The Vapor Intrusion Pathway: Regulatory Updates & VOC Monitoring

Landscience Webinar

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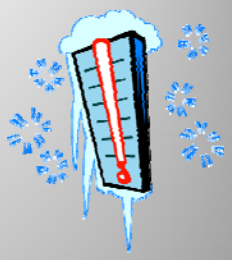
This presentation is an excerpt from the vapor intrusion training that Dr. Hartman has been presenting to Federal & State regulatory agencies, DOD facilities, consulting groups, and stakeholders around the country. As of September 2017, this training has been given to over 30 State Regulatory agencies, including ASTSWMO and the State Coalition of Dry Cleaners, several EPA Regions, England, Brazil & Australia. A 2-day training course has been given to 15 locations around the country since 2014 and will continue into 2018.

Lecture notes are at the bottom of each slide so that if played out as a hard-copy, the presentation can be a useful reference document.

Regulatory Topics

Getting Cold



1. EPA OSWER & OUST Guidances
2. ASTM Phase 1 Standard
3. ITRC PVI Guidance

Red Hot

4. Use of Models
5. Short Term TCE Exposure

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The hottest VI Regulatory topics as of September 2017. Some of the previous-hot topics have cooled down, but there still exists a couple of very hot ones.

EPA OSWER Guidance – June 2015

- Only Test for VOCs Known on Site
- Technical Guidance – Not Regulation

- Preference for soil gas near source (terrible for HCs!)
- Longer indoor air sampling period (terrible for HCs!)
- Fixed Att factor of 0.03 for soil gas (~15x drop in SLs)

- Applies to non-UST Petroleum Sites
- Claim Jurisdiction to Businesses!!
- Very Difficult to Read

Will Complicate VI Assessments

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A summary of the good points, bad points and ugly points in the 2015 EPA OSWER guidance. The ultimate ramification of this guidance is to complicate vapor intrusion assessments.

EPA OUST Guidance – June 2015

- Exclusion Criteria for GW & Soil!!
- Concise. Organization Good

- Lateral Exclusion Distances Diff Than Vertical
- No Screening Levels for Soil Gas:
  Calculate them from an attenuation factor

- Attenuation Factor Text is Contradictory
  - Section 12 says ok to use 3-D model output
  - Section 13 says models not to be used as sole line of evidence

Will Reduce # of PVI Sites

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A summary of the good points, bad points and ugly points in the 2015 EPA OUST guidance. The ultimate ramification of this guidance will be to reduce the number of petroleum sites requiring vapor intrusion assessments.

Table 3 Required Vertical Separation Distance Between Contamination And Building Foundation, Basement, Or Slab.

Media	Benzene	TPH	Vertical Separation Distance (feet)*
Soil (mg/kg)	≤10	≤250	6
	>10 (LNAPL)	>250 (LNAPL)	15**
Groundwater (ug/L)	≤		6
	>5,000 (LNAPL)	>30,000 (LNAPL)	15**

Must Have "Clean Soil"

The thresholds for LNAPL indicated in this table are indirect evidence of the presence of LNAPL. These thresholds may vary depending on site-specific conditions (e.g., soil type, LNAPL source). Investigators may have different experiences with LNAPL indicators and may use them as appropriate. Direct indicators of LNAPL also apply; these include measurable accumulations of free product, oily sheens, and saturated bulk soil samples.

*Vertical separation distance represents the thickness of clean (TPH ≤ 100 mg/kg), biologically active soil between the source of PHC vapors (LNAPL, residual LNAPL, or dissolved PHCs) and the lowest (deepest) point of a receptor (building foundation, basement, or slab).

** EPA recommends that sub-slab monitoring be used to evaluate the risk of vapor intrusion whenever LNAPL is present in any sample and the vertical separation distance is less than 15 feet. When LNAPL is

EPA-OUST guidance adopted exclusion criteria for UST sites. Note requirement for clean soil

States Adopting PVI Exclusion Criteria

- CA
- NJ
- AK
- IN
- MA

- LA
- VT
- MI
- WI
- IL

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These are the States that have adopted exclusion criteria for petroleum VI sites as of November 2015. If the criteria are meant, the vapor intrusion pathway is considered to not be an issue and can be thrown into the VI out basket. It is likely more States will be doing the same. The recently released ITRC guidance also contains exclusion criteria.

More VI Sites
Newest ASTM Phase 1 Standard

- Vapor "Migration" Now A VEC
- Long Distances: Cl-HC:1728', PHC: 528'
- Use Applicable Screening Values
- Most Sites Will Not Be Closed

Result of this:

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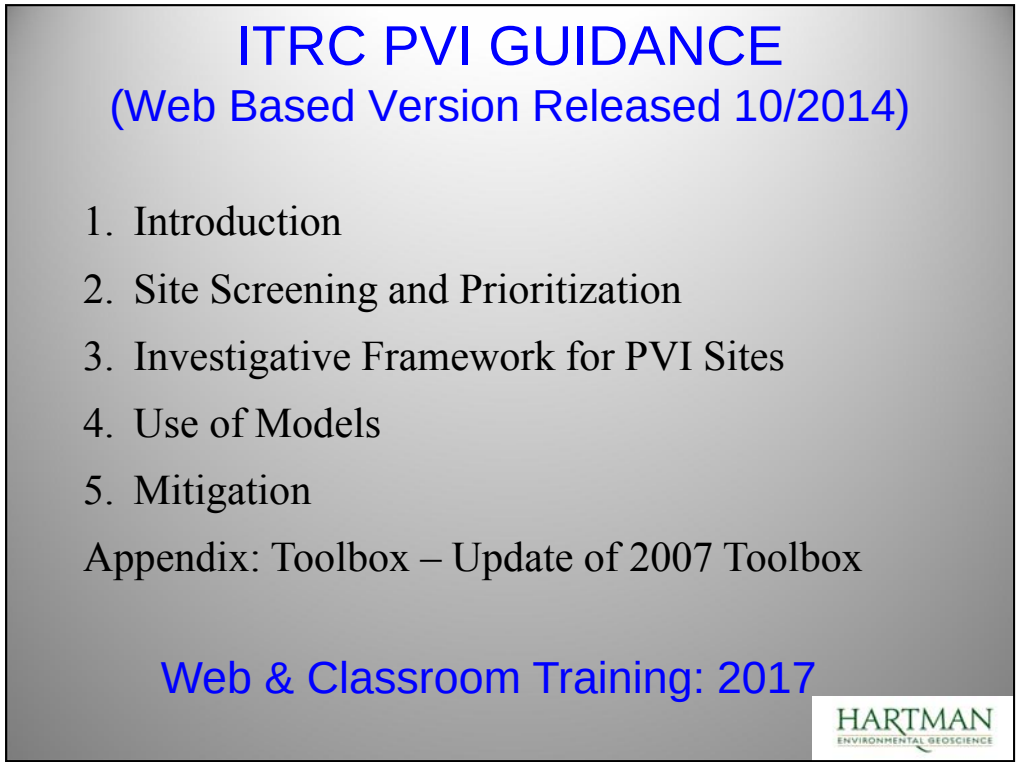
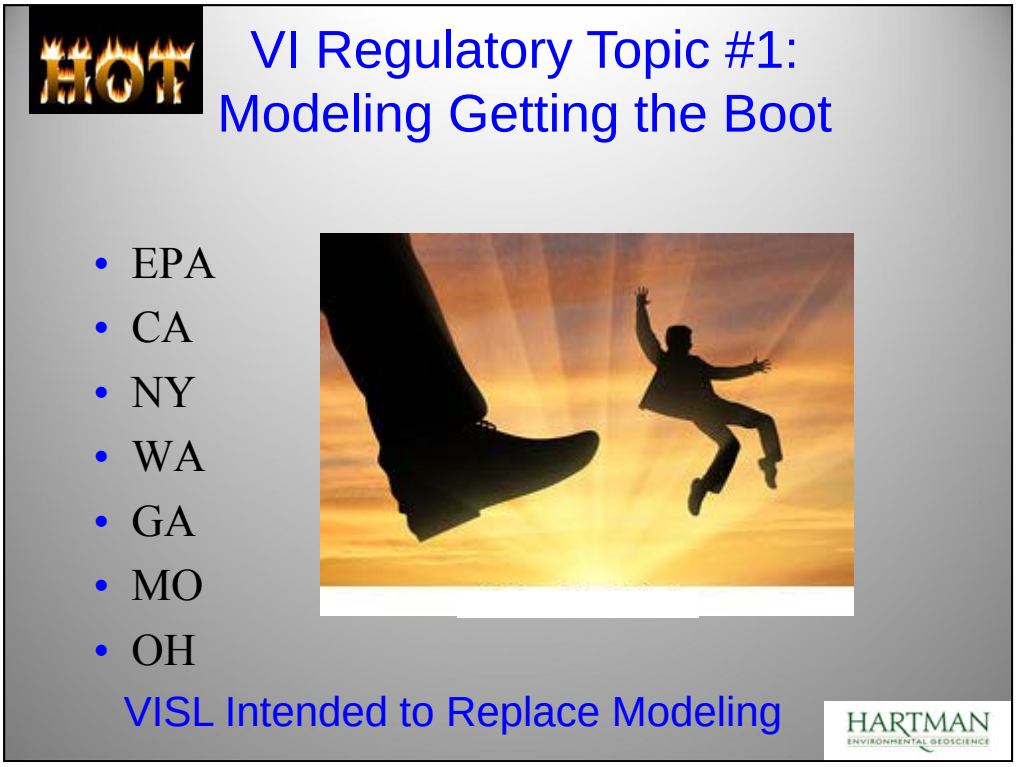
ASTM convened a technical workgroup in 2005 to write a standard for vapor intrusion as it applies to property transactions. The standard was originally released on March 3, 2008. A revised standard was released in June 2010.

In November 2013, the Phase 1 standard was updated to include vapor intrusion as a REC.

The ramification is that more sites will need some level of screening or investigation of the VI pathway.



ITRC released new guidance specifically for petroleum hydrocarbon sites in October 2014. Web-based and classroom training are currently available. Go to: www.itrcweb.org.



One of the currently hot topics is the Federal and State agencies shift away from the use of models to demonstrate the VI pathway is not a risk. More and more states are jumping on the band-wagon. EPA has removed the Excel version of the J-E models from its website and has replaced it with the vapor intrusion screening level (VISL) calculator.

The Mysterious 0.03

EPA's Vapor Intrusion Database:
Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and **Residential** Buildings
EPA 530-R-10-002, March 16, 2012

- Residences with basements (95th percentile): (0.03)
- Residences with slab-on-grade (95th percentile): (0.01)

VISL: 0.03 for All Structures!

Radon to the Rescue?

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Based upon a n empirical database evaluation done in 2012, EPA now recommends that a default attenuation factor be used to determine sub-slab or soil gas screening levels or in turn, predict indoor air from sub-slab or shallow soil gas data. The default value is 0.03. They apply this factor to all types of structures.

But wait, the database is only from residential structures!

And the value from the study for slab-on-grade structures is 3 times lower!!

VI Regulatory Topic #2:

Short Term TCE Exposure

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The current hottest topic throughout the VI world: Short term TCE exposure. The issue: malformation of the hearts of fetuses if the pregnant mother breathes TCE for very short periods of time.

EPA R7 Short Term TCE Guidance

- EPA Region 7, November 2nd, 2016
  - *"It is assumed that an exposure to TCE at any time during an approximate three-week period in early pregnancy could result in one or more types of cardiac malformations."*
  - 2 ug/m^3 – 24 hour period (residential)
  - 6 ug/m^3 – 8 hour (commercial)

- Does this mean the following:
  - 48 ug/m^3 – for 1 hour?
  - 96 ug/m^3 – for 30 minutes?
  - 480 ug/m^3 – for 6 minutes?

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Recent text from a November 2016 document released by EPA R7 which says that the period of exposure for short-term TCE effects is not over a 21 day period but at any time during the 21-day period. The standards they set for residential vs commercial assume an exposure of roughly 48 ug of TCE.

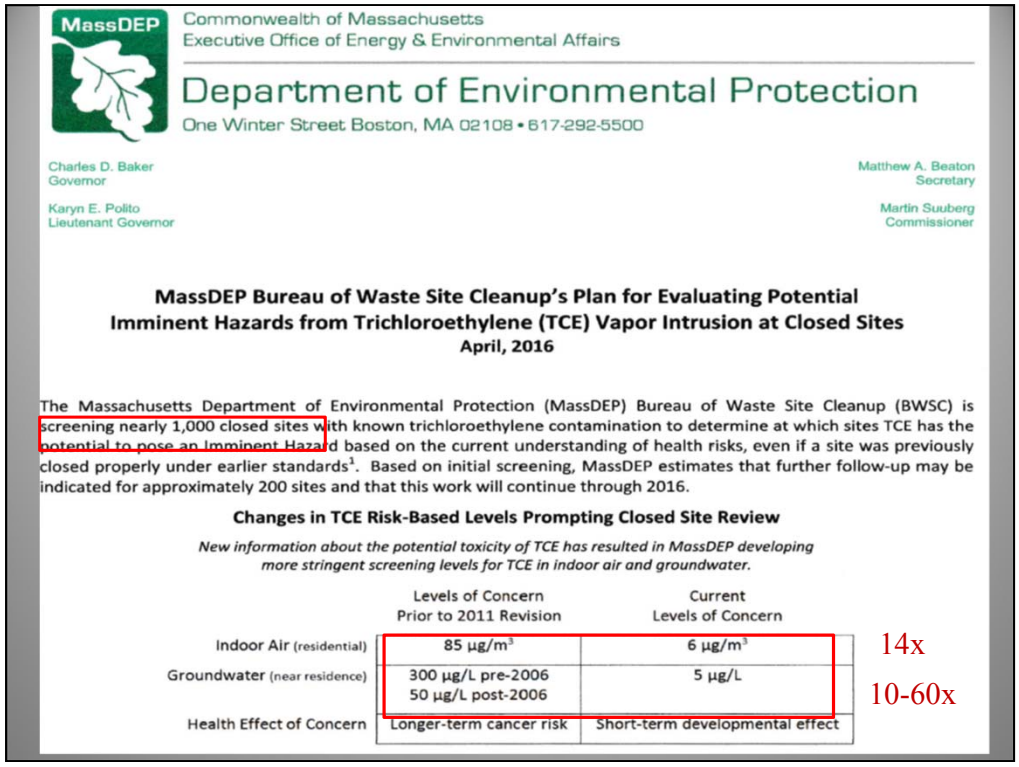
So does this mean exposures as short as 6 minutes could cause harmful effects?

Real News or Fake News: Johnson et al Study

- Fetal heart malformations observed during 21-day gestational period of Sprague-Dawley rat based on oral exposure.

- To date, fetal heart malformation results not replicated in other studies, including: FIVE TCE rodent/rabbit inhalation studies
  - Carney et al., 2006
  - Dorfmueller et al., 1979
  - Hardin et al., 1981
  - Healy et al., 1982
  - Schwetz et al., 1975

The Johnson study upon which current short-term standards are based was actually an oral exposure not inhalation and the results of the study can not be replicated although many studies have tried to do so. So why have the results been adopted? Are the Russians behind it?



MassDEP

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

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Commissioner

MassDEP Bureau of Waste Site Cleanup's Plan for Evaluating Potential Imminent Hazards from Trichloroethylene (TCE) Vapor Intrusion at Closed Sites
April, 2016

The Massachusetts Department of Environmental Protection (MassDEP) Bureau of Waste Site Cleanup (BWSC) is screening nearly 1,000 closed sites with known trichloroethylene contamination to determine at which sites TCE has the potential to pose an Imminent Hazard based on the current understanding of health risks, even if a site was previously closed properly under earlier standards[1]. Based on initial screening, MassDEP estimates that further follow-up may be indicated for approximately 200 sites and that this work will continue through 2016.

Changes in TCE Risk-Based Levels Prompting Closed Site Review

New information about the potential toxicity of TCE has resulted in MassDEP developing more stringent screening levels for TCE in indoor air and groundwater.

	Levels of Concern Prior to 2011 Revision	Current Levels of Concern
Indoor Air (residential)	85 µg/m³	6 µg/m³
Groundwater (near residence)	300 µg/L pre-2006 50 µg/L post-2006	5 µg/L
Health Effect of Concern	Longer-term cancer risk	Short-term developmental effect

14x

10-60x

In April 2016, Massachusetts announced it was re-opening 1000 TCE sites using lower allowed levels.

5/22/2017

The Michigan Department of Environmental Quality (MDEQ) recently announced that it will be evaluating the vapor intrusion (VI) pathway at 4,000 sites, including as many as 375 Resource Conservation and Recovery Act (RCRA) corrective action sites.

With lower screening levels, regulatory triggers and criteria, more sites will likely require detailed VI evaluations,

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In May 2017, Michigan announced it was reevaluating 4000 TCE sites with lower allowed levels.

States Reopening TCE Sites

- MA
- MI
- OH
- NY
- NJ
- CA?

Result of this:

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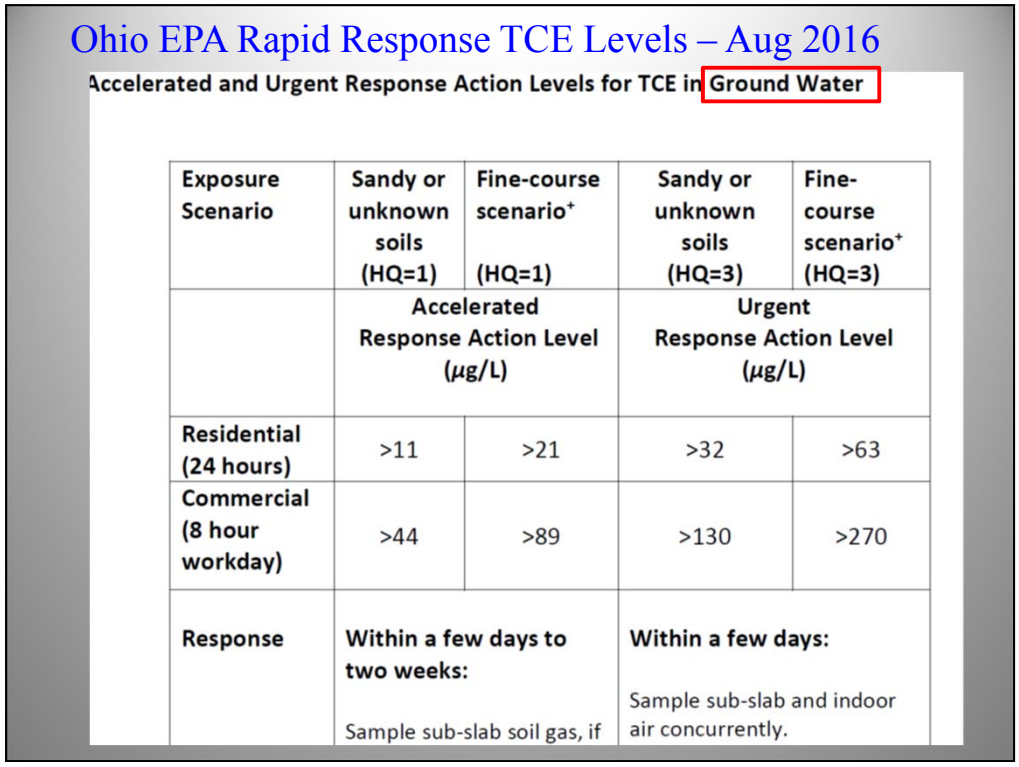
This is a partial list of States that are re-opening TCE sites to re-assess the VI pathway.



Ohio EPA's rapid response actions for TCE in Groundwater (August 2016)

Ohio EPA Rapid Response TCE Levels – Aug 2016

Accelerated and Urgent Response Action Levels for TCE in Sub-Slab Soil Gas

Exposure Scenario	Accelerated Response Action Level (HQ=1)		Urgent Response Action Level (HQ=3)	
	$\mu g/m^3$	ppbv	$\mu g/m^3$	ppbv
Residential (24 hours)	>70	>13	>210	>39
Commercial (8 hour workday)	>290	>54	>880	>160
Response	**Within a few days to two weeks:** Sample indoor air and collect concurrent sub-slab soil gasFollow response actions in Table 1		**Within a few days:** Sample indoor air and collect concurrent sub-slab soil gas sample. Follow response actions in Table 1	

Ohio EPA's rapid response actions for TCE in Sub-Slab Soil Gas (August 2016)

Urgent Response Options

- Air Filtration
  - Costs ~ $1,000/unit
- HVAC Modification
  - Can increase energy costs
- Sealing Floor Cracks
  - Hard to find them all
- Continuously Monitor
  - Determine how often above target level
- Relocate People
  - Could open Pandora's box

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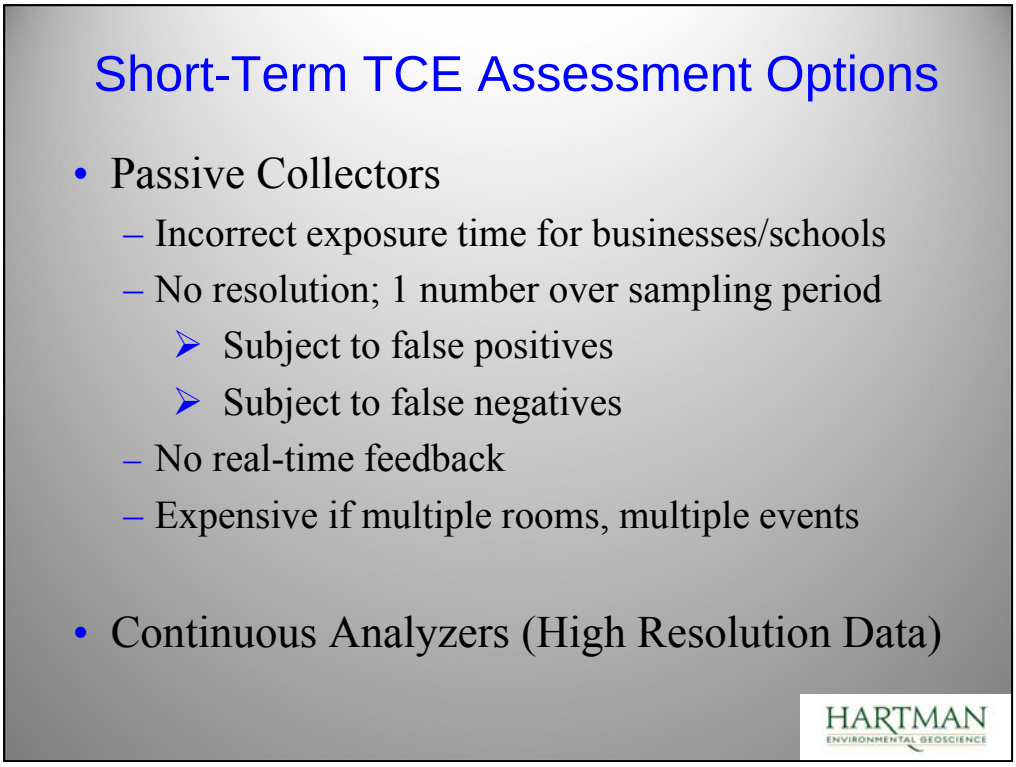
These are some of the options if urgent response is needed.



There are 2 options for assessing the short-term TCE exposure.

One is to use passive collectors over a period of time, such as the 21 day exposure period. However passive collectors have serious limitations, incorrect exposure period for non-residential receptors, no resolution (only 1 data point) and no real-time feedback.

If the exposure period of concern is 24 hours or a few days, passive collectors also become prohibitively expensive.

The second option is to use continuous analyzers.

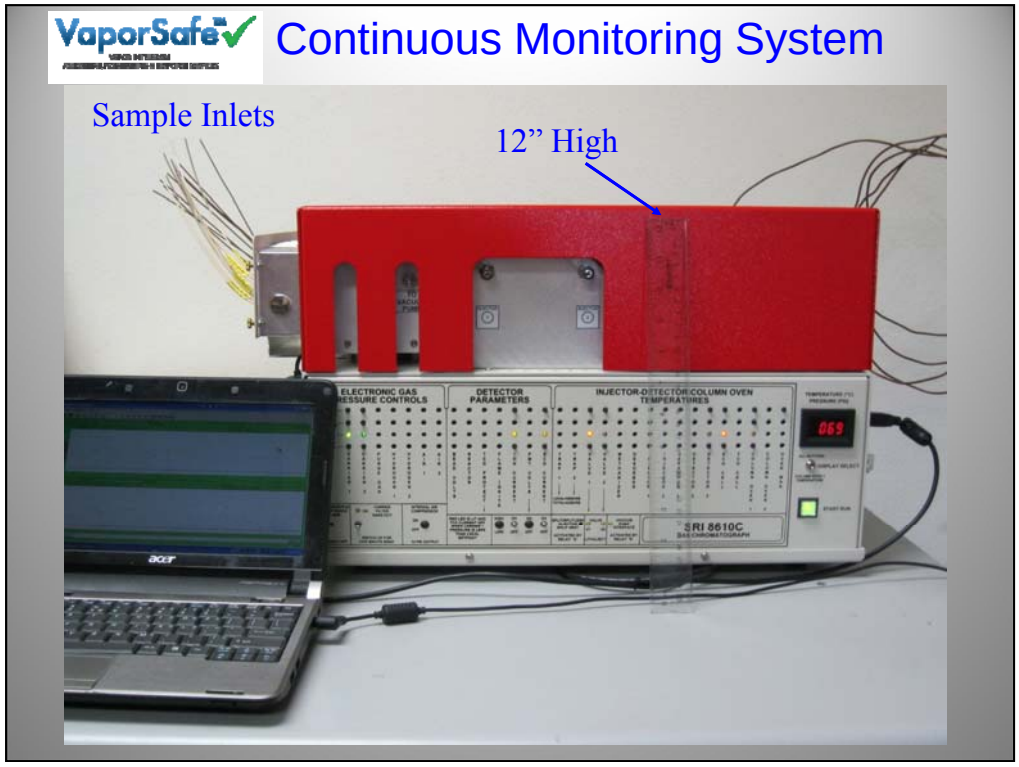


Photo of the Vaporsafe monitoring system. The instrument is about the size of a microwave and can fly around as checked baggage for less than $100.

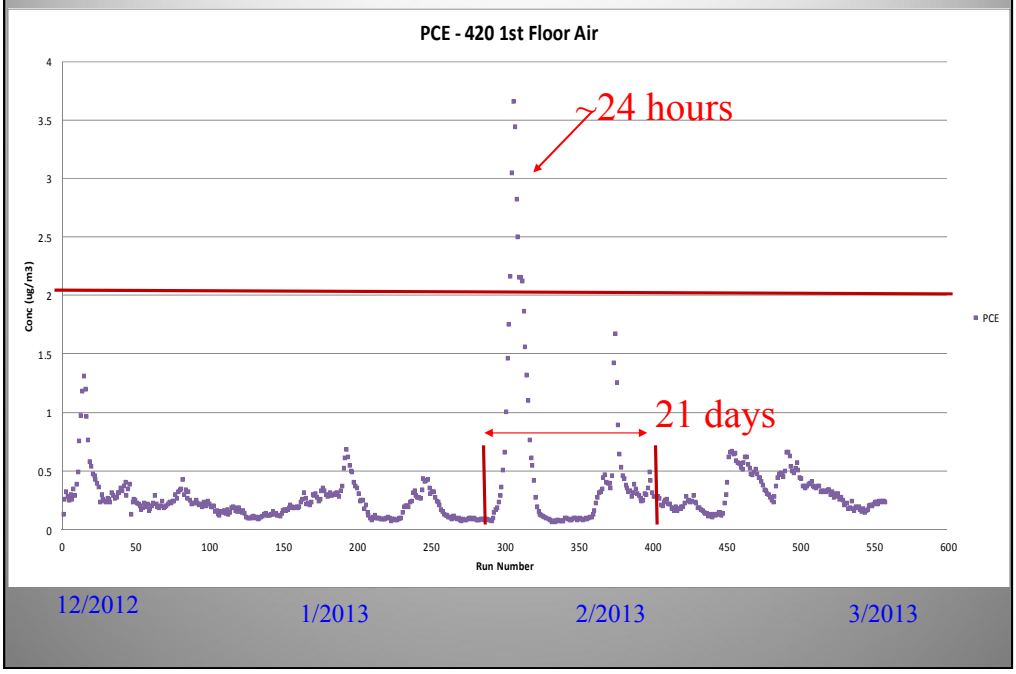
Applications of Monitoring

- Short Term TCE Exposure
  - Hours? 24 hours? A few days? 21 days?
  - How often is a building above SL?
  - Spatial variability?
- Identify VOC Entry Points
  - VI vs Indoor
  - Unexpected VOCs
- Building Modification Feedback
  - HVAC changes. Fans.
  - Sealing cracks.

Motives for collecting continuous indoor air data include the short-term TCE exposure issue. The system can also document both spatial and temporal variability in indoor air concentrations.

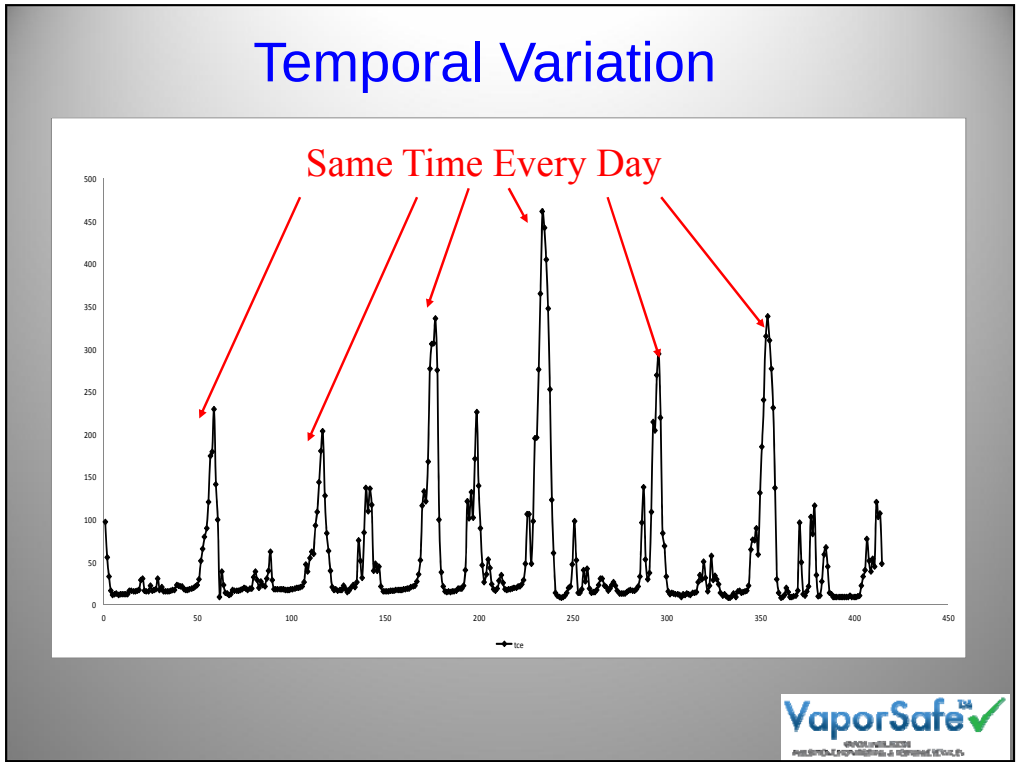
For chronic exposure concerns, continuous monitoring can tell you how long a building is actually above a screening level.

Short Term TCE: How Long Above

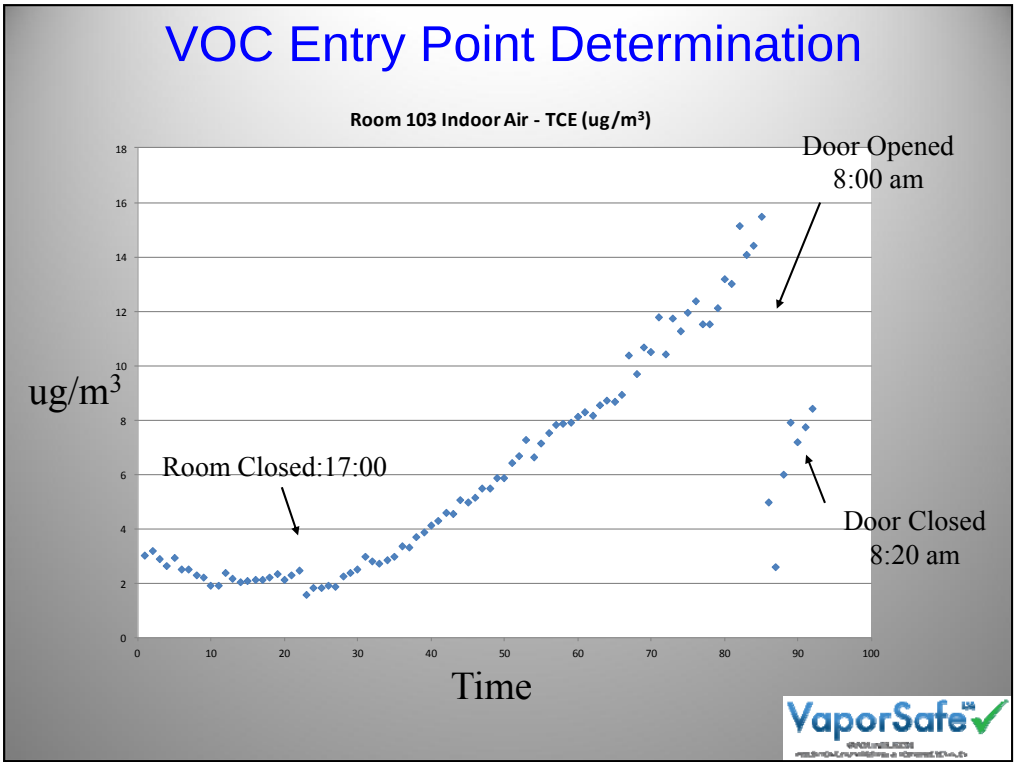


If this was TCE, the short-term exposure level would be 2 ug/m3 over 21 days. There was only 1 occurrence over 2 ug/m3 and only for about a 24 hour period. There were no exceedances for a 21 day period.

Is this a concern? It depends upon the exposure time considered to be a threat to fetuses.

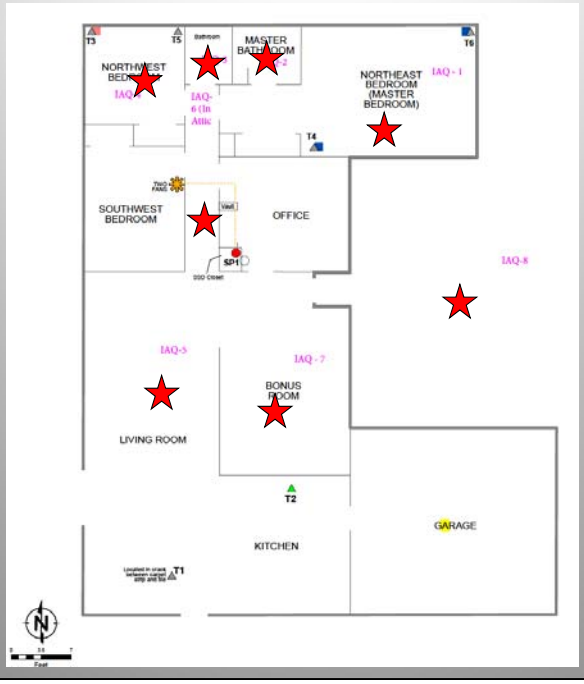


Six days of continuous monitoring of TCE at another large commercial warehouse in San Diego. The huge increases occur at about the same time every day. What is causing this to happen?



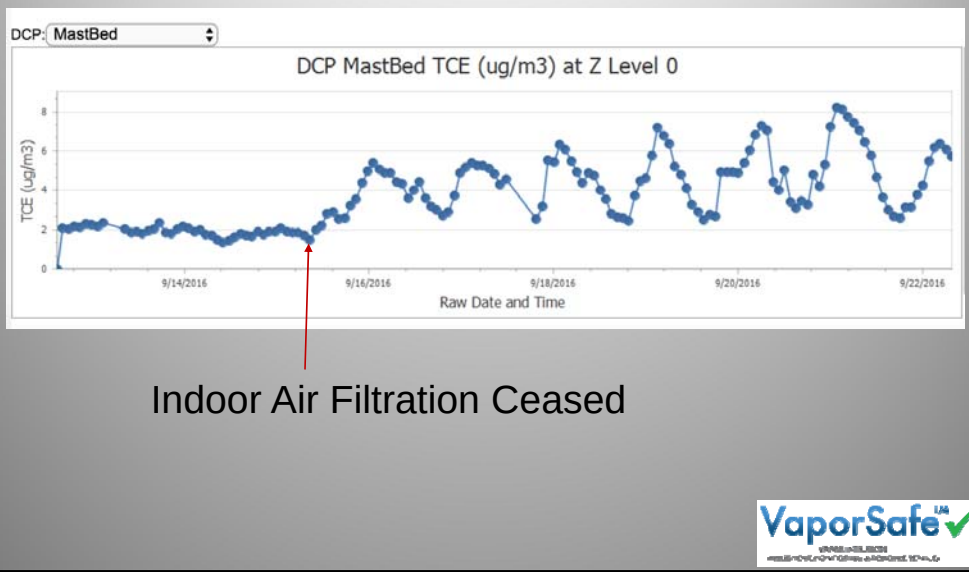
Indoor air TCE concentrations in a small room after the room was closed up for 15 hours, then the door opened the next morning and then closed again. The continuous increase in TCE indoor air values documented that the room was the entry point for the TCE and the total mass entering the room (mass flux) could be calculated.

Single Family Residence Monitoring

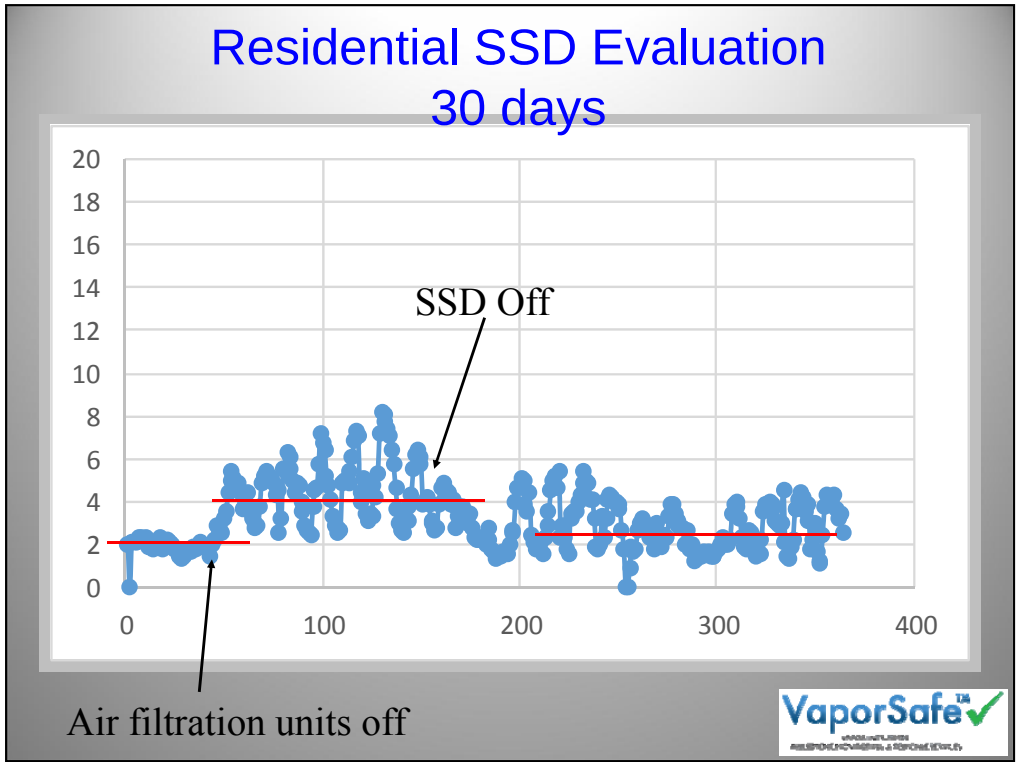


Monitoring of 7 locations in a home in an attempt to find out where the TCE hits were being sourced from, even though an SSD had been installed and was operational. Monitoring locations shown by red stars.

Residential SSD Evaluation
First 7 days

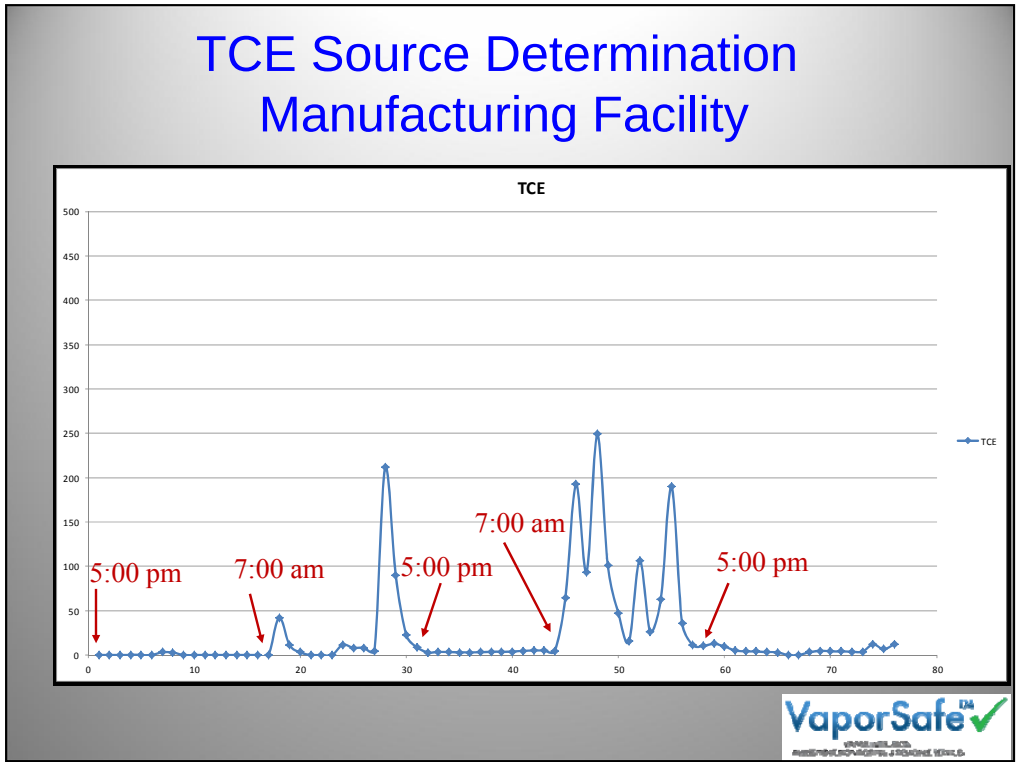


TCE indoor air concentrations in the master bedroom over the first week. Values were about 2 ug/m3 and steady when the indoor air filtration units were operative. Once the filtration units were turned off, a cyclic pattern was observed each day ranging from 2 to 8 ug/m3.

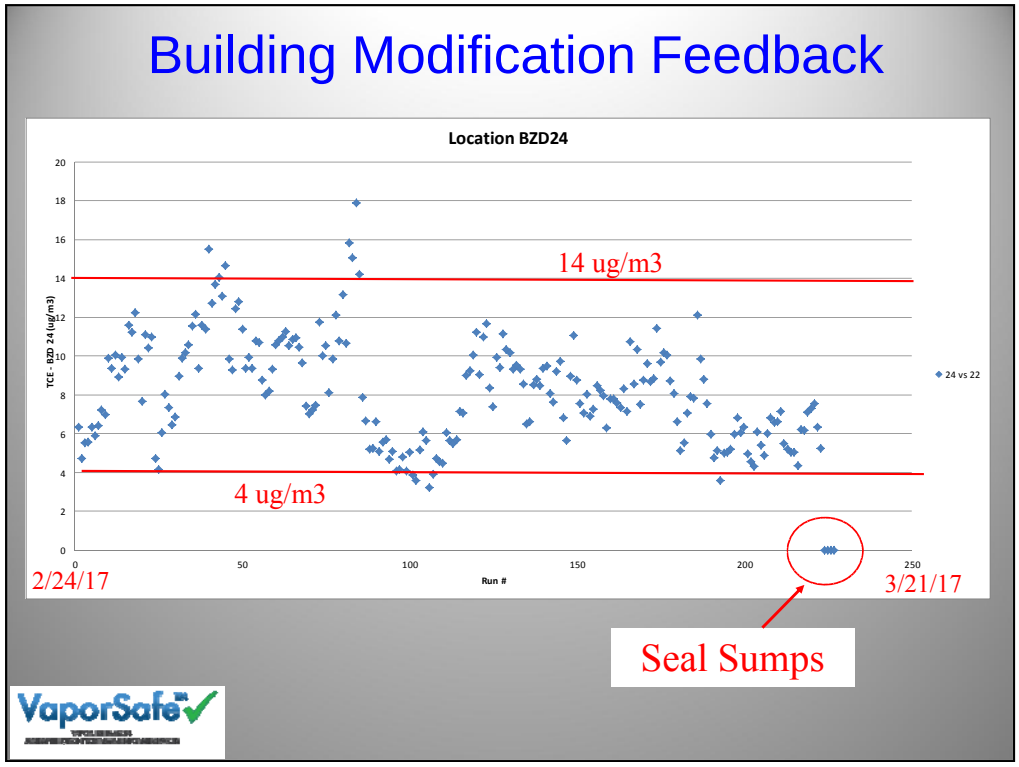


The same master bedroom after nearly 4 weeks of monitoring. The SSD was turned off after 2 weeks (run #190) and the indoor air concentrations DECREASED!!

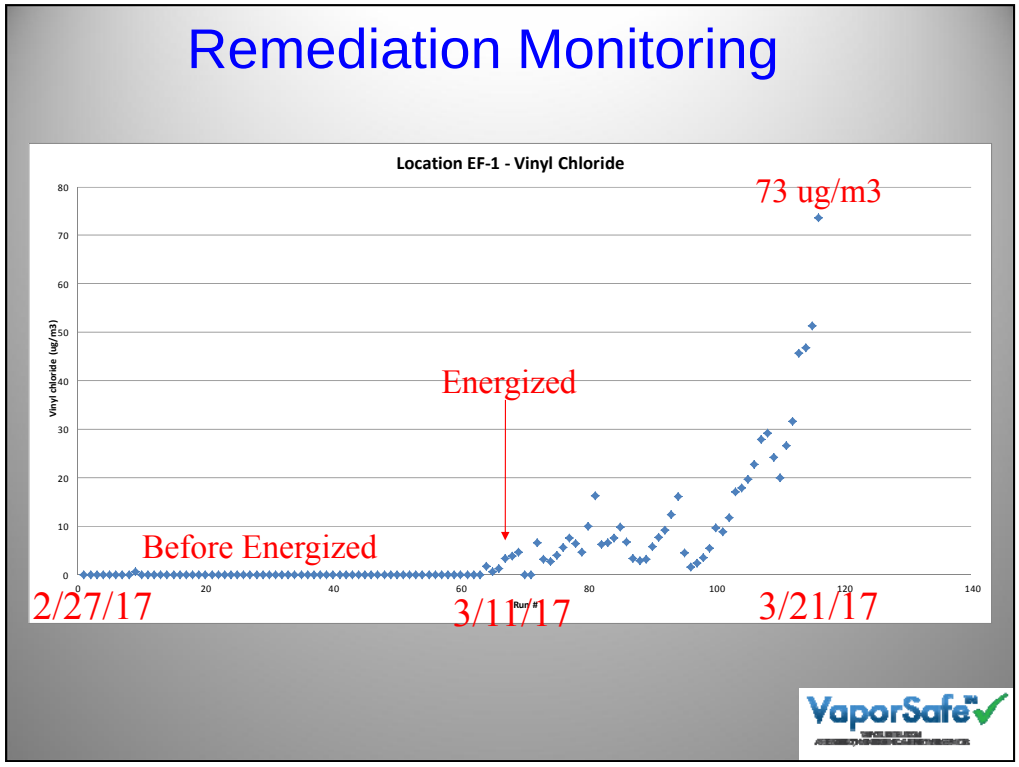
One conclusion from these data is that actual VOC concentration data are necessary to be sure that a mitigation system is operating effectively. The manometer on the SSD system indicated the system was pulling a vacuum, but clearly was not reducing the TCE levels low enough.



TCE indoor air concentrations in a furniture manufacturing facility. Concentrations were low at night, but then increased during the work day. If vapor intrusion was the source, values should have increased at night when the facility was closed up. The opposite was observed. What was the TCE source?



TCE concentrations in a basement at an industrial facility. Values for approximately a month ranged from 4 ug/m3 to 14 ug/m3. But when the two floor sumps were sealed up, values crashed to zero within a couple of hours.



Vinyl Chloride in the effluent from a permanganate scrubber located immediately adjacent to a large thermal remediation project. The vinyl chloride concentrations started increasing almost immediately once the electrodes were energized.

Upcoming vapor intrusion courses given by Hartman Environmental Geoscience