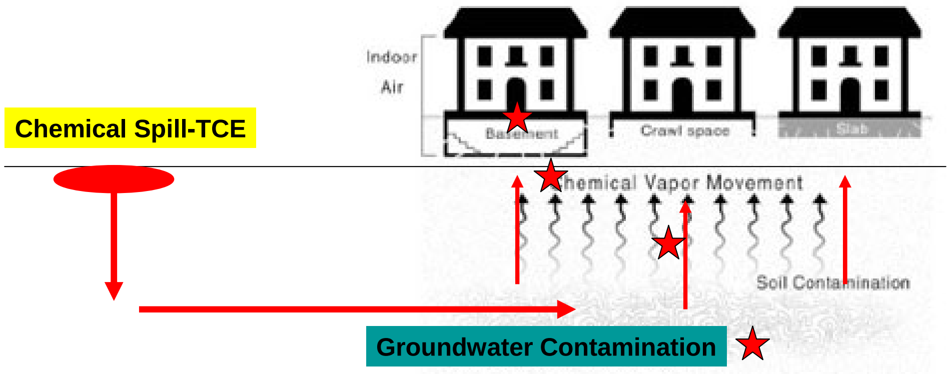
What is Vapor Intrusion?

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

5

Must Connect GW, SG, SS, IA

Vapor Intrusion Sites Across the U.S.

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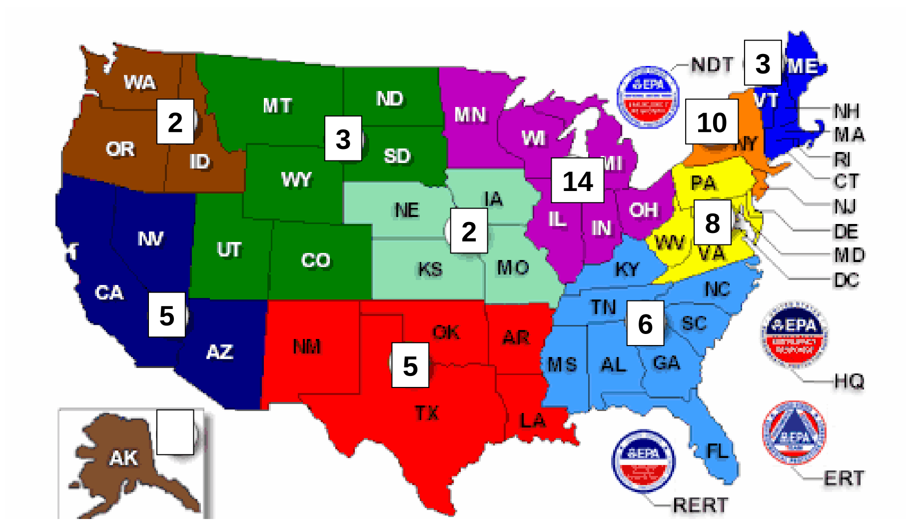
(Removal Program as of Feb 2009)



6

http://www.tceblog.com/posts/1186116180.shtml

ustomize Links   Free Hotmail   Windows   Windows Marketplace   Windows Media   Best of the Web   Channel Guide   Internet Start   Microsof

A peek inside the Toxic Chemical Exposure Reduction Act

by Neil Fischbein on Friday, August 3, 2007 [Permalink] [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

8

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Questions/Discussion	

9

Vapor Intrusion Case Study

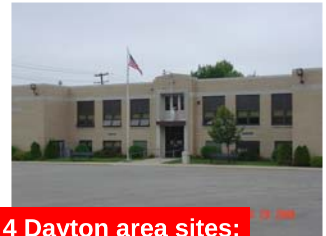
Behr VOC Site

Dayton, Ohio

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

10

Vapor Intrusion Sites in Dayton, Ohio



2006: Springfield S
systems installed,

/PCE): 16 res
ool. 80 sampled

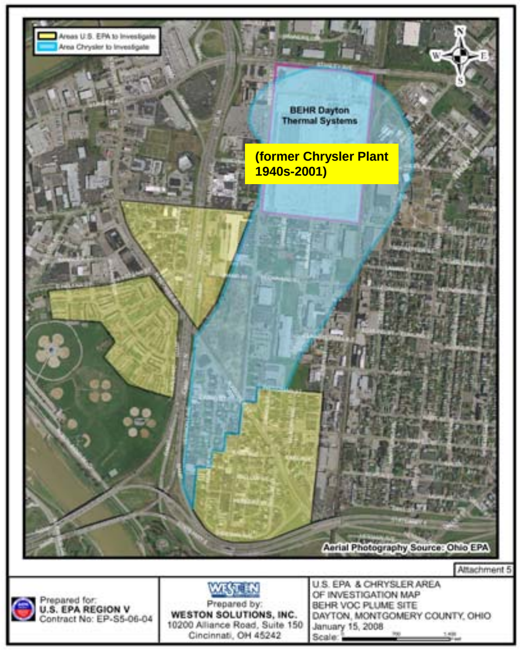
Common Denominator in 4 Dayton area sites:
Shallow groundwater (<25')
VOC groundwater contamination >200 ppb
Residential areas

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)



12

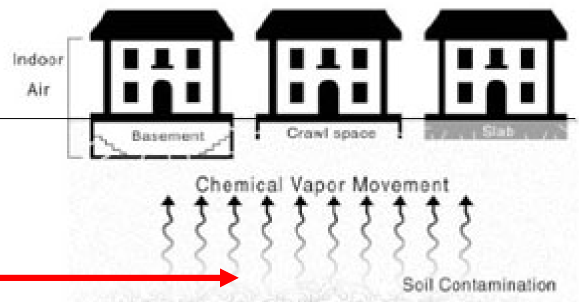
What is Trichloroethylene (TCE)

- **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)**

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

What are Screening Levels?

Chemical Spill-TCE



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

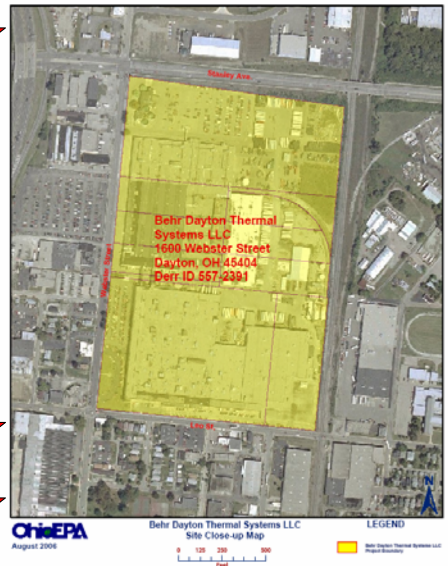
***Commercial levels also provided**

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 *

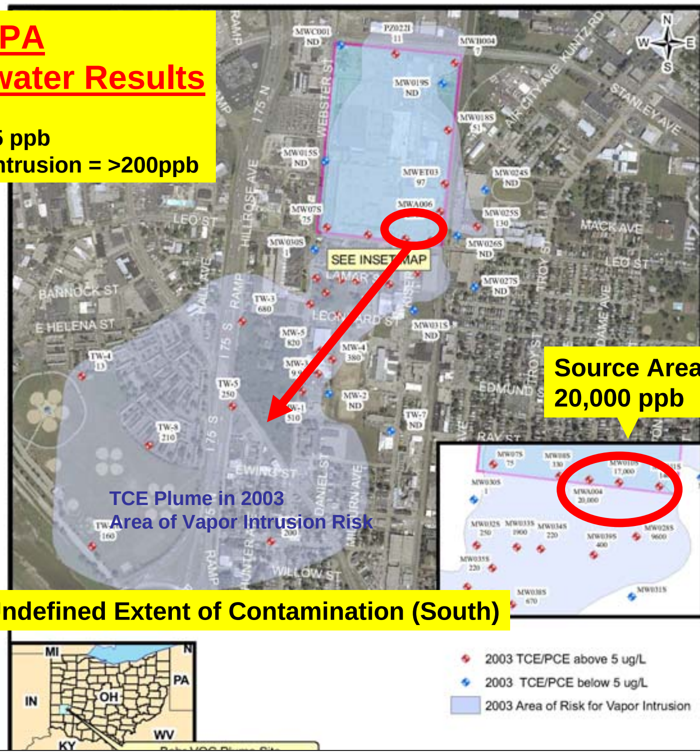
2003 Groundwater Monitoring

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

16

2003 OEPA Groundwater Results

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

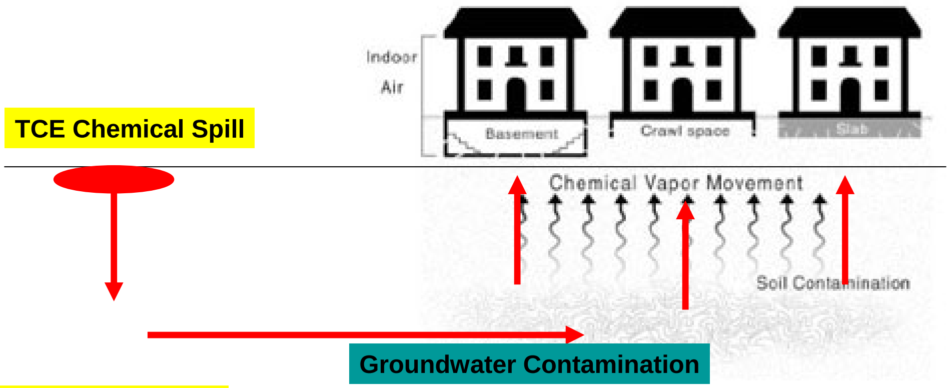


Source Area = 20,000 ppb

Note: Undefined Extent of Contamination (South)

17

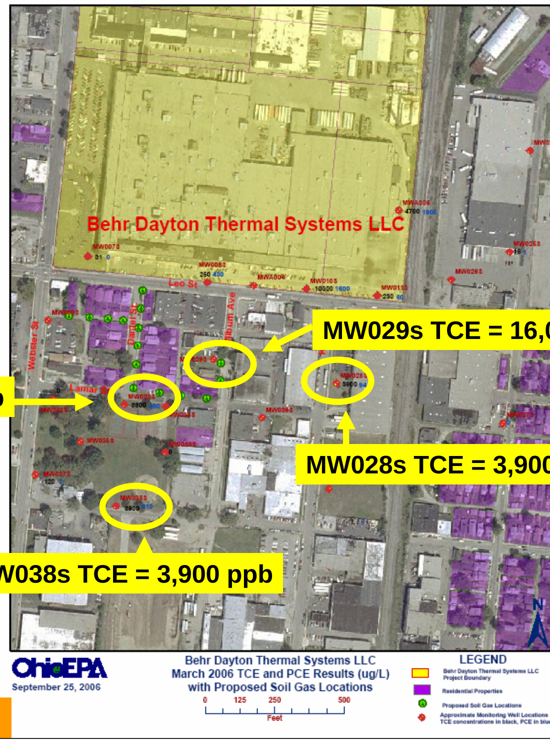
Vapor Intrusion



Groundwater TCE = 20,000 ppb

18

Groundwater Data 2003-2006



MW029s TCE = 16,000 ppb

MW033s TCE = 3,800 ppb

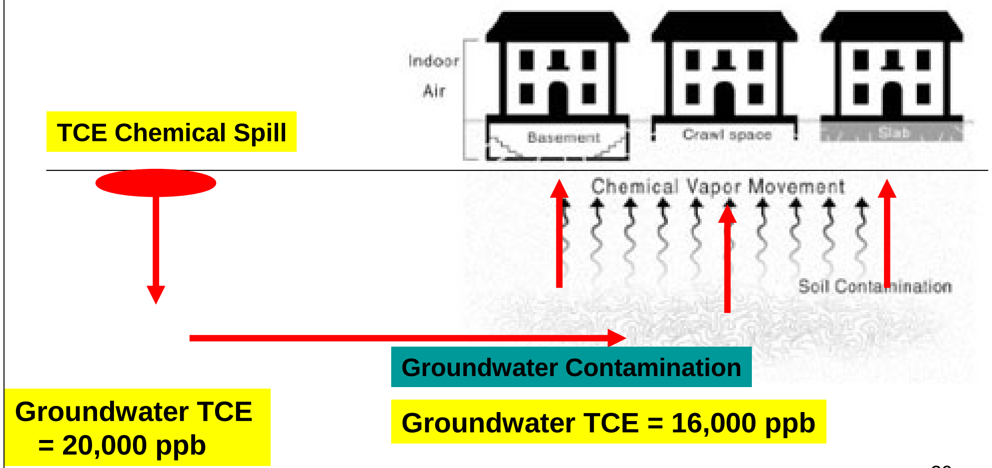
MW028s TCE = 3,900 ppb

MW038s TCE = 3,900 ppb

Vapor Intrusion > 200 ppb?

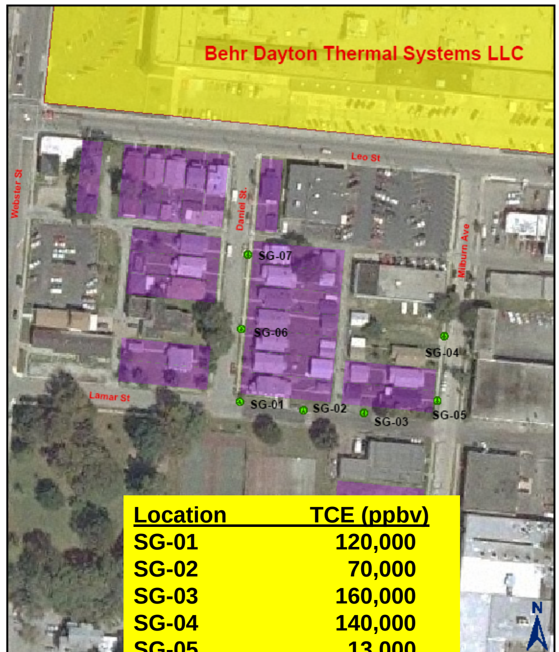
19

Vapor Intrusion



Soil Gas Sampling Results - Oct 24, 2006

7 Vapor Probes installed & sampled utilizing Geopobe

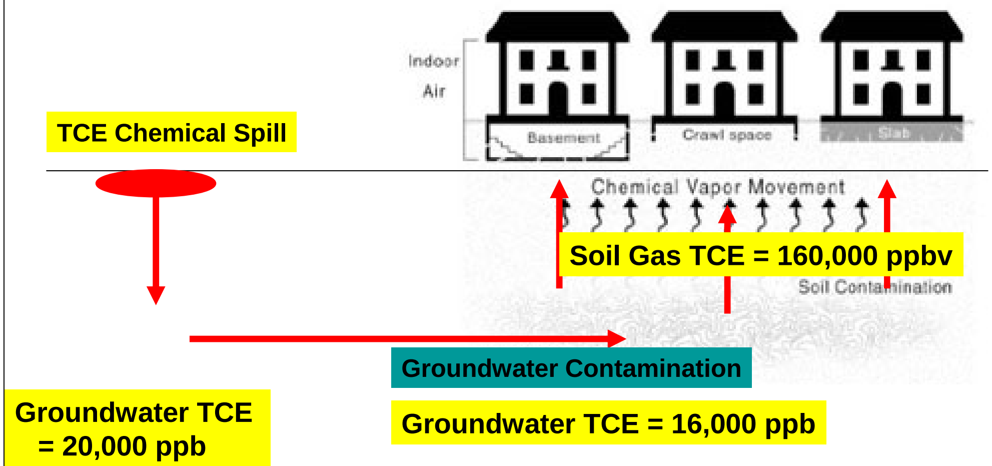


Location	TCE (ppbv)
SG-01	120,000
SG-02	70,000
SG-03	160,000
SG-04	140,000
SG-05	13,000
SG-06	16,000
SG-07	12,000

October 24, 2006

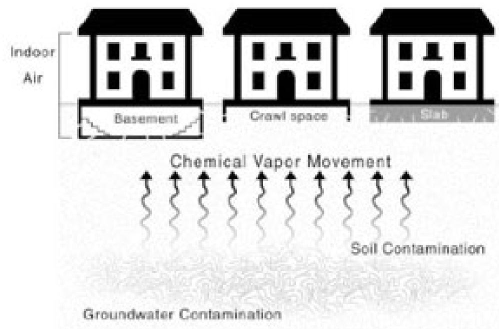
LEGEND

Vapor Intrusion



22

Request for Assistance



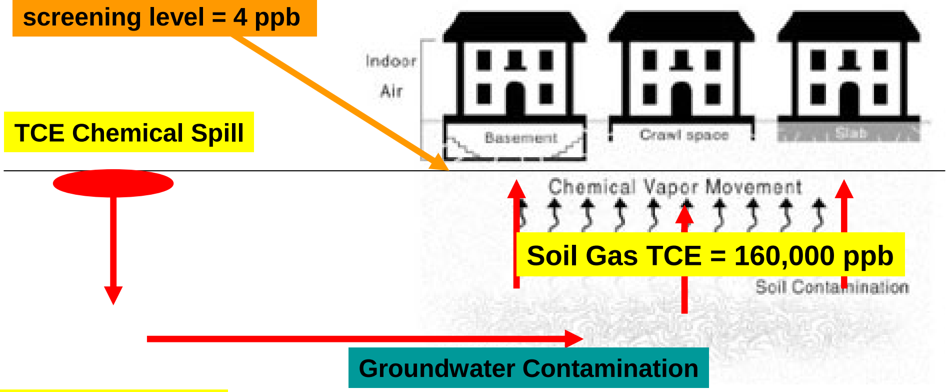
- **Ohio EPA requested assistance from U.S. EPA on November 6, 2006**
- **Noted elevated levels of TCE present in soil gas and groundwater.**
- **Evaluate potential for Vapor Intrusion into occupied structures.**

23

Sub-Slab Sampling

Sub-Slab sampling conducted next. TCE screening level = 4 ppb

TCE Chemical Spill



Soil Gas TCE = 160,000 ppb

Groundwater Contamination

Groundwater TCE = 20,000 ppb

Groundwater TCE = 16,000 ppb

24

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

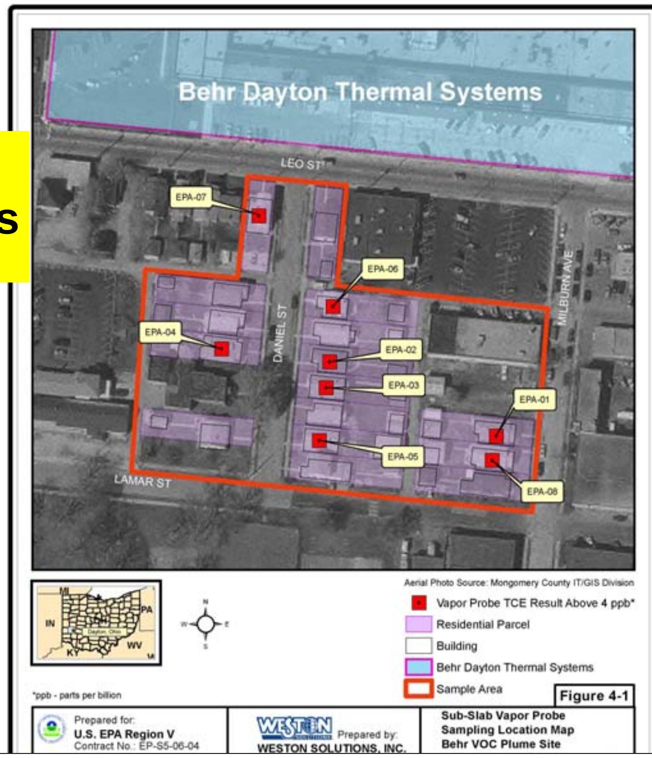
26

EPA Sub-Slab Sample Results

November 2006

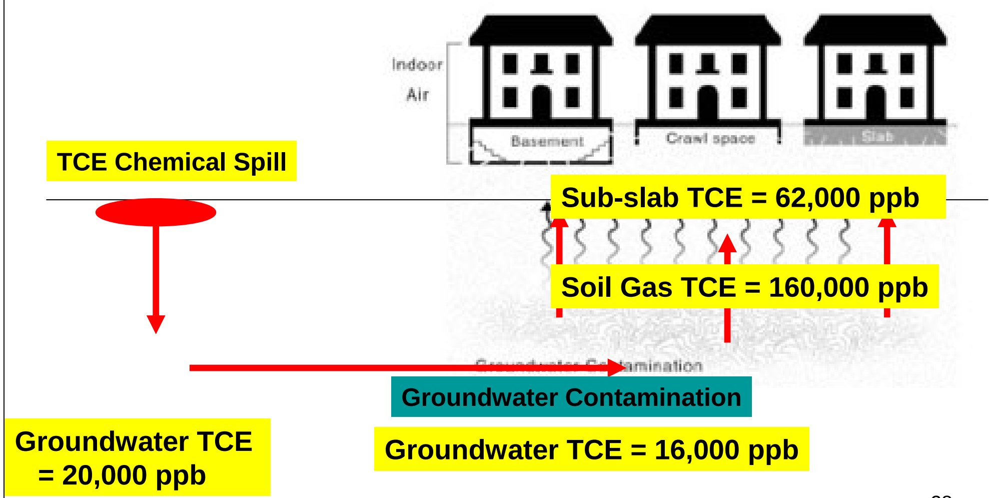
Location	TCE (ppb)
EPA-01	980
EPA-02	18,000
EPA-03	16,000
EPA-04	260
EPA-05	62,000
EPA-06	3,700
EPA-07	49
EPA-08	62,000

ATSDR & ODH Sub-Slab Screening Level = 4 ppb



27

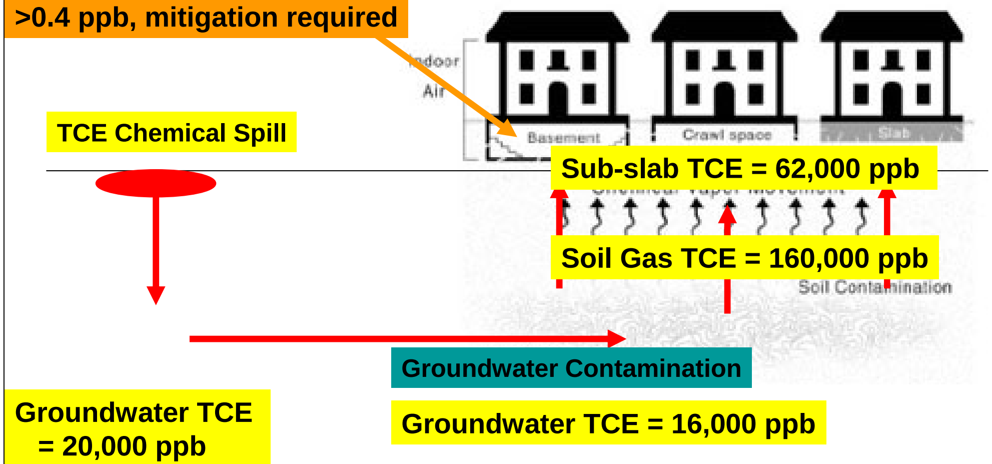
Vapor Intrusion



28

Indoor Air Sampling

If Indoor Air TCE Sample >0.4 ppb, mitigation required



29

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

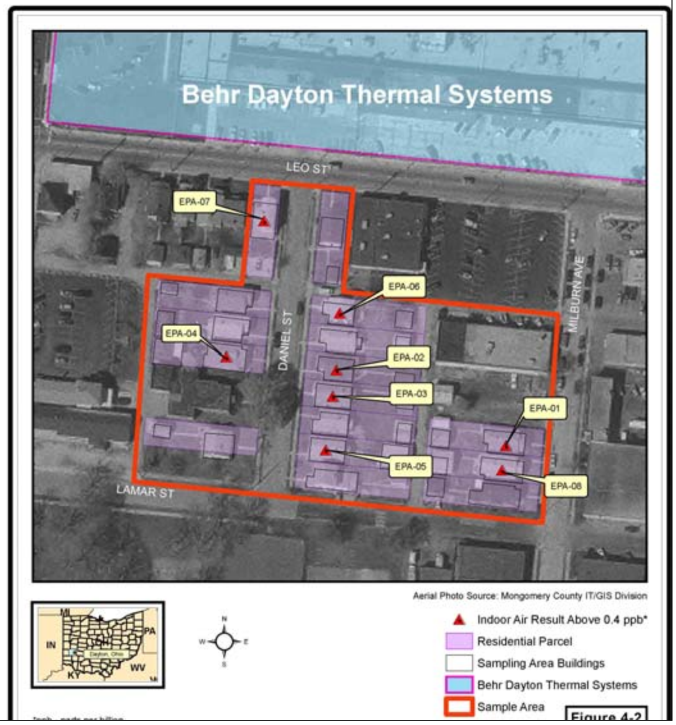
Has the structure been weatherized with any of the following? (check all that apply):
Insulation ☐ Storm Windows ☐ Energy-Efficient Windows ☐
Other

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

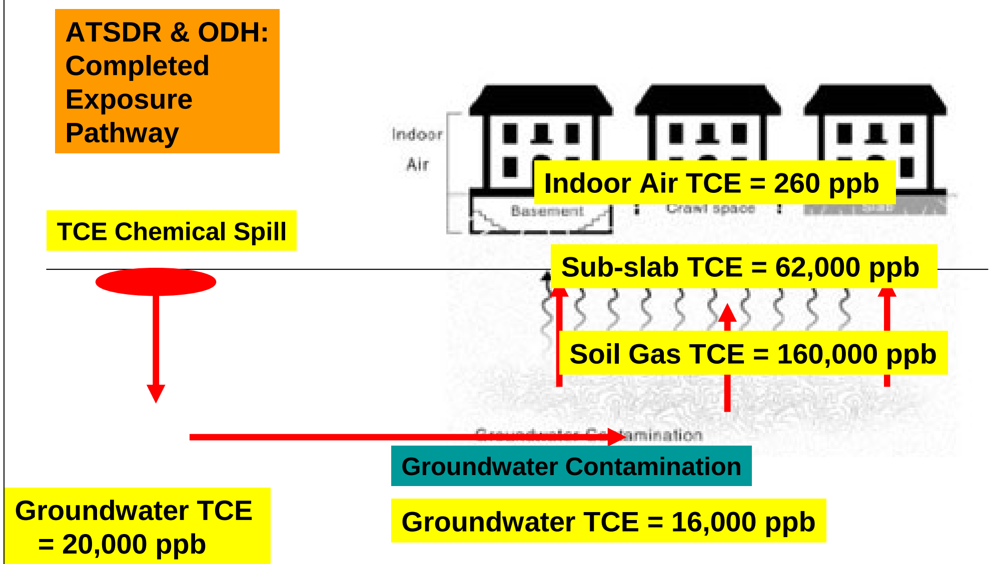
ATSDR & ODH Indoor Air Screening Level = 0.4 ppb (requiring mitigation)

3 residences > Immediate Action Level (100 ppb)



31

Vapor Intrusion



32

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)**

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**

34

Ohio Department of Health Fact Sheets

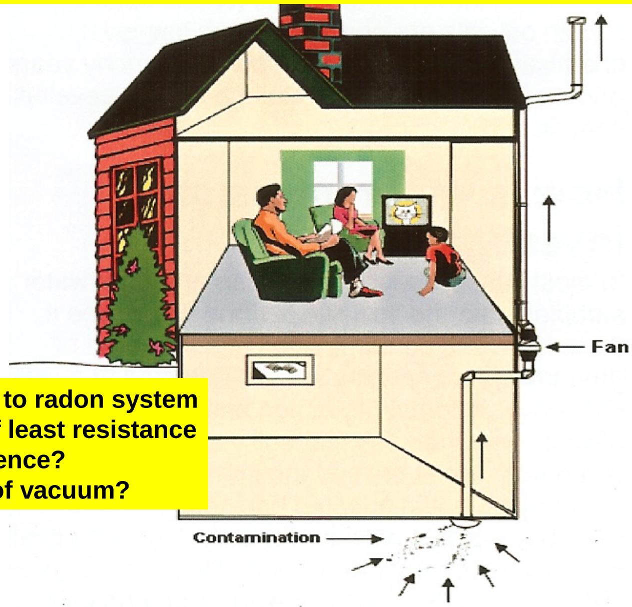
Ohio.gov So much to Discover

Ohio Department of HEALTH

www.epaosc.net/behrvocplume

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?

37

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

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

Vapor Abatement System Installation

U Tube Manometer on Extraction Pipe

1”- 2” vacuum applied to extraction point

46

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.

47

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 [illegible] the "On" position at all times to ensure its effectivene[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 hav[illegible] related questions concerning this matter, please [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,

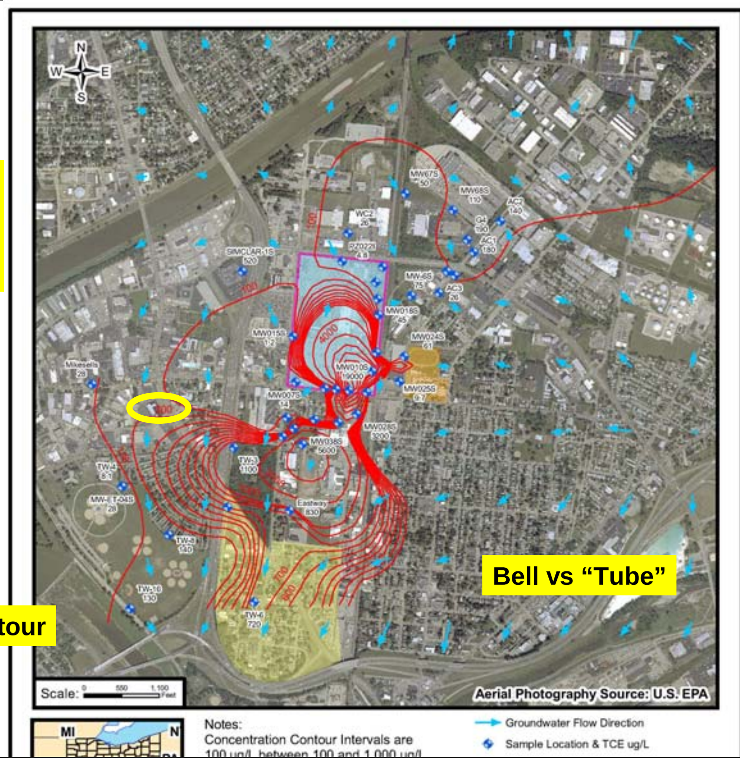
Steven L. Renninger
On-Scene Coordinator - U.S. EPA Region 5

Internet Address (URL) • http://www.epa.gov

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

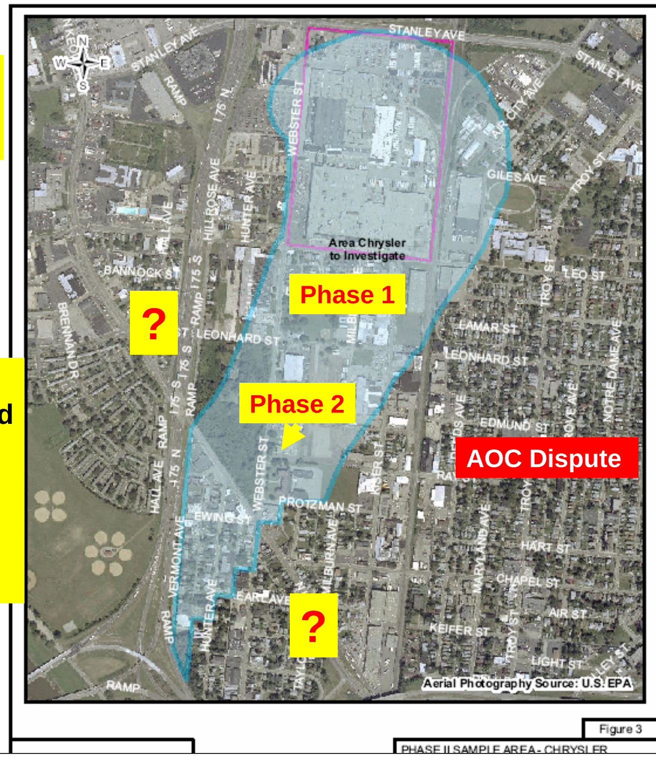
49

Phase 2 Area Plume Dispute

CHRYSLER

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

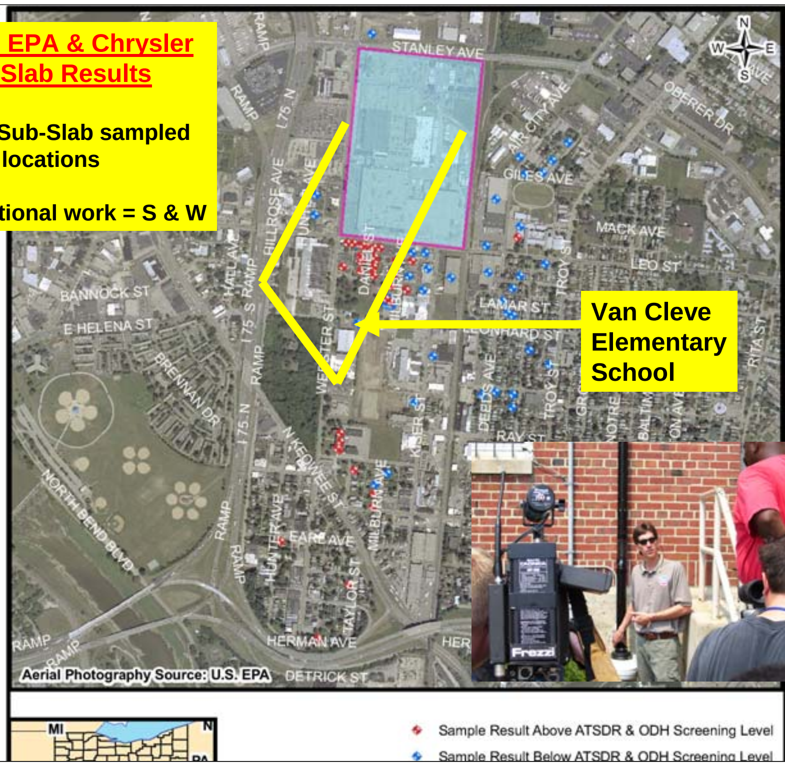
Sub-Slab Sampling
Indoor Air Sampling
Mitigation



2007 EPA & Chrysler Sub-Slab Results

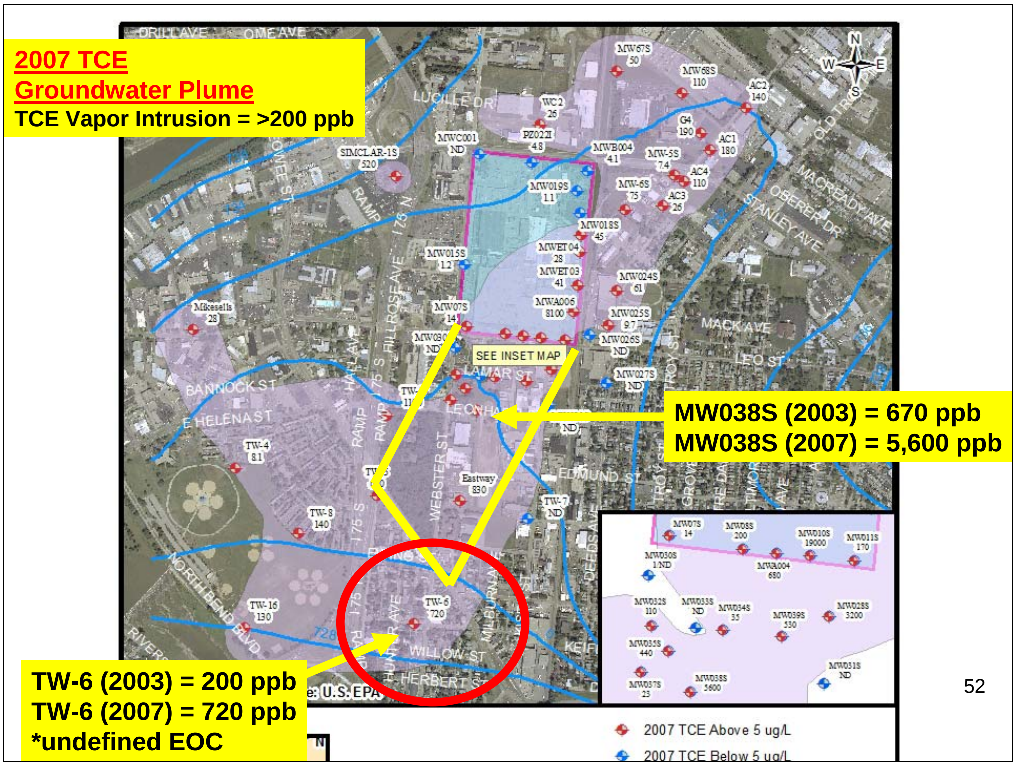
EPA Sub-Slab sampled at 30 locations

-additional work = S & W



Van Cleve Elementary School

51


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
2007 TCE Above 5 ug/L
2007 TCE Below 5 ug/L

52

Behr VOC Site Summary Map Dec 2008

Chrysler area = blue

EPA area = yellow

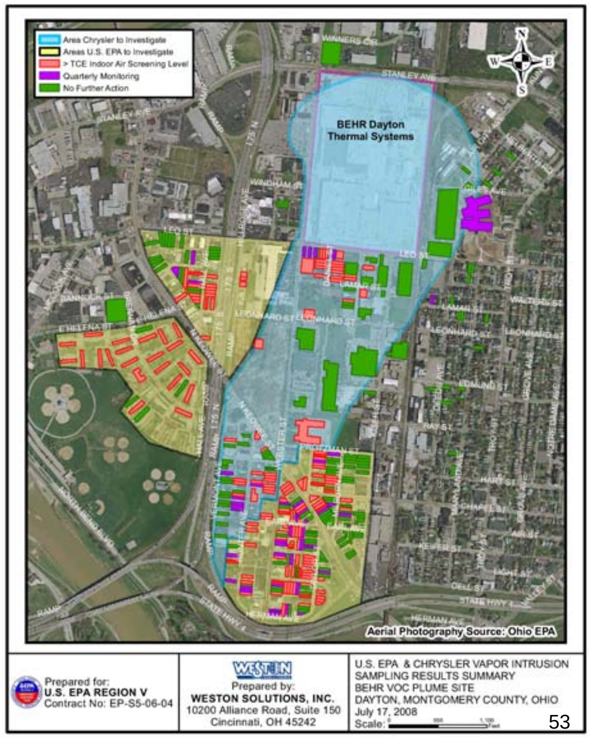
350 locations sampled to date

210 residences mitigated to date

SVE system = Aug 2008

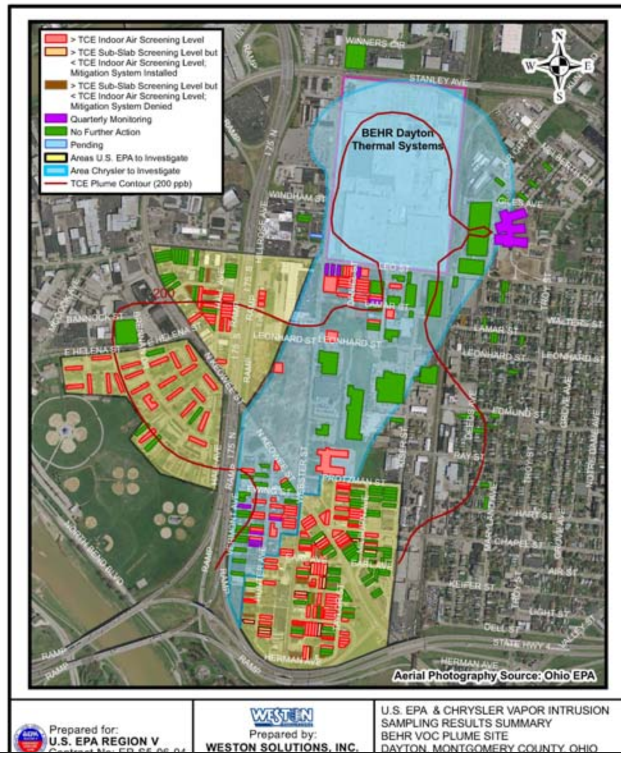
EPA Removal completion = Nov 2008

NPL listing = Sept 2008



53

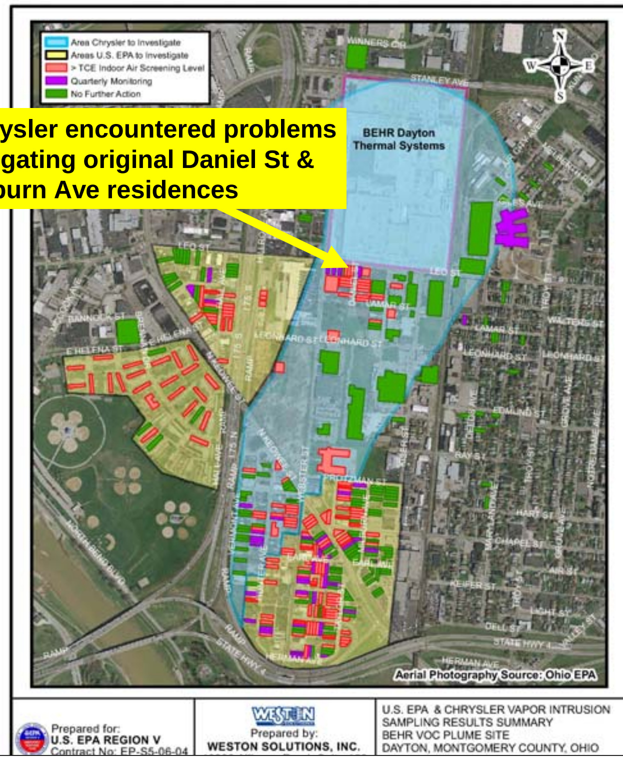
Behr VOC Site Summary Map w/ 200 ppb GW contour



54

Behr VOC Site
<u>SVE System</u>

Chrysler encountered problems mitigating original Daniel St & Milburn Ave residences



55

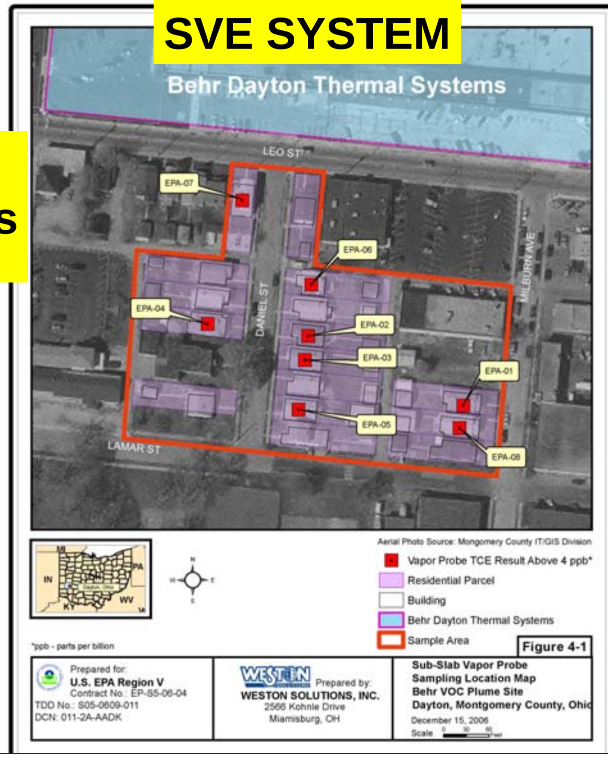
EPA Sub-Slab Sample Results

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

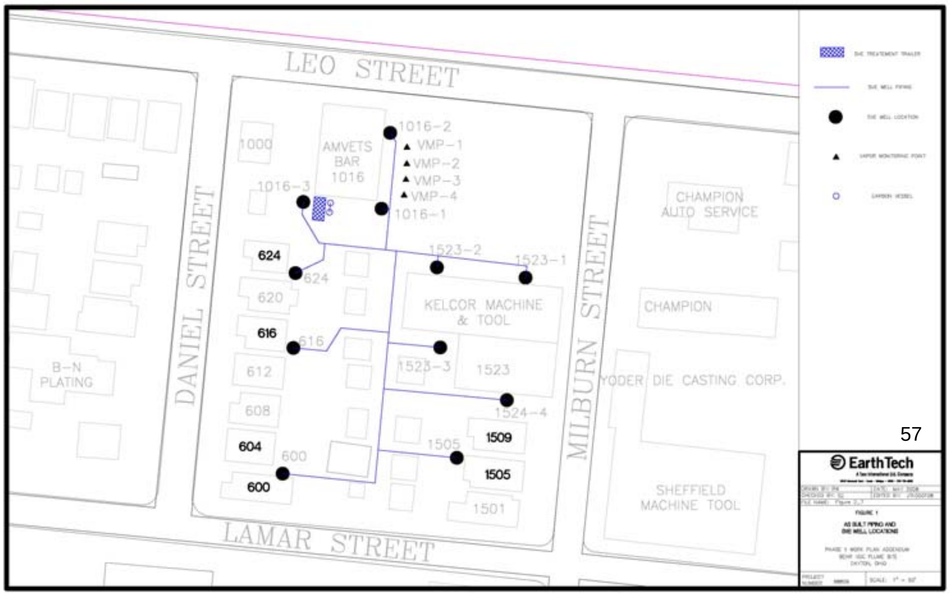
ATSDR & ODH Sub-Slab Screening Level = 4 ppb

SVE SYSTEM



56

SVE System – July 2008



57

SVE System

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

58

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**

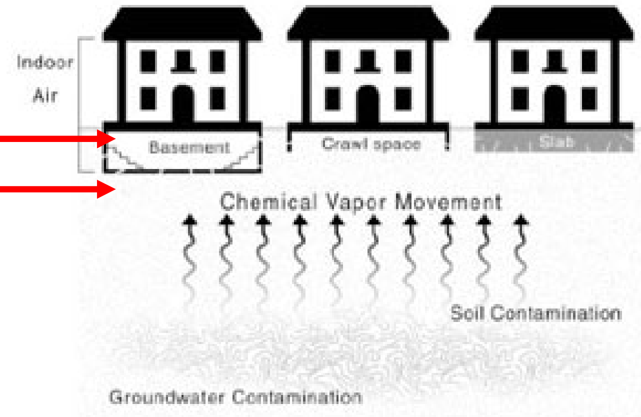
- For residences requiring mitigation (>SS & >IA)
  - **Average TCE Indoor Air result = 16.1 ppbv (40 x IA)**
  - **Average TCE Sub-Slab result = 3,758 ppbv (93 x SS)**

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"

60

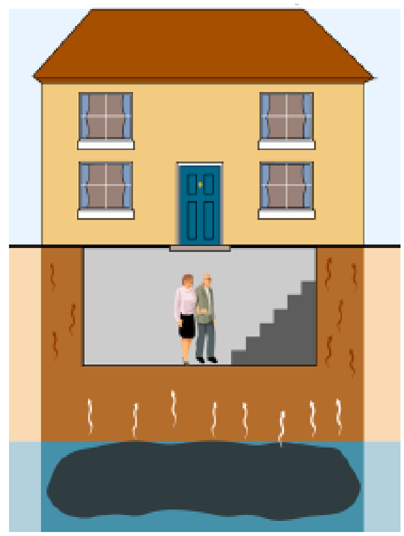
Vapor Intrusion Sample Decision Matrix

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)



61

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

62

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Vapor Intrusion Issues – Agenda

Introduction	Turner / Renninger
Behr VOC Site - Example	Renninger
Health Issues	Renninger / Turner
Groundwater Issues	Renninger / Turner
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Vapor Intrusion Guidance	Renninger / Turner
Questions/Discussion	

63

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

64

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

65

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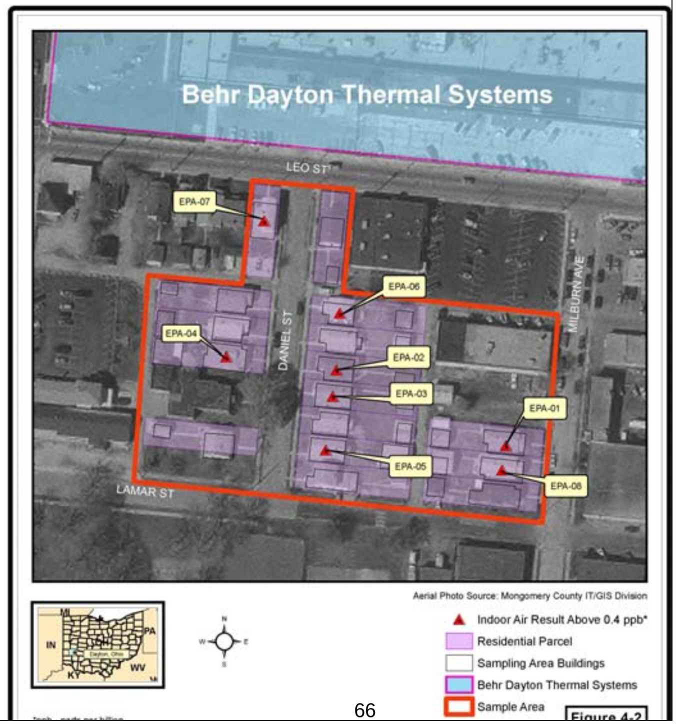
EPA Indoor Air Sample Results
November 2006

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)



66

"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)

67

Resources for Health Information on Toxic Substances

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- ATSDR
  - Toxic Substances Portal
  http://www.atsdr.cdc.gov/substances/
  - ToxFAQ, ToxGuide, Public Health Statements

- State Health Departments

- EPA
  - Integrated Risk Information System (IRIS)

68


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69

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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.

70

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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

71

		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

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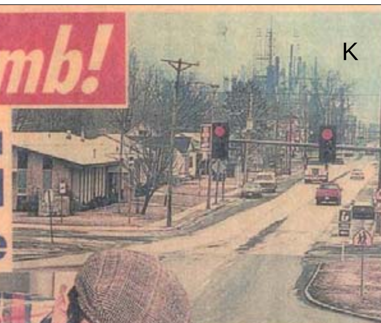
Town is a time bomb!

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.

73 "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

75

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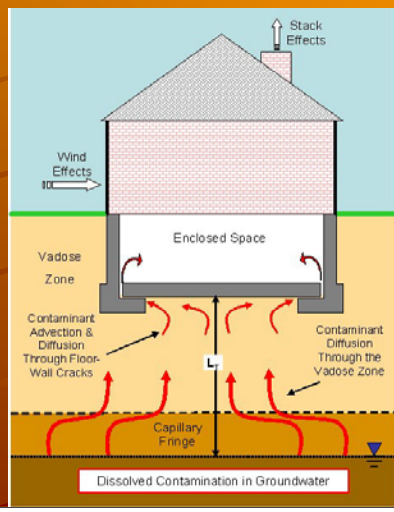
76

SITE HYDROGEOLOGY & URBAN FEATURES

- KEY TO DETERMINING IF VAPOR INTRUSION IS LIKELY.



77

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.

78

TEMPORARY WELLS

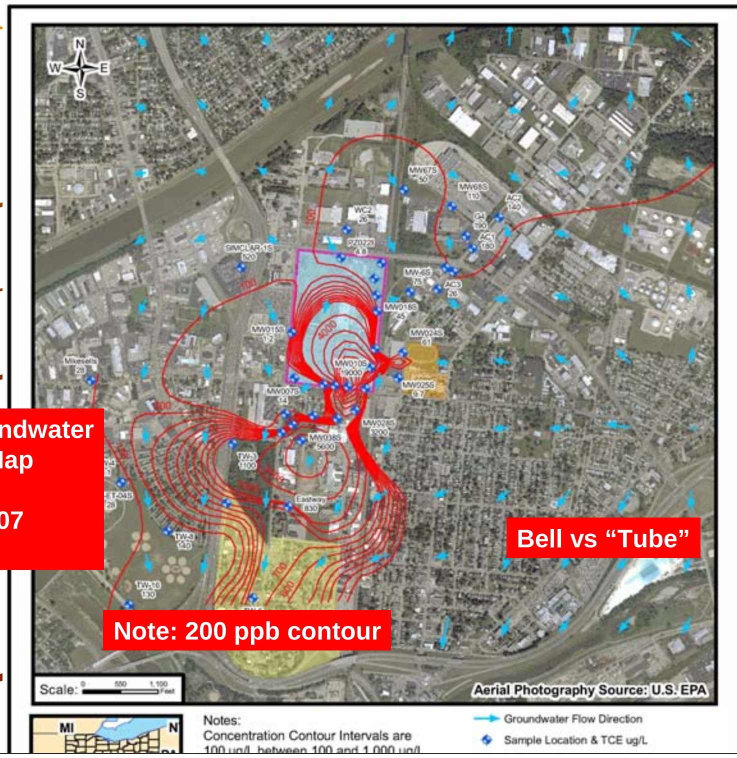
- Quickly installed by direct push method. Grab or vapor sample can be collected.
- An efficient way to get a ‘snapshot’ of the ground water and possibly the vapor plume.
- Temporary wells may help limit the number of permanent wells thus saving money.

79

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,………..

80

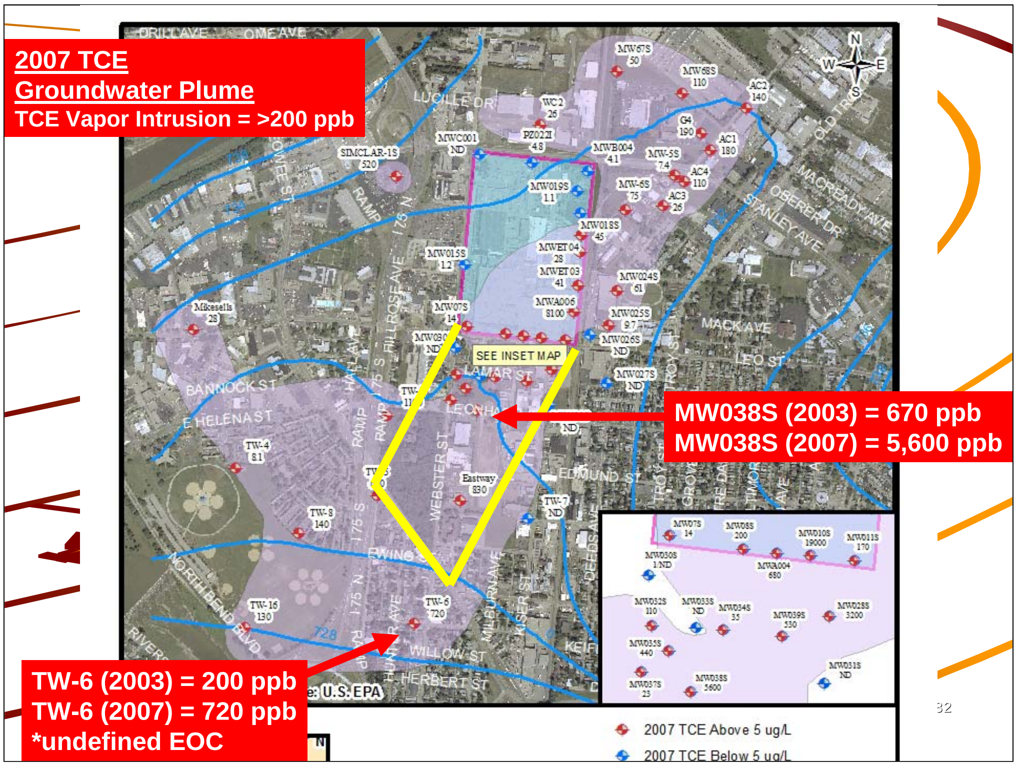


EPA Groundwater Contour Map

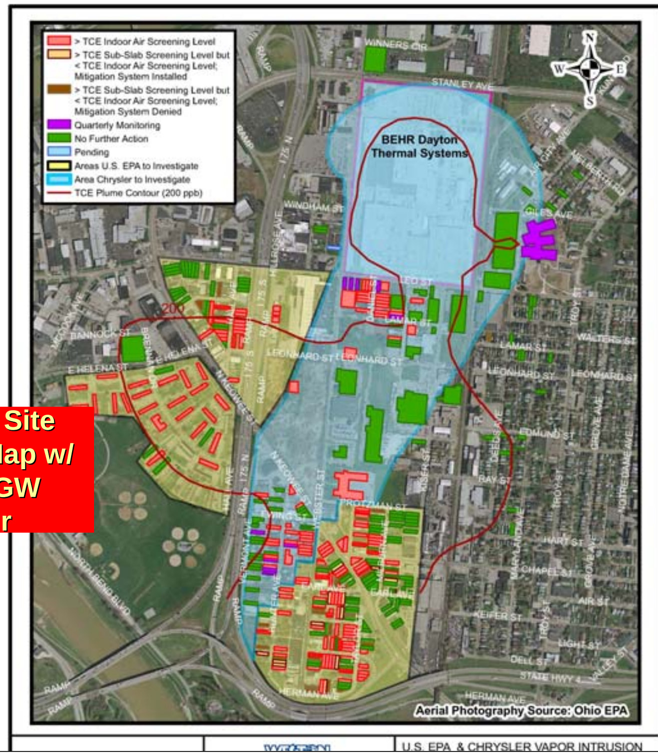
Sept 2007

Note: 200 ppb contour

Bell vs "Tube"


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
2007 TCE Above 5 ug/L
2007 TCE Below 5 ug/L

Behr VOC Site Summary Map w/ 200 ppb GW contour



83

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84

Vapor Intrusion Case Study

Hartford Hydrocarbon Site

North Hartford, Illinois

85

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

87

Significant Field Actions and Studies

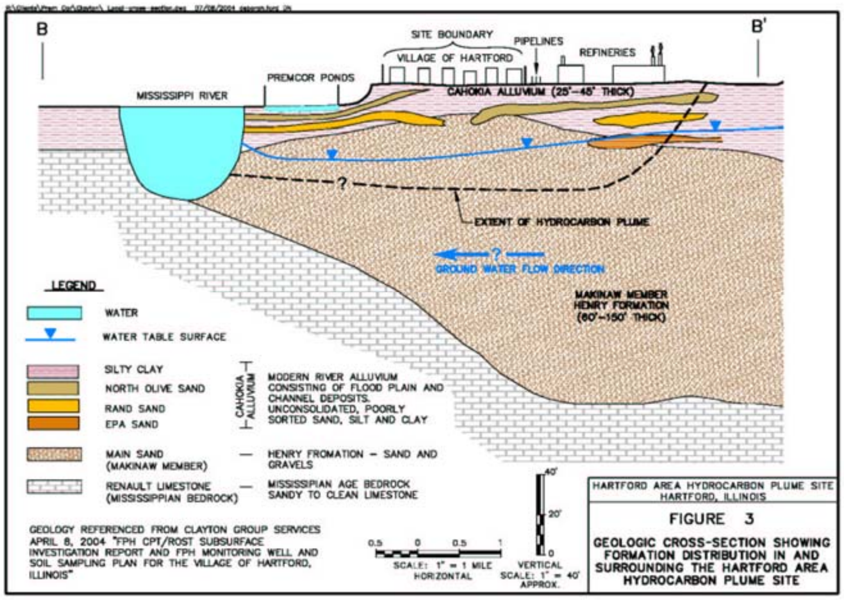
- Multiple Work Plan submittals
  - Free Product, Dissolved, Vapors, Residuals, Pipeline corridors
- Pilot Test Studies
  - Interim Measures
  - Multi-Phase - Bio-slurp - Hi-Vac
  - Soil Vapor Extraction (SVE)
  - Skimming and pump testing
  - Cone of Depression??

Details of Interim Measures

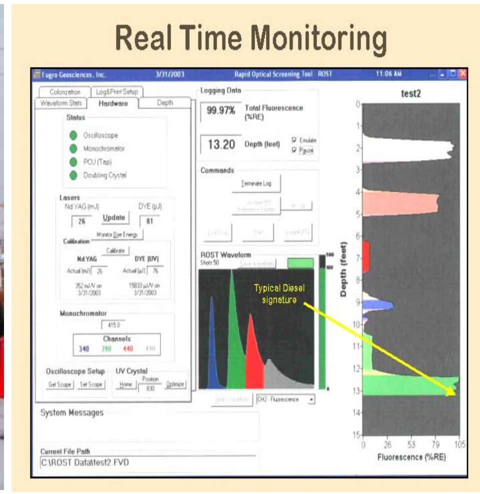
- Conduct “Needs Assessment” of each structure
- Make a Sub-Slab Depressuration System or Ventilation Fan available to all
- Emergency Response and Contingency Plan programs

89

Located in Alluvial Deposits

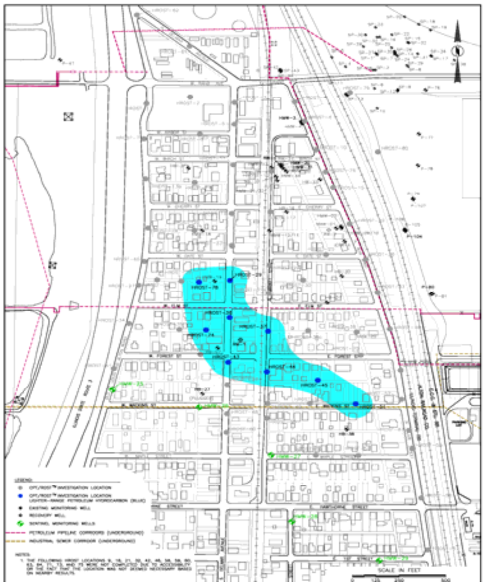


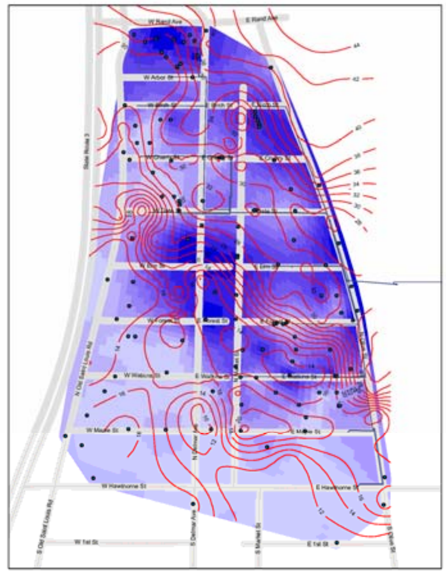
ROST Investigation



91

ROST LNAPL Extent – Main Stratum

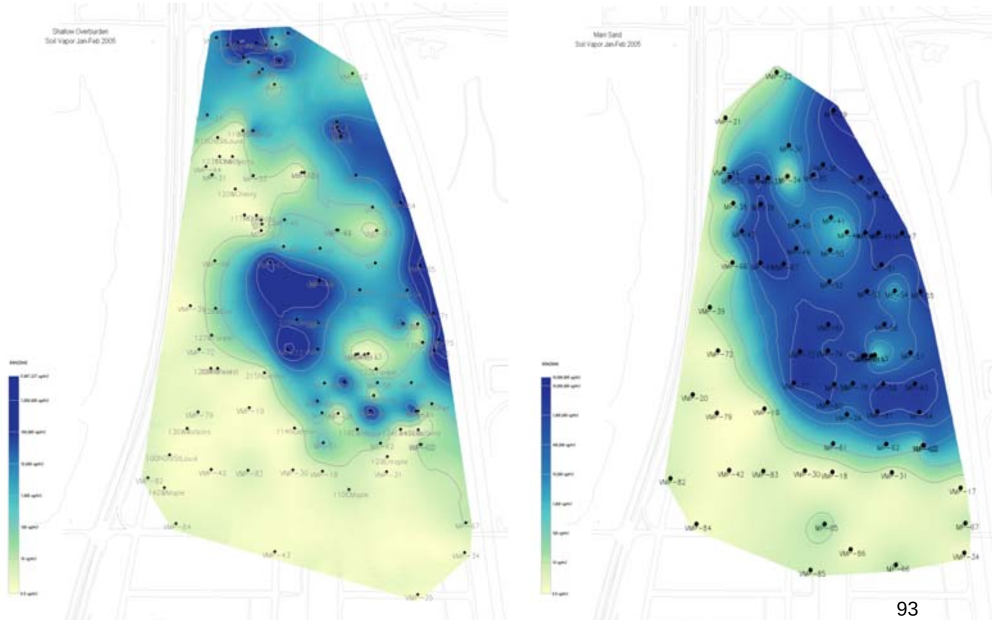




92

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.

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
	ppb	μg/m³	(in μg/m³)
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

96

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

97

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.

98

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.

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

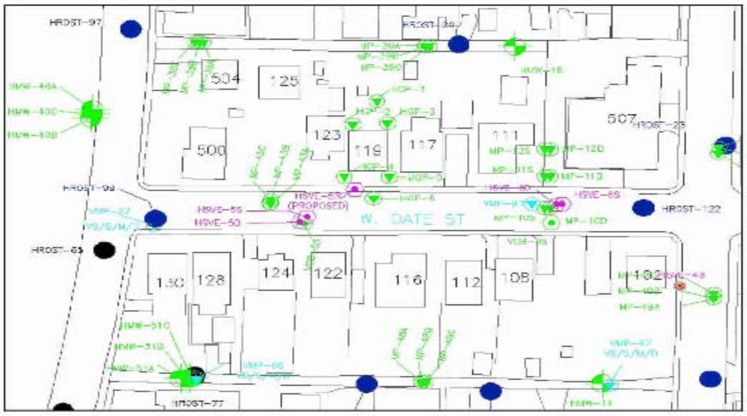


Figure 1 - Monitoring Points / Proposed Location of HSVE-5R

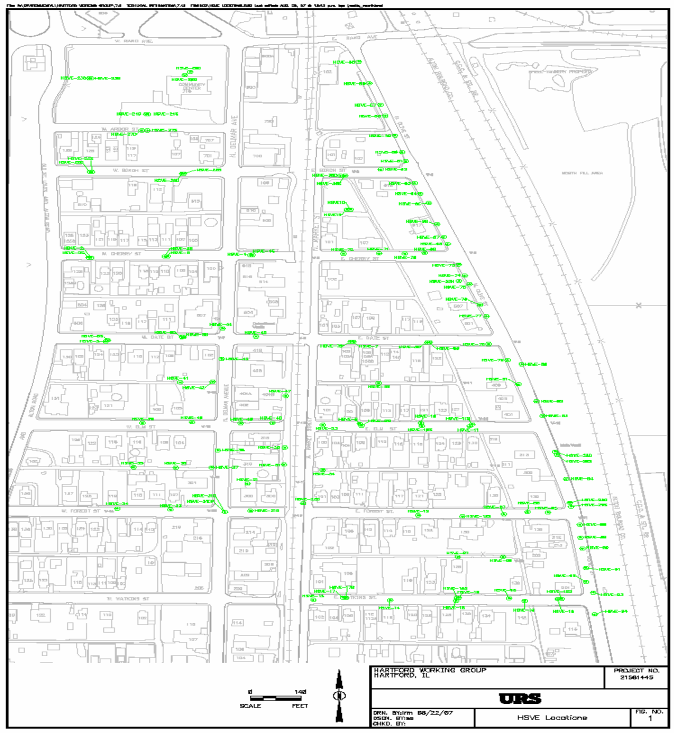
Conclusion

- 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

102

SVE Well Locations Dec 2008



103

Hartford Hydrocarbon Site

104

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]	**[illegible]**	< 25	< 3,50
14		021005 112 W Birch SS2	2/10/2005	< 46,000	< 46,000	< 20,000J	**12,000**	< 260	**[illegible]90,000**	**10,000,000**	< 260	< 150,(
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,(
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,(
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	[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	< 9.5
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	52	< 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

Page 1

105

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.

106

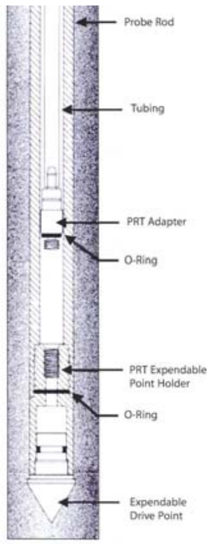
S/K

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	

107

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

109

Sampling Implant Installation

110

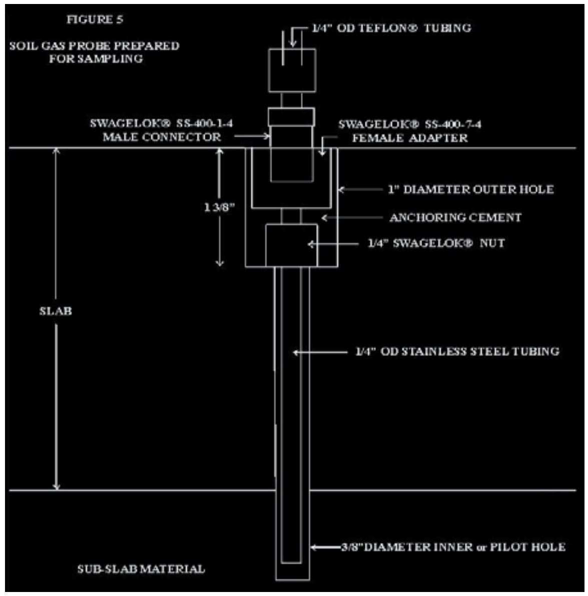
Soil Vapor and Sub Slab Vapor Investigation

- Step-wise approach

Property Sampling → Sub Slab Sampling → Indoor Air Sampling

111

Subslab Sampling Port



112

Drilling Through Slab

113

Placement and Cementing of the Probe

114

Installing Inert Sample Collection Line

115

Collecting an Indoor Air Sample using a SUMMA Canister

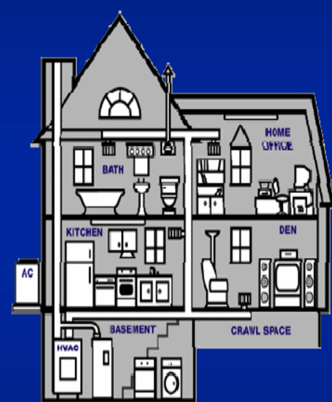
116

Collecting an Ambient Air Sample Using a SUMMA Canister

117

Sources of Background IA Contamination

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



118

TAGA Pre-Screening

119

120

Trace Atmospheric Gas Analyzer (TAGA) Mobile Laboratory

Gas Chromatograph with Concentrator for Volatiles

121

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

What does your data tell you???

122

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	

123


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
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Steven Renning...
Chevron Hooven
Presentation1
Site Profile - Micr...
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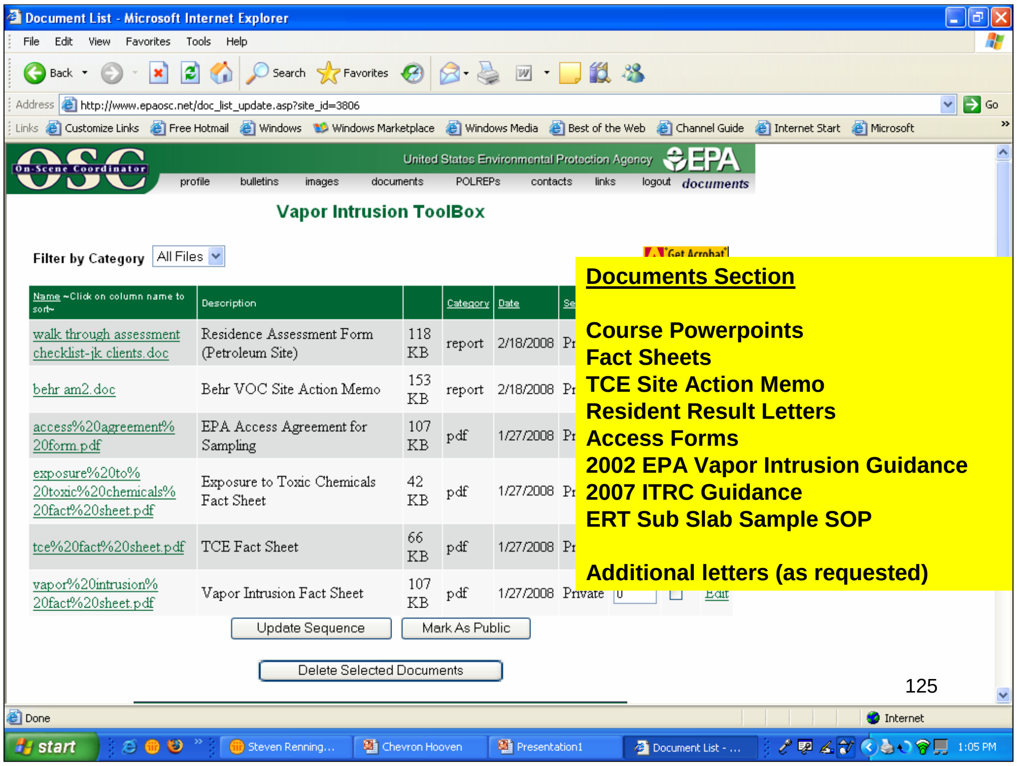
Document List - Microsoft Internet Explorer
http://www.epaosc.net/doc_list_update.asp?site_id=3806
United States Environmental Protection Agency EPA
profile bulletins images documents POLREPs contacts links logout documents
Vapor Intrusion ToolBox
Filter by Category All Files
Name ~Click on column name to sort~
Description
Category
Date
walk through assessment checklist-jk clients.doc
Residence Assessment Form (Petroleum Site)
118 KB
report
2/18/2008
behr am2.doc
Behr VOC Site Action Memo
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report
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Exposure to Toxic Chemicals Fact Sheet
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Vapor Intrusion Fact Sheet
107 KB
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Private
Edit
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
1:05 PM

S/K

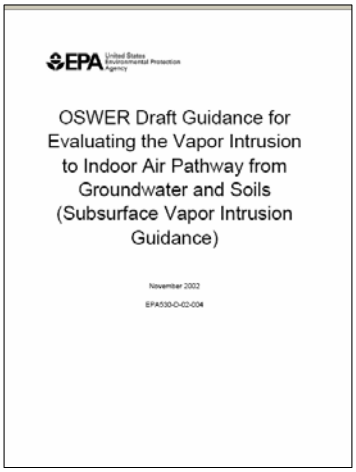
Vapor Intrusion Issues – Agenda

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	

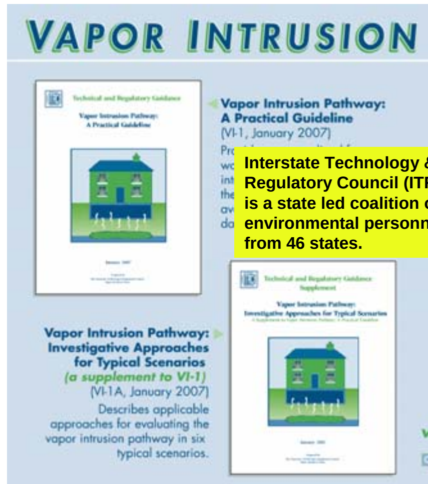
126

S

Vapor Intrusion Guidance



2002 EPA Guidance



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

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127

S

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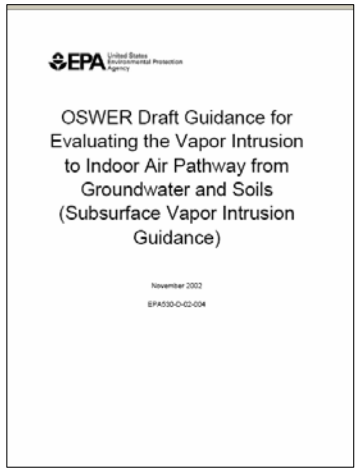
EPA United States Environmental Protection Agency

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

Overview of Guidance: Where to find answers, definitions, etc 128

S

EPA Vapor Intrusion Guidance – 2002

Table of Contents

Options

S

EPA Vapor Intrusion Guidance – 2002

Introduction

Options

DRAFT GUIDANCE FOR EVALUATING THE VAPOR INTRUSION TO INDOOR AIR PATHWAY FROM GROUNDWATER AND SOILS
INTRODUCTION
EXPLANATION OF VAPOR INTRUSION
SUMMARY OF DRAFT GUIDANCE
USE OF THIS GUIDANCE
TIER 1 - PRIMARY SCREENING
TIER 2 - SECONDARY SCREENING
TIER 3 - SITE-SPECIFIC ASSESSMENT
VAPOR
REFERE
TABLE 1
TABLE 2
TABLE 3
APPEND
APPEND
APPEND
APPEND
APPEND
APPEND
APPENDIX G: CONSIDERATIONS FOR THE USE OF THE JOHNSON AND ETTINGER VAPOR INTRUSION MODEL
APPENDIX H: COMMUNITY INVOLVEMENT GUIDANCE
APPENDIX I: CONSIDERATION OF BACKGROUND INDOOR AIR VOC LEVELS IN EVALUATING THE SUBSURFACE VAPOR INTRUSION PATHWAY

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.

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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

INTRODUCTION

EXPLANATION OF VAPOR INTRUSION

SUMMARY OF DRAFT GUIDANCE

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 ... FACTORS (α)

APPENDIX A: DATA QUALITY ASSU

APPENDIX B: DEVELOPMENT OF A ... OR INTRUSION PATHWAY

APPENDIX C: DETAILED FLOW DIA

APPENDIX D: DEVELOPMENT OF T

APPENDIX E: RELEVANT METHODS

APPENDIX F: EMPIRICAL ATTENUA

APPENDIX G: CONSIDERATIONS FO ... ODEL

APPENDIX H: COMMUNITY INVOLV

APPENDIX I: CONSIDERATION OF ... URFACE VAPOR INTRUSION PATHWAY

<u>Explanation of Vapor Intrusion:</u>

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

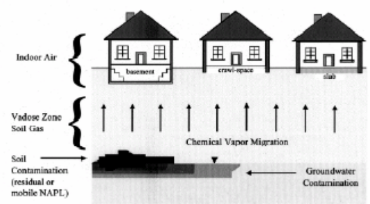

Figure 1: Generalized schematic of the pathway for subsurface vapor intrusion

S

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Primary Screening

Options

DRAFT GUIDANCE FOR EVALUATING THE VAPOR INTRUSION TO INDOOR AIR PATHWAY FROM GROUNDWATER AND SOILS
INTRODUCTION
EXPLANATION OF VAPOR INTRUSION
SUMMARY OF DRAFT GUIDANCE
USE OF THIS GUIDANCE
TIER 1 - PRIMARY SCREENING
TIER 2 - SECONDARY SCREENING
TIER 3 - SITE-SPECIFIC ASSESSMENT
VAPOR INTRUSION PATHWAY SUMMARY PAGE
REFERENCES
TABLE 1: QU
TABLE 2: QU
TABLE 3: QU
APPENDIX A:
APPENDIX B: ... AY
APPENDIX C:
APPENDIX D:
APPENDIX E:
APPENDIX F:
APPENDIX G: CONSIDERATIONS FOR THE USE OF THE JOHNSON AND ETTINGER VAPOR INTRUSION MODEL
APPENDIX H: COMMUNITY INVOLVEMENT GUIDANCE
APPENDIX I: CONSIDERATION OF BACKGROUND INDOOR AIR VOC LEVELS IN EVALUATING THE SUBSURFACE VAPOR INTRUSION PATHWAY

Tier 1 Primary Screening:

Does the site have characteristics of potential vapor intrusion?

VOCs present in soil?
Inhabited buildings near subsurface VOC contamination?

S

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Secondary Screening

Options

- DRAFT GUIDANCE FOR EVALUATING THE VAPOR INTRUSION TO INDOOR AIR PATHWAY FROM GROUNDWATER AND SOILS
- INTRODUCTION
- EXPLANATION OF VAPOR INTRUSION
- SUMMARY OF DRAFT GUIDANCE
- USE OF THIS GUIDANCE
- TIER 1 - PRIMARY SCREENING
- TIER 2 - SECONDARY SCREENING
- TIER 3 - SITE SPECIFIC ASSESSMENT
- VAPOR INTRUSION PATHWAY SUMMARY PAGE
- REFERENCE
- TABLE 1: QU
- TABLE 2: QU
- TABLE 3: QU
- APPENDIX A:
- APPENDIX B:
- APPENDIX C:
- APPENDIX D:
- APPENDIX E:
- APPENDIX F:
- APPENDIX G:
- APPENDIX H
- APPENDIX I: ... WAY

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

133

S

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Site Specific Screening

Options

- DRAFT GUIDANCE FOR EVALUATING THE VAPOR INTRUSION TO INDOOR AIR PATHWAY FROM GROUNDWATER AND SOILS
- INTRODUCTION
- EXPLANATION OF VAPOR INTRUSION
- SUMMARY OF DRAFT GUIDANCE
- USE OF THIS GUIDANCE
- TIER 1 - PRIMARY SCREENING
- TIER 2 - SECONDARY SCREENING
- TIER 3 - SITE-SPECIFIC ASSESSMENT
- VAPOR INTRUSION PATHWAY SUMMARY PAGE
- REFERENCES
- TABLE 1: QUESTION 1 SUMMAY SHEET
- TABLE 2: C
- TABLE 3: C
- APPENDIX
- APPENDIX
- APPENDIX
- APPENDIX
- APPENDIX
- APPENDIX
- APPENDIX
- APPENDIX H: COMMUNITY INVOLVEMENT GUIDANCE
- APPENDIX I: CONSIDERATION OF BACKGROUND INDOOR AIR VOC LEVELS IN EVALUATING THE SUBSURFACE VAPOR INTRUSION PATHWAY

<u>Tier 3 Site Specific Assessment:</u>

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)

S

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Appendix F

Options

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

INTRODUCTION

EXPLAN

SUMMA

USE OF

TIER 1 -

TIER 2 -

TIER 3 -

VAPOR

REFERE

TABLE 1

TABLE 2

TABLE 3

APPEND

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

APPENDIX B: DEVELOPMENT OF A CONCEPTUAL SITE MODEL (CSM) FOR ASSESSMENT OF THE VAPOR INTRUSION PATHWAY

APPENDIX C: DETAILED FLOW DIAGRAMS OF THE EVALUATION APPROACH USED IN THE GUIDANCE

APPENDIX D: DEVELOPMENT OF TABLES 1, 2, AND 3

APPENDIX E: RELEVANT METHODS AND TECHNIQUES

APPENDIX F: EMPIRICAL ATTENUATION FACTORS AND RELIABILITY ASSESSMENT

APPENDIX G: CONSIDERATIONS FOR THE USE OF THE JOHNSON AND ETTINGER VAPOR INTRUSION MODEL

APPENDIX H: COMMUNITY INVOLVEMENT GUIDANCE

APPENDIX I: CONSIDERATION OF BACKGROUND INDOOR AIR VOC LEVELS IN EVALUATING THE SUBSURFACE VAPOR INTRUSION PATHWAY

S

EPA Vapor Intrusion Guidance – 2002

Appendix H

Options

DRAFT GUIDANCE FOR EVALUATING THE VAPOR INTRUSION TO INDOOR AIR PATHWAY FROM GROUNDWATER AND SOILS
INTRODUCTION
EXPLAN
SUMMA
USE OF
TIER 1 -
TIER 2 -
TIER 3 -
VAPOR
REFERE
TABLE 1
TABLE 2
TABLE 3

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)

APPENDIX A: DATA QUALITY ASSURANCE CONSIDERATIONS
APPENDIX B: DEVELOPMENT OF A CONCEPTUAL SITE MODEL (CSM) FOR ASSESSMENT OF THE VAPOR INTRUSION PATHWAY
APPENDIX C: DETAILED FLOW DIAGRAMS OF THE EVALUATION APPROACH USED IN THE GUIDANCE
APPENDIX D: DEVELOPMENT OF TABLES 1, 2, AND 3
APPENDIX E: RELEVANT METHODS AND TECHNIQUES
APPENDIX F: EMPIRICAL ATTENUATION FACTORS AND RELIABILITY ASSESSMENT
APPENDIX G: CONSIDERATIONS FOR THE USE OF THE JOHNSON AND ETTINGER VAPOR INTRUSION MODEL
APPENDIX H: COMMUNITY INVOLVEMENT GUIDANCE
APPENDIX I: CONSIDERATION OF BACKGROUND INDOOR AIR VOC LEVELS IN EVALUATING THE SUBSURFACE VAPOR INTRUSION PATHWAY

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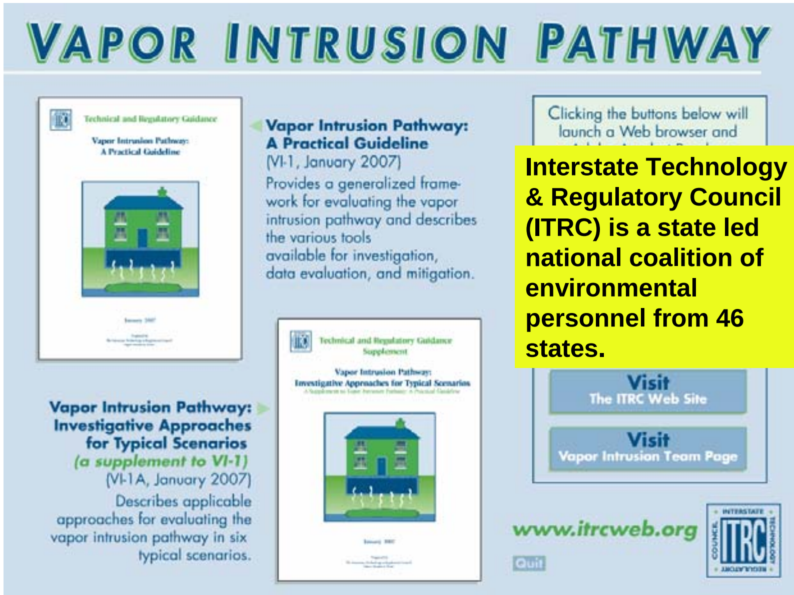

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137

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Conceptual Model

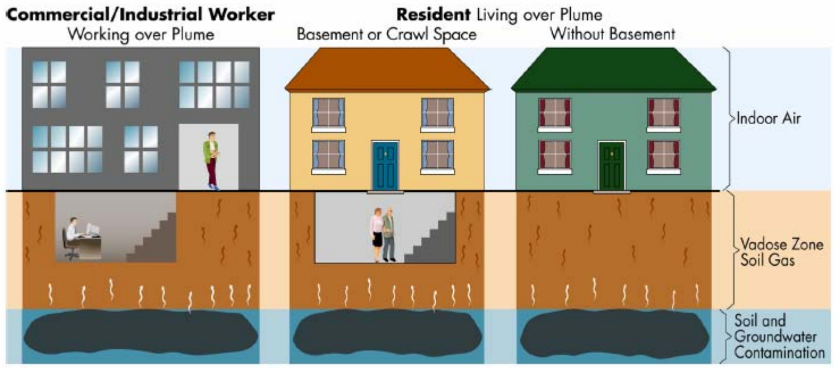

Figure 1-1. Typical conceptual model of vapor intrusion.

Note: Hartford Site volumes of data

138

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Soil Gas & Soil Vapor

ɛd approach, it is recommended g., analytical results, building ɪtes) be used in making a ɛer vapor intrusion is occurring ɪtial 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

139

K

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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

140

S

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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)

141

S

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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 ... ng 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 $?

142

S

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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

143

S

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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)

144

S

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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

145

S

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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.

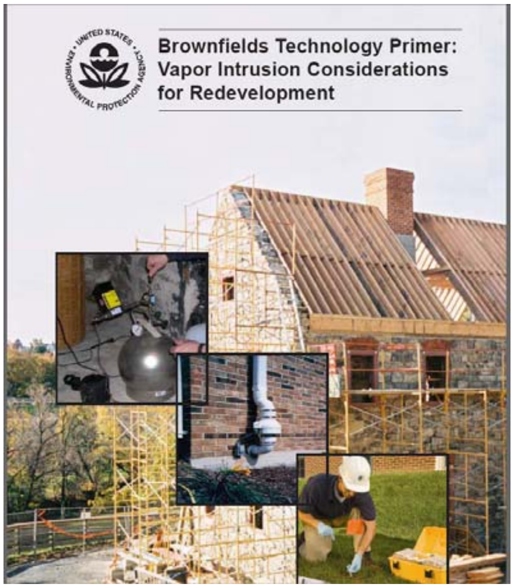
Figure D-5. Stainless steel canisters.

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

146

K

Good introduction to Vapor Intrusion



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

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

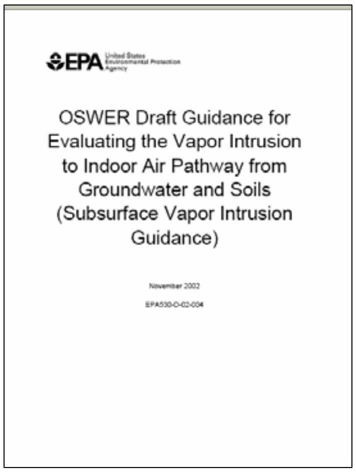
S

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

148

Vapor Intrusion Guidance

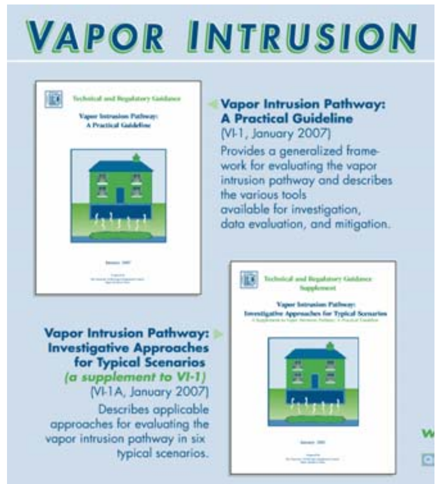


EPA United States Environmental Protection Agency

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



149

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	

150

Vapor Intrusion Issues

Seminar

November 2, 2009

151

Thank You

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152