Welcome to the CLU-IN Internet Seminar

NARPM Presents...Vapor Intrusion Issues at the Hill Air Force Base

Sponsored by: EPA Office of Superfund Remediation and Technology Innovation

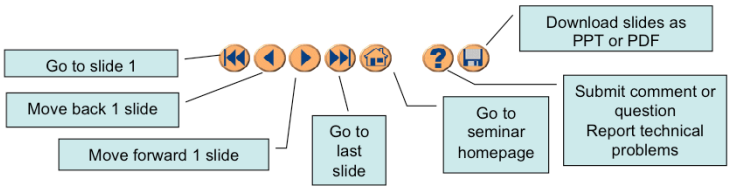
Delivered: March 24, 2011, 2:00 PM - 4:00 PM, EDT (18:00-20:00 GMT)

Instructors:
Sandra Bourgeois, U.S. EPA Region 8 (bourgeois.sandra@epa.gov or (303) 312-6666)
Maple Barnard, U.S. EPA Region 8 (barnard.maple@epa.gov or (303) 312-6321)
Moderator:
Jean Balent, U.S. EPA, Technology Innovation and Field Services Division (balent.jean@epa.gov or (703) 603-9924)

Visit the Clean Up Information Network online at www.cluin.org 1

Housekeeping

- Please mute your phone lines, Do NOT put this call on hold
  - press *6 to mute #6 to unmute your lines at anytime
- Q&A
- Turn off any pop-up blockers
- Move through slides using # links on left or buttons



- This event is being recorded
- Archives accessed for free http://cluin.org/live/archive/

2

Although I'm sure that some of you have these rules memorized from previous CLU-IN events, let's run through them quickly for our new participants.

Please mute your phone lines during the seminar to minimize disruption and background noise. If you do not have a mute button, press *6 to mute #6 to unmute your lines at anytime. Also, please do NOT put this call on hold as this may bring delightful, but unwanted background music over the lines and interupt the seminar.

You should note that throughout the seminar, we will ask for your feedback. You do not need to wait for Q&A breaks to ask questions or provide comments. To submit comments/questions and report technical problems, please use the ? Icon at the top of your screen. You can move forward/backward in the slides by using the single arrow buttons (left moves back 1 slide, right moves advances 1 slide). The double arrowed buttons will take you to 1st and last slides respectively. You may also advance to any slide using the numbered links that appear on the left side of your screen. The button with a house icon will take you back to main seminar page which displays our agenda, speaker information, links to the slides and additional resources. Lastly, the button with a computer disc can be used to download and save today's presentation materials.

With that, please move to slide 3.

CASE STUDY
VAPOR INTRUSION
HILL AIR FORCE BASE, UT
Other Federal Agency Lead

Sandra Bourgeois, EPA R8
Annette Barnard, EPA R8

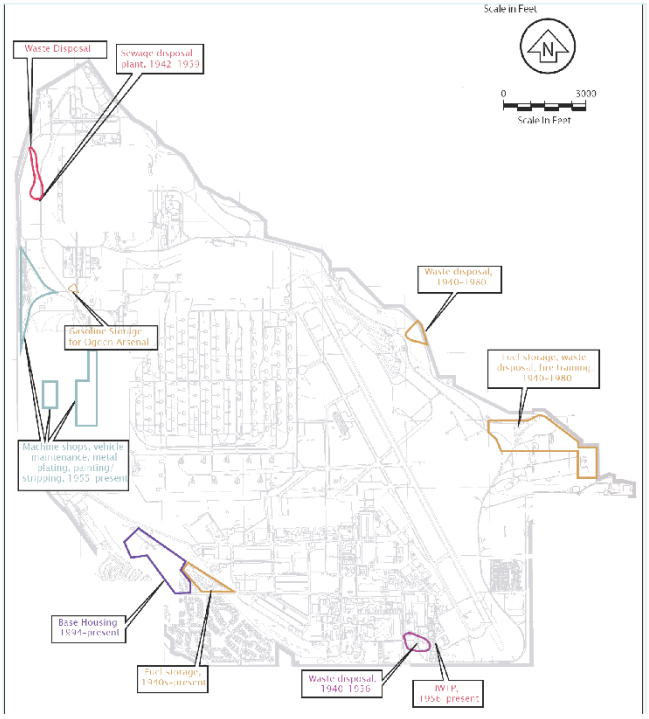
March 24, 2011

3

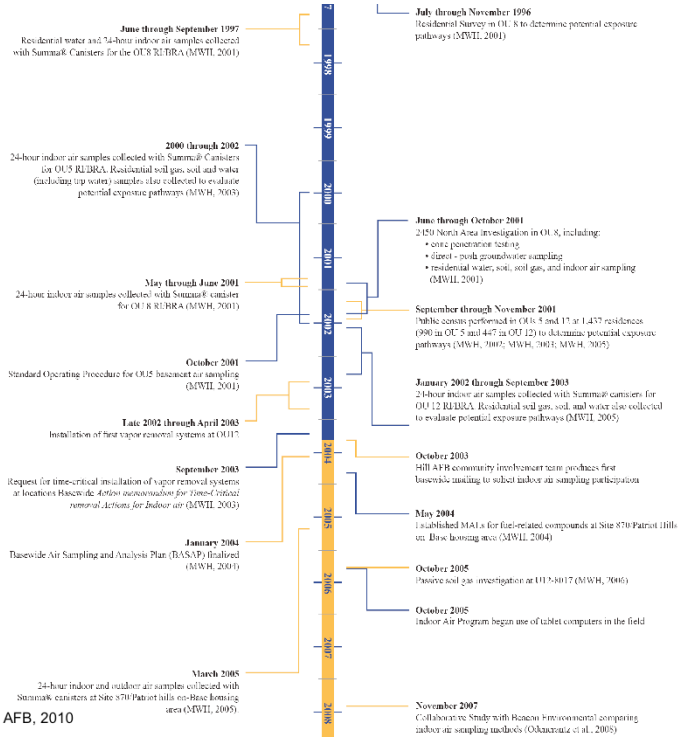
OVERVIEW OF HILL AFB VAPOR INTRUSION PROGRAM

- History
- Program Overview
- Mitigation
- Challenges and Optimization
- Community Involvement
- Exit Strategy
- Case Studies
  - 1,2 DCA
  - Pressure Control Example
  - Preferential Flow

4

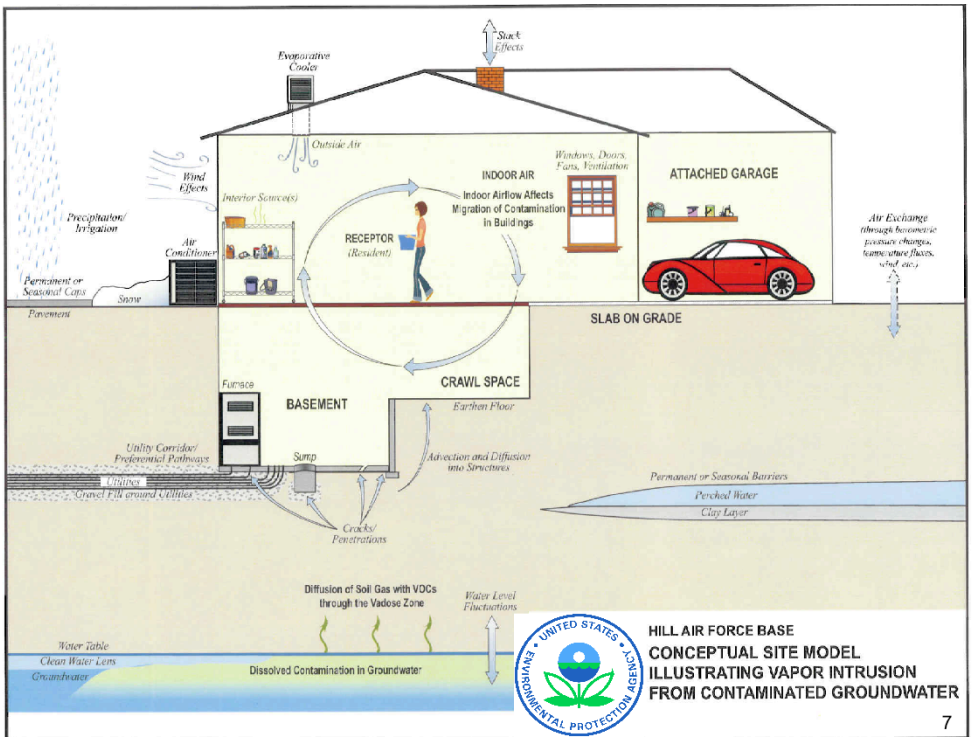

Scale in Feet
N
0
3000
Scale in Feet
Waste Disposal
Sewage disposal plant, 1942-1955
Waste disposal, 1940-1980
Gasoline Storage for Ogden Arsenal
Fuel storage, waste disposal, fire training 1940-1980
Machine shops, vehicle maintenance, metal plating, painting/ stripping, 1955-present
Base Housing 1894-present
Fuel storage, 1940s-present
Waste disposal, 1940-1956
IWTP, 1956-present

5



Adapted from Hill AFB, 2010

6


Stack Effects
Evaporative Cooler
Outside Air
Wind Effects
Interior Source(s)
Precipitation/ Irrigation
Air Conditioner
Permanent or Seasonal Caps
Snow
Pavement
INDOOR AIR
Indoor Airflow Affects Migration of Contamination In Buildings
RECEPTOR (Resident)
Windows, Doors, Fans, Ventilation
ATTACHED GARAGE
Air Exchange (through barometric pressure changes, temperature fluxes, wind, etc.)
SLAB ON GRADE
CRAWL SPACE
Earthen Floor
Furnace
BASEMENT
Sump
Utility Corridor/ Preferential Pathways
Utilities
Gravel Fill around Utilities
Advection and Diffusion into Structures
Cracks/ Penetrations
Permanent or Seasonal Barriers
Perched Water
Clay Layer
Diffusion of Soil Gas with VOCs through the Vadose Zone
Water Level Fluctuations
Water Table
Clean Water Lens
Groundwater
Dissolved Contamination in Groundwater
HILL AIR FORCE BASE
CONCEPTUAL SITE MODEL
ILLUSTRATING VAPOR INTRUSION
FROM CONTAMINATED GROUNDWATER
7

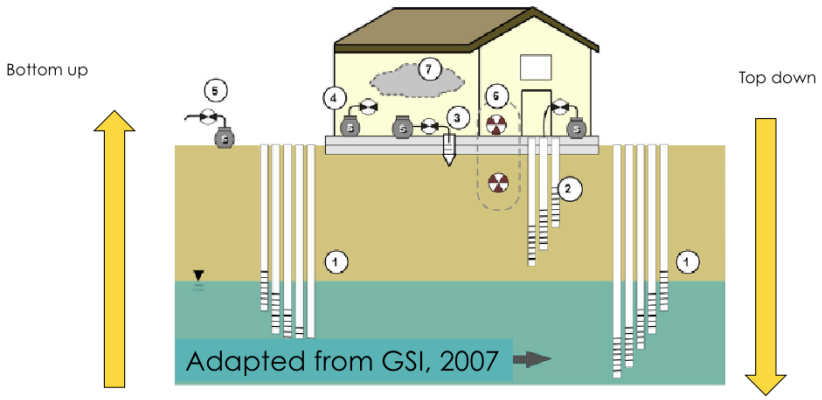
Hill Air Force Base

Operable Unit Summary Sheet

1/2011

		OU-1	OU-2	OU-3	OU-4	OU-5	OU-6	OU-7	OU-8	OU-9	OU-10	OU-11	OU-12	OU-13
Affected Communities		South Weber	South Weber	Hill AFB *(soil contamination only)*	South Weber Riverdale	Sunset Clinton	Riverdale	Hill AFB *(soil contamination only)*	Layton *(also includes groundwater below OU 3 and OU 7)*	Hill AFB *(consists of 3 unrelated sites)*	Clearfield Sunset Clinton	Hill AFB	Roy	Hill AFB
Approx. Acres Affected	Off Base	53	19	-	32	288	19	-	434	-	142	-	123	-
	On Base	57	5	12	19	63	31	1	301	28	12	12	10	32
Approx. Homes in the Area		30	Less than 10		Less than 10	750	50-100		1,150		300-350		300-350	100
Project Manager		Barbara 'B' Hall 801-777-0403	Kyle Gorder 801-775-2550	Lance Kovel 801-775-5242	Rob Wallace 801-777-3684	Mark Roginske 801-775-3651	Mark Roginske 801-775-3651	Lance Kovel 801-775-5242	Lance Kovel 801-775-5242	Shannon Smith 801-775-6013	Rob Wallace 801-777-3684	Lance Kovel 801-775-5242	Mark Roginske 801-775-3651	Rob Wallace 801-777-3684
Primary Contaminants		Cis-1,2-DCE Arsenic	TCE	Petroleum-based products, cleaning solvents, sodium hydroxide, metals	TCE	TCE	TCE	Chromium Cadmium	TCE DCA cis-1,2-DCE chlorobenzene	TCE PCE cis-1,2-DCE CTCL	TCE PCE cis-1,2-DCE	BTEXN TCE MTBE	TCE CT	PCBs
CERCLA Stage		Remedial Action	Remedial Action	Remedial Action	Remedial Action	Remedial Action	Remedial Action	Remedial Action	Remedial Action	Proposed Plan	Feasibility Study	Feasibility Study	Remedial Action	Draft ROD
ROD		1998	1996	1995	1994	2006	1997	1995	2005	Sept. 2011	Oct. 2014	July 2013	2005	Feb. 2011
Source		Industrial waste Fire training areas	Chemical disposal pit	Sodium hydroxide tank Berman Pond (stormwater retention)	Landfill 1 (used for dump and burn wastes) Waste solvents and degreasers	Tooele Army Rail Shop (TARS) industrial chemicals Waste solvents and degreasers	No record, but potentially waste solvents, leaky underground storage tanks, or former dry cleaning operations	Bldg 225 chromium spill	Aircraft maintenance facilities Storm water retention ponds Storage tanks Refueling vehicle maintenance facility	Waste solvents and degreasers	Waste solvents and degreasers	Leaked underground diesel and gasoline tanks Waste solvents and degreasers	Waste solvents and degreasers	Electrical transformers storage area
Cleanup Actions/ Treatment Systems		Source containment system Landfill caps	Groundwater containment wall Source recovery system Interceptor trench Soil vapor extraction system Groundwater collection system	2 asphalt caps	Horizontal drain collection system Soil cap	Groundwater extraction trench Aeration curtain	On-base groundwater extraction system Off-base groundwater extraction system Carbon filtration system (inactive)	Monitored natural attenuation	1,2-DCA extraction system Base boundary groundwater containment system	Soil removal Soil cover	Phyto-remediation treatability study	Soil vapor extraction system	Permeable reactive barrier Base boundary Groundwater containment system Soil excavation	Soil excavation
Status		Cleanup ongoing. Plume shrinking.	Cleanup ongoing. Plume shrinking.	3 of original 5 sites successfully closed.	Cleanup ongoing. Plume stable.	One plume shrinking, other expanding. Cleanup ongoing.	Cleanup ongoing.	Monitoring ongoing.	Cleanup ongoing. Plume stable.	1100 Area plume shrinking. Five sites successfully closed.	Analyzing site conditions. Plume predicted to be stable.	MTBE expanding, BTEXN shrinking.	Cleanup ongoing.	Cleanup in progress. Immediate excavation complete.

General investigation strategies

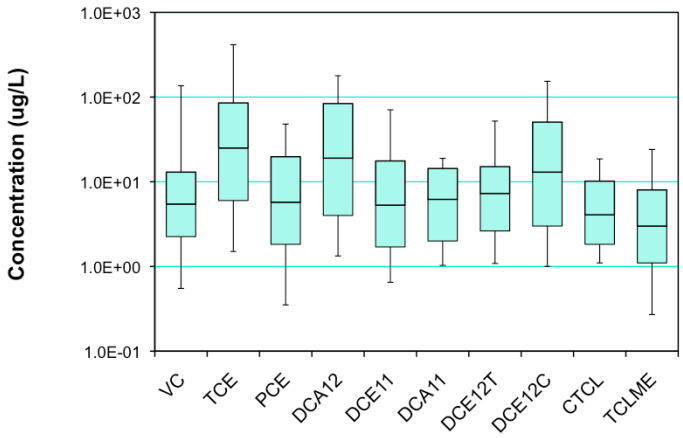


9

Charateristics of Vapor Intrusion at Hill AFB

- Hydrogeology
- VOC concentrations in groundwater
- Residential areas over and adjacent to groundwater plumes
- Military Installation… surrounded by houses
- Residential homes with and without basements ~ 50%

VOC Concentrations in Groundwater

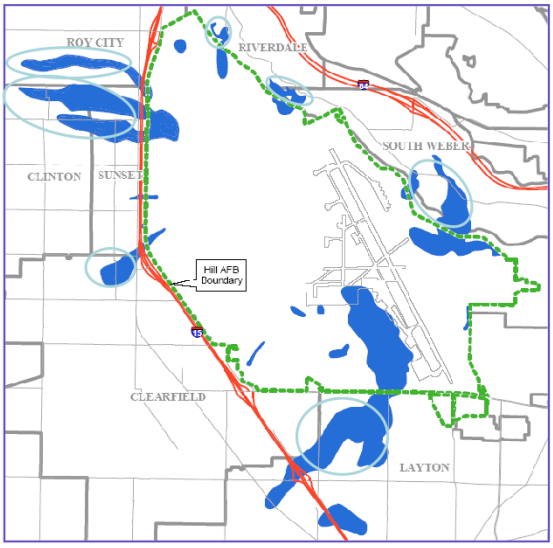


11

Vapor Intrusion Program Approach

- Sample indoor air – Determine if exposure is occurring
  - 24-Hour samples analyzed to EPA Method TO 15
  - Project-dedicated, batch-certified clean Summa® canisters
  - Chemical inventory and inspection prior to sampling
- Advantages
  - Measure exposure concentration
  - Public relations
- Disadvantages
  - Doesn't distinguish vapor source

Air Sampling Focus Areas



Areas of shallow groundwater contamination

General Area of Indoor Air Sampling Locations

~2900 Homes 7 cities
~300 On-base buildings

13

Project Approach

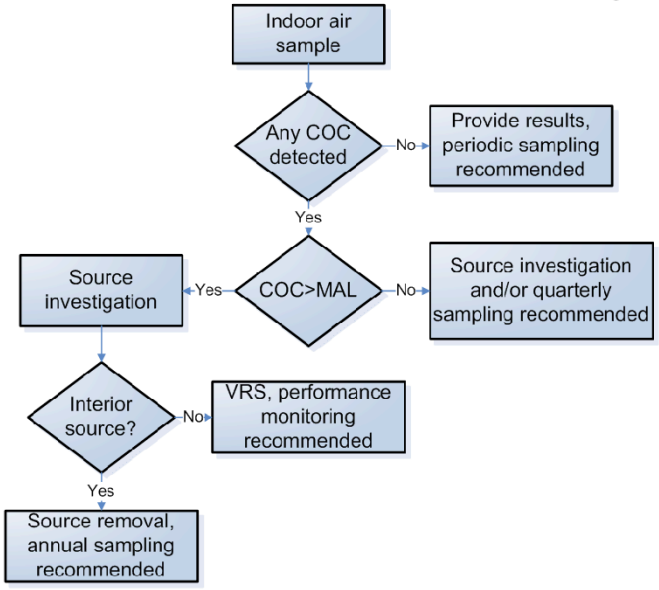
- Indoor Air Sampling offered annually
  - Sample during cold months
  - Area-specific COC list
    - Only look for COCs in air that are present in nearby groundwater
  - 24-hr samples
- Established Action Levels
  - Agreed with EPA/State of UT

Compound	Mitigation Action Level ($\mu g/m^3$)	(ppbv)
Carbon Tetrachloride	1.6	0.26
1,1-Dichloroethane	15	3.8
1,2-Dichloroethane	0.94	0.23
1,1-Dichloroethene	209	53
cis-1,2-Dichloroethene	63	16
trans-1,2-Dichloroethene	63	16
Tetrachloroethene	4.1	0.61
Trichloroethene	12	2.3
Vinyl Chloride	2.8	1.1

CR= 1x10-5 or HI = 1

14

Simplified Decision Logic

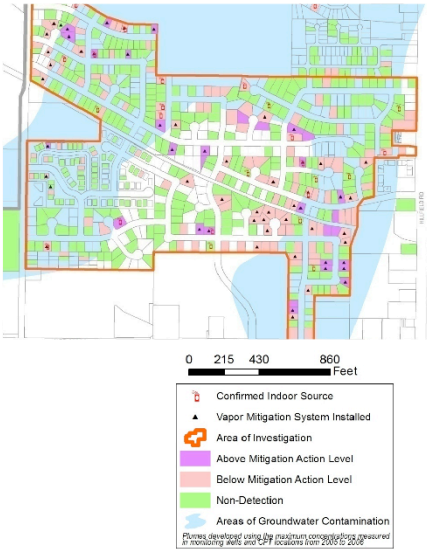


15

Update

Hill Program Results

- Since January 2001:
  - 1820 of 2900 homes have agreed to sampling
  - >7500 samples collected
  - TCE detections in 290 (16%) of homes sampled
  - TCE detected above action level in 123 homes
    - 35 of these known or suspected indoor sources
  - 106 Sub Slab Depressurization (SSD) systems installed

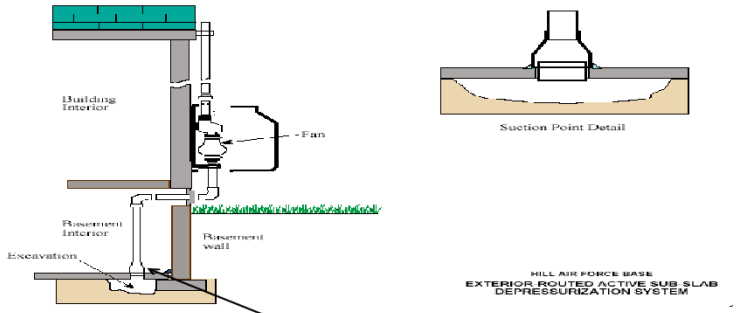


16

Indoor Air 2010 Summary

- 2,710 letters sent
  - 633 agreed to sampling
  - 630 homes sampled
  - 77 homes had detection
    - 12 above action level (All interior sources*)
      - » 9 -Tetrachloroethene (PCE)
      - » 1 -Trichloroethene (TCE)
      - » 1 -Carbon Tetrachloride (CTCL)
      - » 1 -trans-Dichloroethene (tDCE)
    - Interior sources found in all above except one PCE home that did not agree to source investigation

MITIGATION

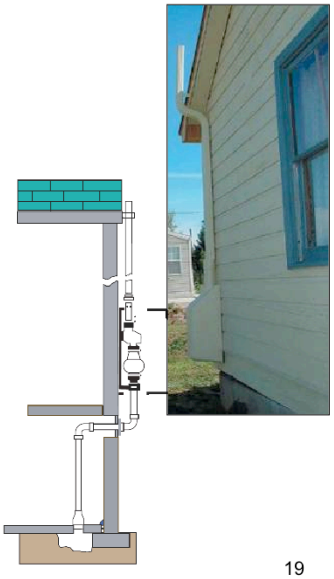


This shows suction point close to basement wall. Note that we always try to put these in the center of the home where possible – some do end up against the wall, but it's not typical

18

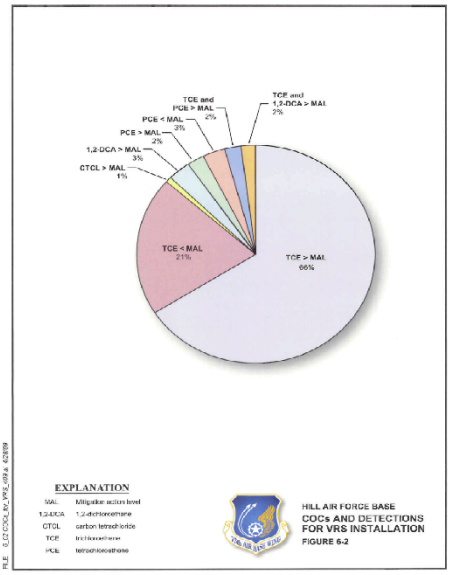
Mitigation

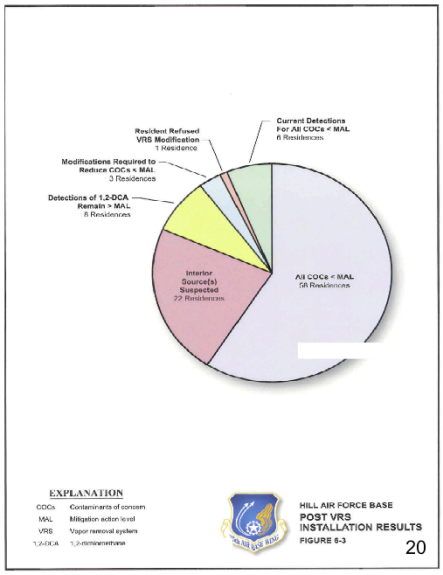
- Sub-slab depressurization systems
  - Have been effective when VI is source of vapors
  - Air Force pays for power/ maintenance and performance monitoring
  - Annual inspection
  - In many cases, will not be effective when an indoor source is present
    - But, we have seen cases where they do pull significant indoor air



19

Mitigation Efficiency





20

Typical Mitigation Costs

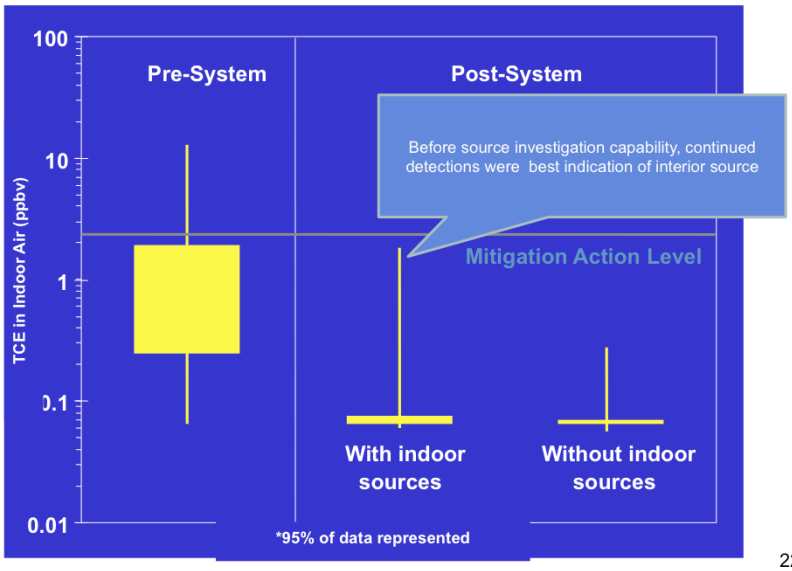
- **$5,000 - $10,000 Simple SSD**
- **$30,000 Complex Case**

Advantages

Successful track rate

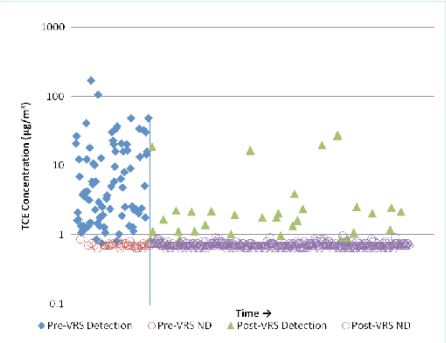
Application

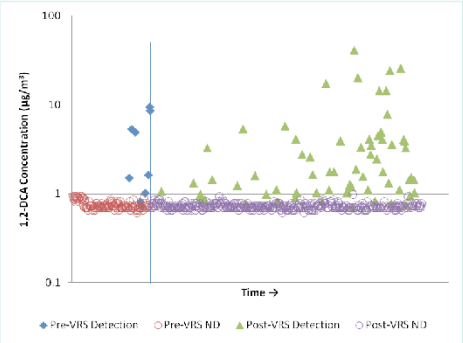
Mitigation Results



22

Mitigation and indoor sources





McHugh and Gorder, 2010

- TCE detection frequency and concentration decrease post-mitigation
- In same homes, 1,2-DCA detection frequency and concentration increase post mitigation

23

Challenges and Optimization

- Interior sources
  - 1,2-DCA case study
  - Portable GC/MS
- Temporal variability

Community Involvement

- Strong community outreach helps inform and prepare public
- Access issues
- Health & Safety Concerns
- Claims Process/Property Values

Hill Program Review

- Summary
  - Apparent vapor intrusion into homes
  - VRS have been effective at reducing concentration below MALs

- Indoor sampling first approach
  - Overall positive reaction by residents
    - Reaction if we'd chosen another approach?
  - Indoor source problems
    - Potential over-estimate of VI impacts
    - Concern/frustration for residents

Decision Logic for New and Existing VRSs

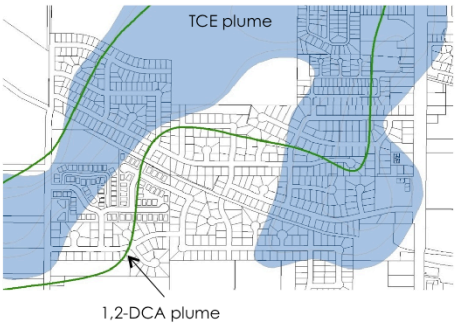
- Minimize unnecessary VRSs
- Multiple-lines-of-evidence

Exit Strategy Recommendations

- Align areas with the risk of VI
- Install a comprehensive monitoring network and develop water-table concentration maps for each OU
- Use groundwater modeling and CSM to predict when the COC concentrations no longer pose a VI risk.

1,2-DCA Case Study

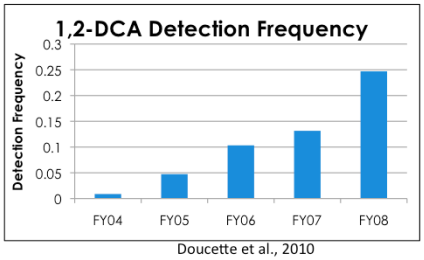
- **No known products (indoor sources) with 1,2-DCA**
- **TCE & 1,2-DCA in groundwater**
- **Both 1,2-DCA and TCE on indoor COC list in entire area**



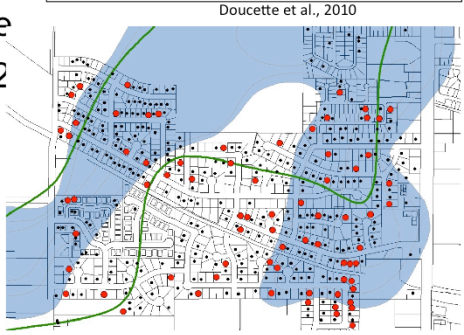
29

1,2-DCA study (cont'd)

- Few detections early in program
- VR systems did not reduce concentrations
  - Suspected indoor source
  - Detections outside of 1,2 DCA plume



Doucette et al., 2010



- **Indoor source study**
  - Try to find a non-groundwater source

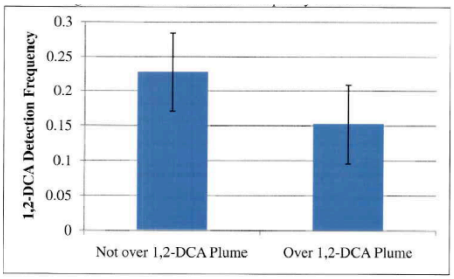
1,2-DCA study (cont'd)

- Initial indoor source study identified 1,2-DCA in a molded plastic decoration
  - Confirmed with laboratory emission rate testing (Doucette et al., 2010)
- Portable GC/MS – molded plastics are a significant source
  - Molded plastic decorations emitting 1,2-DCA have been identified in many (>20) homes.

31

1,2-DCA study

- Data review – other 'lines of evidence' VI is not the source
  - Detection frequency (over plume vs. not)
  - 1,2-DCA attenuation factors 10 to 100X those of TCE
  - Simplified modeling (J&E)



- EPA/UDEQ concurrence to remove 1,2-DCA from COC list

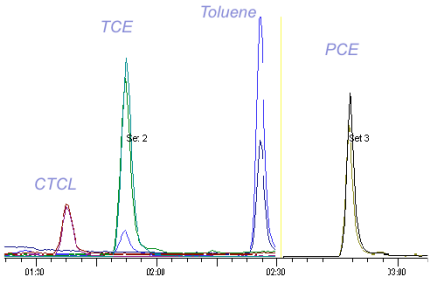
32

Portable GC/MS

- Instrumentation
- Approach
- Examples

Instrumentation

- Inficon HAPSITE® GC/MS
- Key features:
  - Custom Methods
    - (~6 min) sample turn time
  - “Clean” chromatograms
    - Target VOCs in SIM mode
  - “Positive” identification
    - Full scan using NIST library
  - Low quantitation limits
    - Chlorinated aliphatics in ppt



34

Investigation Approach

Follow the data…

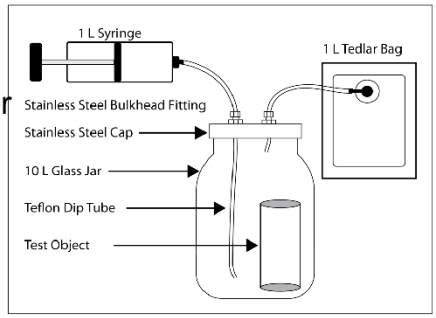
- Area-by-area sampling
  - Basement, main level, garage
- Focused sampling in high concentration area
  - Room-by-room sampling
  - Container survey/sampling
  - Individual product survey, sampling, and emission rates

35

Confirming Interior Source

- Emission rate measurement
- Purpose: determine if consumer products are a primary source of target VOC

$$E = \frac{C}{V_t * t} \qquad C_{air} = \frac{E}{IV}$$



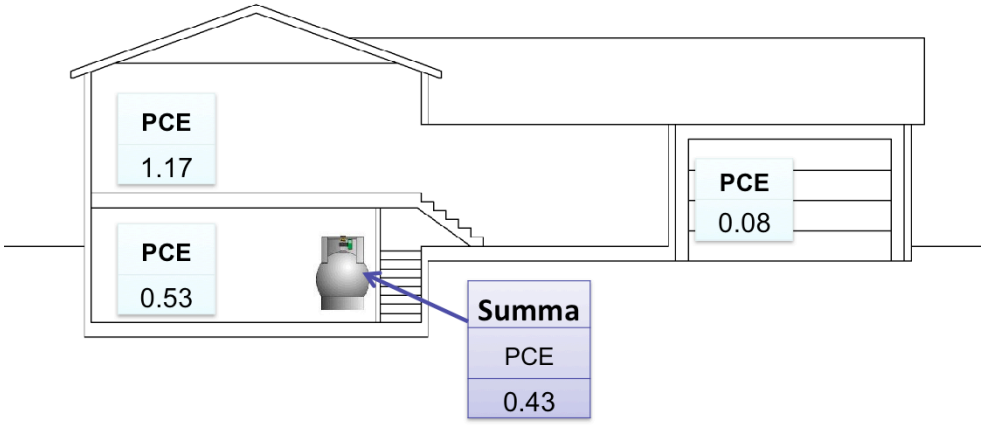
Product	Emission Rate (µg/min)	Calculated Indoor[1] (µg/m³)	Risk Based Conc.[2] (µg/m³)
Hobby adhesives (PCE)	12	3.0	0.41
Degreaser (TCE)	7	1.7	1.2
Toilet Cleaner (CT)	0.03	0.008	0.41

1. Box model assuming 2500 ft² home, 10 air exchanges/day
2. EPA Regional Screening Levels, May 2010 (10^{-6})

36

Interior Source Example

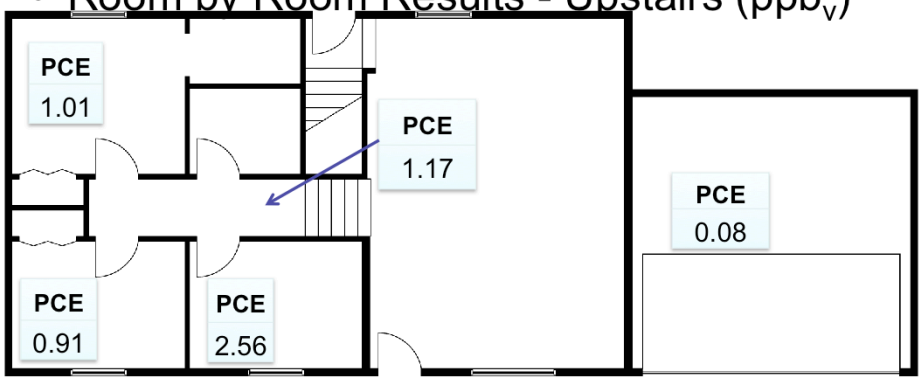
- **Area by Area Results (ppb_v)**



37

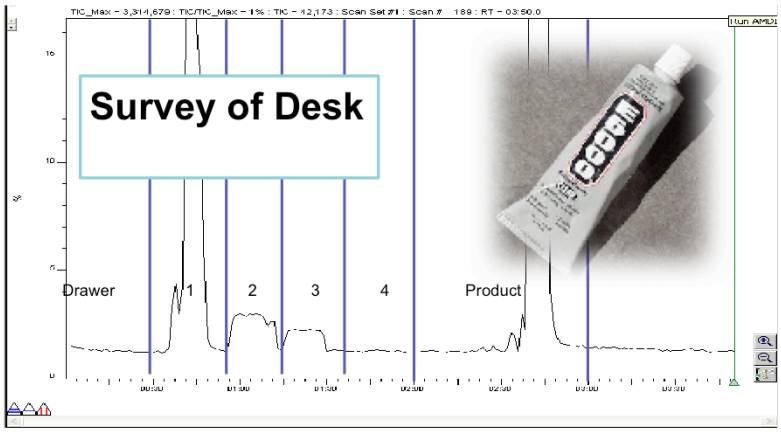
Interior Source Example

- Room by Room Results - Upstairs (ppb_v)



38

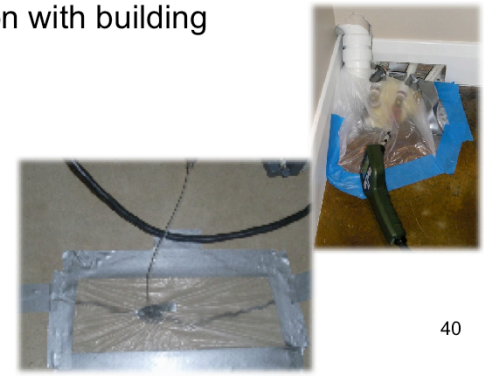
Interior Source Example



39

Confirming VI

- Entry point sampling
  - Can be isolated
  - Best if done after interior source is ruled out
  - Best done in combination with building pressure control



40

Investigation Results

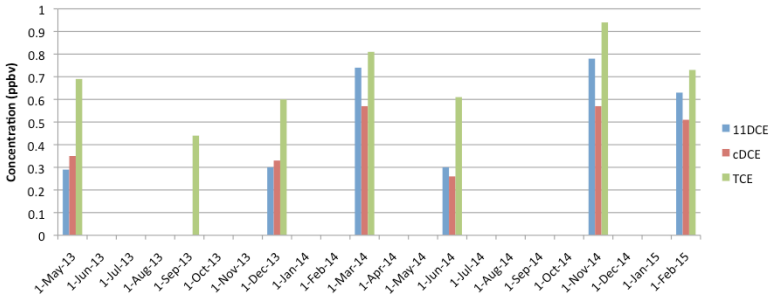
- HAPSITE
  - 45 Total investigations
  - 41 Homes = Interior sources
  - 2 Homes = VI related
  - 2 “ND” on day of investigation

- Total Homes with Interior Sources to date = 233
  - 63 unique products containing TCE
  - 95 unique products containing PCE
    - See Dettenmaier and Gorder, 2010 for details

Temporal Variability

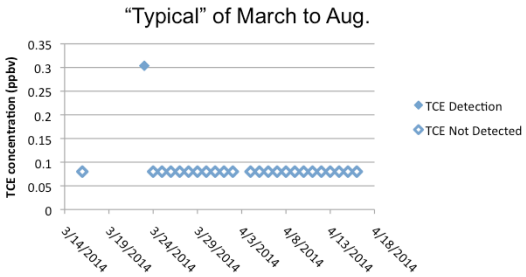
- Two observed behaviors in homes likely to have VI
  - Steady Type – High detection frequency and low variability
    - High probability that one sample will:
      - » indicate if VI is occurring
      - » be good indicator of exposure concentration
  - Variable Type – Low detection frequency and high variability
    - Low probability that one sample sufficient to indicate occurrence of VI

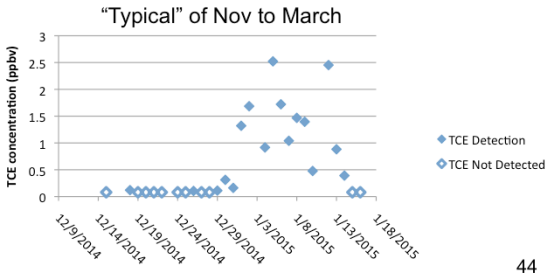
Steady Type VI



43

Variable Type VI





Managing Temporal Variability

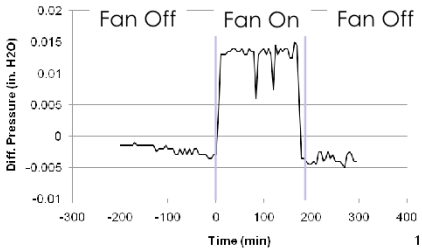
- Variable Type VI poses a number of problems
  - Access Expense/time of multiple samples
  - False positive/false negative results
  - Uncertainty for building occupants
- Sampling while controlling building pressure (P) is a way to manage temporal variability

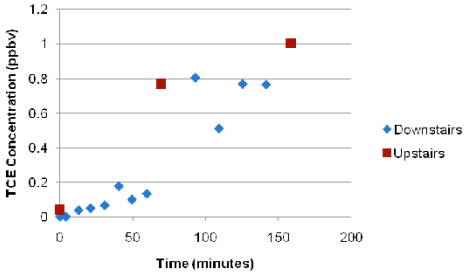
45

Building Pressure Control

- Development for VI led by Tom McHugh (GSI) – See references
  - Induce positive or negative building P during investigation
  - To confirm VI, negative building P is most useful in turning VI on
  - Induced negative P provides a “worse than normal” case

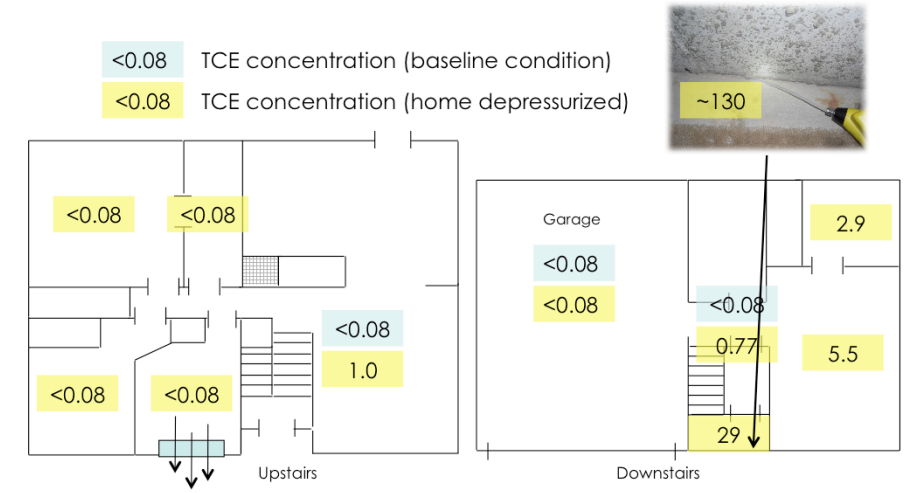
VI & Pressure Control Example





47

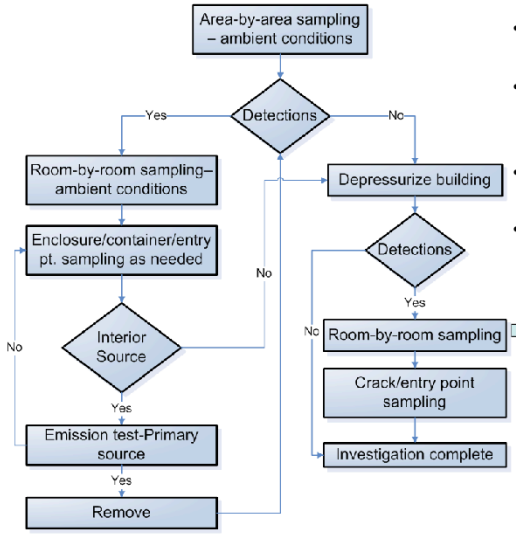
Pressure Control Example



Fan blowing out of window

48

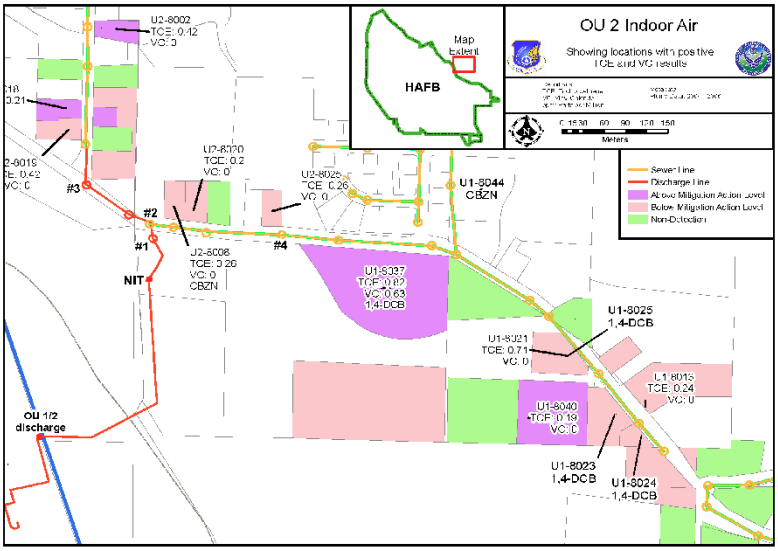
Conceptual Investigation Strategy



- Consider a single 'indicator' compound
  - Another way to avoid interior source
- Don't assume on-site analysis approach is more costly
  - One event vs. many
- Work with stakeholders to agree as much as possible before starting
- Be (or encourage) innovation!

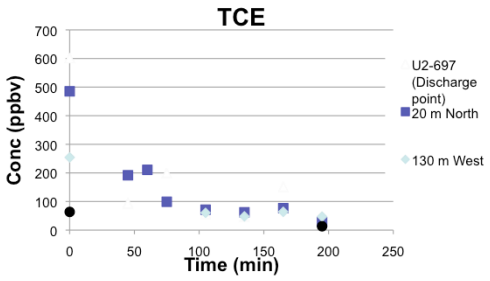
Use average/max etc. for comparison to standard

Sewer VI Summary

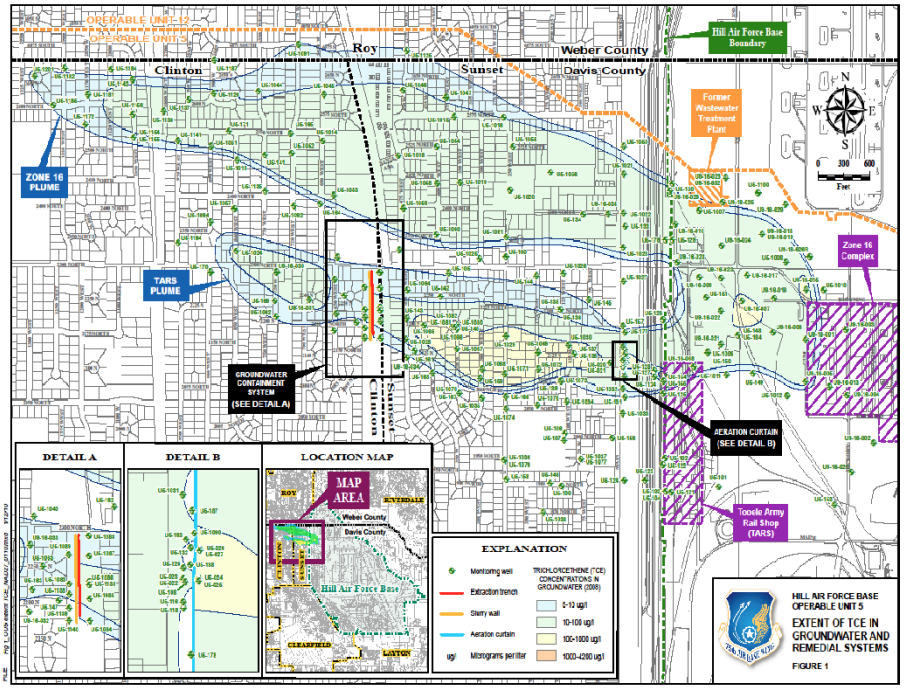


50

Sewer VI Summary



51


OPERABLE UNIT 1
OPERABLE UNIT 2
OPERABLE UNIT 3
Roy
Clinton
Sunset
Weber County
Davis County
Hill Air Force Base Boundary
Former Wastewater Treatment Plant
Zone 16 Complex
ZONE 16 PLUME
TARS PLUME
GROUNDWATER CONTAINMENT SYSTEM (SEE DETAIL A)
AERATION CURTAIN (SEE DETAIL B)
Tooele Army Rail Shop (TARS)
DETAIL A
DETAIL B
LOCATION MAP
MAP AREA
Hill Air Force Base
EXPLANATION
Monitoring well
Extraction trench
Slurry wall
Aeration curtain
ug/l Micrograms per liter
TRICHLOROETHENE (TCE) CONCENTRATIONS IN GROUNDWATER (2009)
5-12 ug/l
10-100 ug/l
100-1000 ug/l
1000-4260 ug/l
HILL AIR FORCE BASE
OPERABLE UNIT 5
EXTENT OF TCE IN GROUNDWATER AND REMEDIAL SYSTEMS
FIGURE 1

52

Key Points

- Hill AFB chose to sample inside air for VI characterization
- VI is determined in some homes
- Indoor sources are very problematic
  - Some progress identifying sources
  - Looking toward more “top down” investigation
- Public reaction has been generally favorable
- Would choose indoor sampling approach again
  - Plan on ‘top-down’ characterization
  - Add better water-table characterization
  - Consider pre-screening for indoor sources

Acknowledgement: Jarrod Case, Hill AFB
Kyle Gorder, Hill AFB
Eric Dettenmaier, Hill AFB

54

References

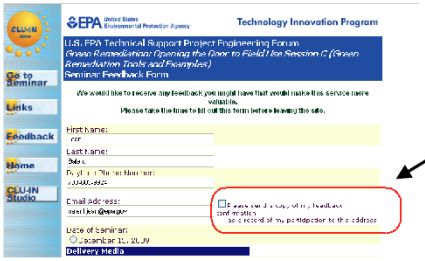
- Doucette, W.J.; Hall, A.J.; Gorder, K.A. Emissions of 1,2-dichloroethane from holiday decorations as a source of indoor air contamination. *Ground Water Monitoring and Remediation* **2010**, 30 (1), 64-71.
- McHugh, T.; Gorder, K. Methods to distinguish between vapor intrusion and indoor sources of VOCs at residences near Hill AFB, Utah, USA. In *Vapor Emission to Outdoor Air and Enclosed Spaces for Human Health Risk Assessment: Site Characterization, Monitoring, and Modeling*; Saponaro, S., Sezenna, E., Bonomo, L., Eds.; Nova Science Publishers, Inc.: Hauppauge, NY 2010.
- Dettenmaier, E., and K.A. Gorder. Detailed Indoor Air Characterization and Interior Source Identification by Portable GC/MS. Presented to the Air and Waste Management Association Vapor Intrusion Specialty Conference, Chicago, IL. September 30, 2010. http://events.awma.org/education/Presentations/Session%208/3_AF_AWMA_IA_09272010_EMD.pdf (accessed Feb 24, 2011)

55

Questions

Resources & Feedback

- To view a complete list of resources for this seminar, please visit the **Additional Resources**
- Please complete the **Feedback Form** to help ensure events like this are offered in the future



Need confirmation of your participation today?

Fill out the feedback form and check box for confirmation email.

57