

PVI Specific Sampling Issues

- Soil Gas VOC Analysis
 - Benzene, ethylbenzene & naphthalene
 - TPH??
- Might Need to Sample <5' bgs
 - If samples >5' bgs exceed allowable levels
 - How to know? On-site analysis best
 - If not, collect samples anyway
- Always Collect Oxygen Data

HARTMAN
ENVIRONMENTAL GEOSCIENCE

There are some differences in soil gas sampling for petroleum hydrocarbon VOCs than for chlorinated solvents.

The COCs need to be determined and vary from State to State.

If samples at deeper depths exceed allowable values, shallower samples (<5' bgs) may need to be collected to document the effect of bioattenuation.

Oxygen data should always be collected to document presence of the aerobic zone.

Which Soil Gas Method?

- Active?
- Passive? (limited use)
- Flux Chambers? (limited use)

Active method most often employed for VI

HARTMAN
ENVIRONMENTAL GEOSCIENCE

There are three types of soil gas methods. Active refers to actively withdrawing vapor out of the ground. It gives quantitative values. Passive refers to burying an adsorbent in the ground and letting the vapors passively contact and adsorb onto the collector. It does not give quantitative data and hence can not be used for risk applications, except for screening. Surface flux chambers were discussed previously.

The active method is the one most applicable to risk assessments.

Methods to Assess VI



- Indoor Air Sampling
- Groundwater Sampling
- Soil Phase Sampling
- Predictive Modeling
- Measure Flux Directly
- Soil Gas Sampling
- Supplemental Tools/Data



HARTMAN
ENVIRONMENTAL GEOSCIENCE

These are the primary techniques/tools used to assess the vapor intrusion pathway.

Approach Generalizations

- Indoor Air
 - Always find something
 - Multiple sampling rounds: extra time & \$
- Groundwater Data
 - Typically over-predicts risk – no bioattenuation
- Soil Phase Data
 - Typically not allowed; over-predicts risk
- Soil Gas Data
 - Transfer rate unknown
 - Sub-slab intrusive



Each investigatory approach has pros and cons that must be considered before choosing the one to use at a site.



Hydrocarbons are ubiquitous in all the products that we use everyday.

Do's and Don'ts...

Indoor Air Testing – Occupant Dos & Don'ts

Because many common household products contain hydrocarbons, it is important that these products not be used during the air sample collection period. It is also preferred that these products and associated activities be minimized for 24 to 48 hours prior to the start of the indoor air collection period.

Do's

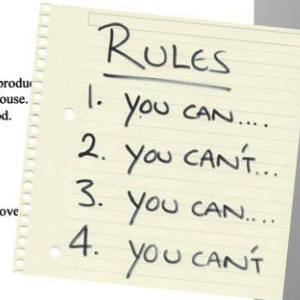
- Keep doors and windows closed as much as possible.
- Operate your heater/AC unit as you normally would.
- Thoroughly wash hands before entering house if you have handled any type of petroleum product.
- Remove any clothes that may have petroleum products and/or smoke before entering the house.
- Remove all vehicles from an attached garage 24 to 48 hours in advance of the testing period.

Don't Use the Following Products

- Shaving creams
- Liquid dish or clothes detergents (such as Dawn, Wisk, Shout, etc.)
- Strong cleaners such as Scubbing Bubbles, BBQ cleaners, Drain-o, oven cleaner, spot remover
- Air fresheners (spray, plug-in or candles)
- Any products from aerosol cans (hair sprays, cooking spray, deodorants, etc.)
- Any type of oils or polishes (mink oils, furniture polish, shoe polish, etc.)
- Fingernail polish & polish removal
- Any type of fuels (gasoline, sterno, propane) in or immediately near the residence
- Any types of lubricants (lubricating oils, WD-40, etc.) in or immediately near the residence
- Any types of herbicides, pesticides, or petroleum-based products used for insect or rodent control.
- Paints or glues in or immediately near the residence

Don't do the Following Activities During Sample Collection

- Open the door between the garage and the residence
- Use natural gas or propane fired stoves, ovens, or outdoor barbeques (either gas-fired or wood)
- Use the fireplace
- Use plug-in air fresheners
- Burn candles or incense.
- Any activity that generates smoke



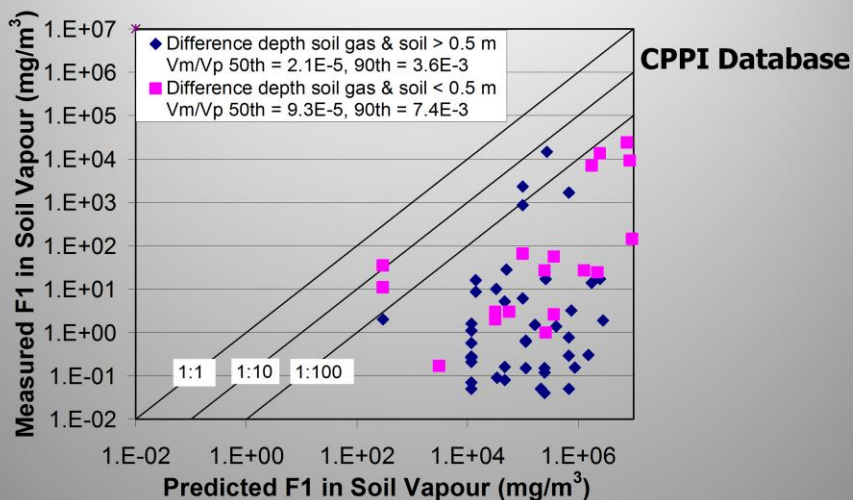
Part of communication for indoor air sampling programs is the do's and don'ts list. Don't park your car in the garage. Don't have a birthday party. Don't paint your walls or do any home improvements. This is a burden on people for 24 hours, but manageable. Now imagine 21 day air sampling events. Don't wash your hair please. Try to only do dishes once a week. Shaving...that's certainly out of the question. It's just not possible to avoid all these sources and the result will be false positives.

Indoor Air Measurement

- Pros:
 - Actual Indoor Concentration
- Cons:
 - Where From?
 - Inside sources (everything!)
 - Outside sources (exhaust)
 - People activities – **NO CONTROL!**
 - Time-intensive protocols
 - Snapshot, limited data points
 - Expensive!!

Measuring indoor air might seem to be the most direct and simplest approach, but it has its share of problems. The biggest problem is background sources of contaminants. Many commonly used household products contain some of the target compounds of concern. For example, benzene from consumer products, PCE from dry cleaned clothes, TCE from degreasing cleaners. In addition, the protocols are laborious, intrusive, offer little control, and are expensive. For these reasons, the EPA and many States shy away from this method, especially for PVOCs. However, this method may still be the method of choice if the contaminant of concern is not one commonly found in household products (e.g., 1,1 DCE).

Measured Soil Gas Data vs. Predicted from Soil Phase Data

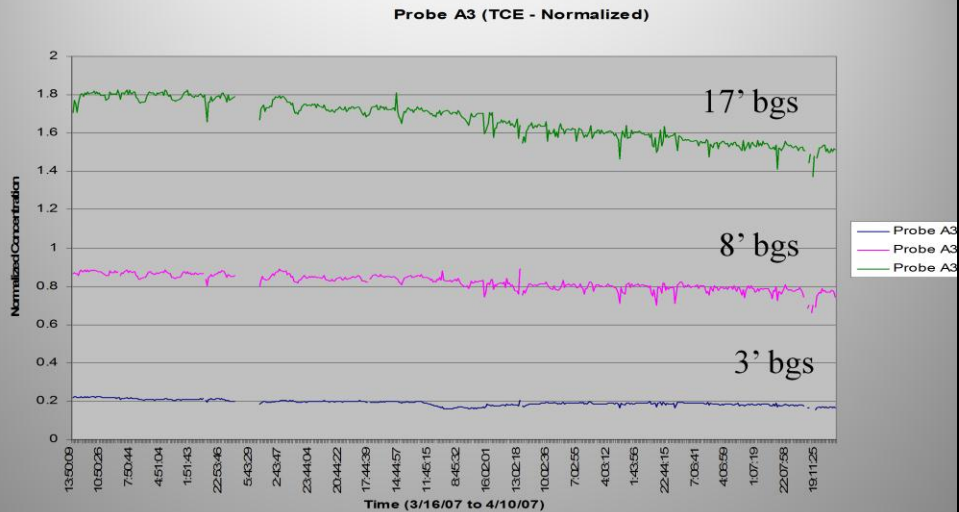


Measured vapor concentrations 10 to 1000x less than predicted

This slide compares measured soil gas concentrations to soil gas concentrations predicted from co-located soil phase data for petroleum hydrocarbons. You can see that the vast majority of measured values fall orders of magnitude below the calculated values. This proves that soil gas values for hydrocarbons predicted from soil data are likely to be over-estimated. The same is not necessarily true for chlorinated solvents.

Slide courtesy of Ian Hers, Golder and Associates.

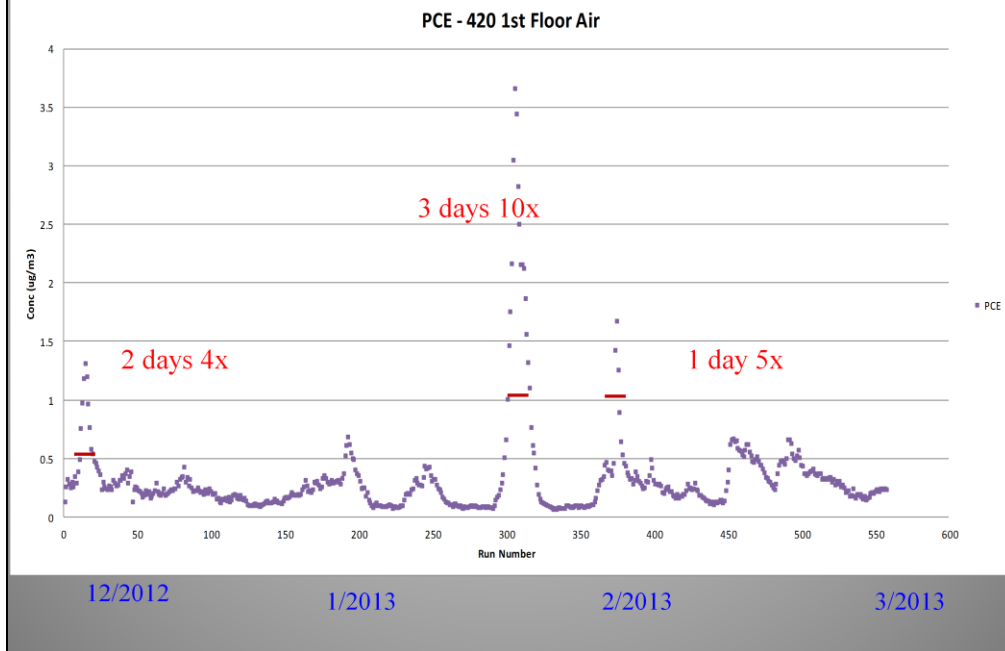
Soil Gas Temporal Study



Less than 15% Variation in all Probes

This is a plot of data recently collected for an EPA funded study by an automated instrument at at Vandenberg AFB site from three probes at the same location but at different depth (3', 8, & 17' bgs). This plot consists of over 500 points per probe collected once per hour over a 4 week period from mid March to mid April 2007. The soil gas concentrations varied by less than 10% over these four days even for probes only 3 feet below the surface.

Continuous Monitoring – PCE in Indoor Air



Continuous monitoring data of PCE in indoor air from a house. Sensitive chlorine detectors exist to allow this type of data to be collected.

Continuous monitoring data of PCE in indoor air from a second room from the same house (collected every 4 hours). Significant (greater than 2x) increases in IA values occur randomly, but seem to last for at least 2 or more days.

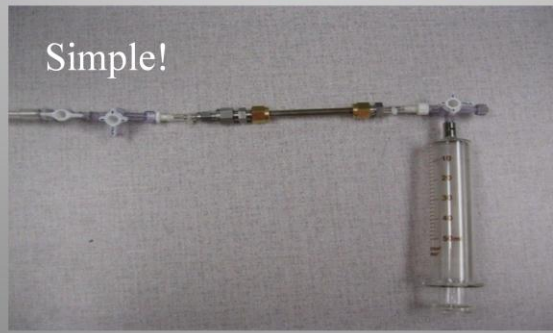
As with the other room, Indoor air concentration variations over 1 day are almost always less than a factor of 2. This implies that instantaneous grab samples will be within a factor of 2 of 24-hour time integrated samples more than 95% of the time.

Canisters vs. Tubes



New style adsorbent tubes are much smaller than bulky canisters and can't be broken.

SVOC TO-17 Sampling



HARTMAN
ENVIRONMENTAL GEOSCIENCE

Top photo: A typical sampling arrangement used for collection of samples on adsorbants. Note the abundance of fittings and the need for duplicate cartridges for breakthrough. A very complicated set-up, prone to leaks.

Bottom photo: A much simpler sampling arrangement for adsorbent tubes with better control on actual vapor volumes passed through the adsorbent.

Common Soil Gas Analyses

- VOCs
 - Soil and Water Methods: 8021, 8260
 - Air Methods: TO-14, TO-15, TO-17
- Hydrocarbons
 - 8260, TO-3, MA-APH
 - Must check lab to see if they can do
- Oxygen, carbon dioxide
 - ASTM 1945-96
 - Portable meters ok
- SVOCs: TO-4, TO-10, TO-13

TO-17 gets PVOCs, TPHg, TPHd in same run!!

This slide gives a summary of the most common analytical methods used for soil gas samples. Most of the methods listed here are fixed lab methods.

Beware of the Hardware



The tackle box on the left shows the required hardware to collect soil gas samples in Summas.

The syringe to the right is the only collection device required for on-site analysis of soil gas or to collect tedlar bag samples or to collect onto adsorbent tubes.

TPH Compounds

- Typical
 - BTEX (BE only risk drivers)
 - Methane
 - Naphthalene (risk about same as benzene)
- Some States:
 - Aliphatics (C5-C8 & C9-C18)
 - Aromatics (C6-C8 & C9-C16)
 - 1-2 dichloroethane (EDC) & 1-2 dibromoethane (EDB)

TO-17 gets PVOCs, TPHg, TPHd in same run!!



Petroleum compounds of concern vary from State to State. Consult the oversight agency's specifications.

TPH Analysis Considerations

- Laboratory Issues
 - Has does the lab certify?
 - Do they subtract?
 - What volume do they need?
- FID Based Methods (TO-15, TO-17, 2015)
 - Can't distinguish non-HCs from HCs
 - Will over-report
- Best to Use a Mass Spec Method
 - TO-15, TO-17

Certified?

ITRC VI Document, Appendix D. API Table D-1

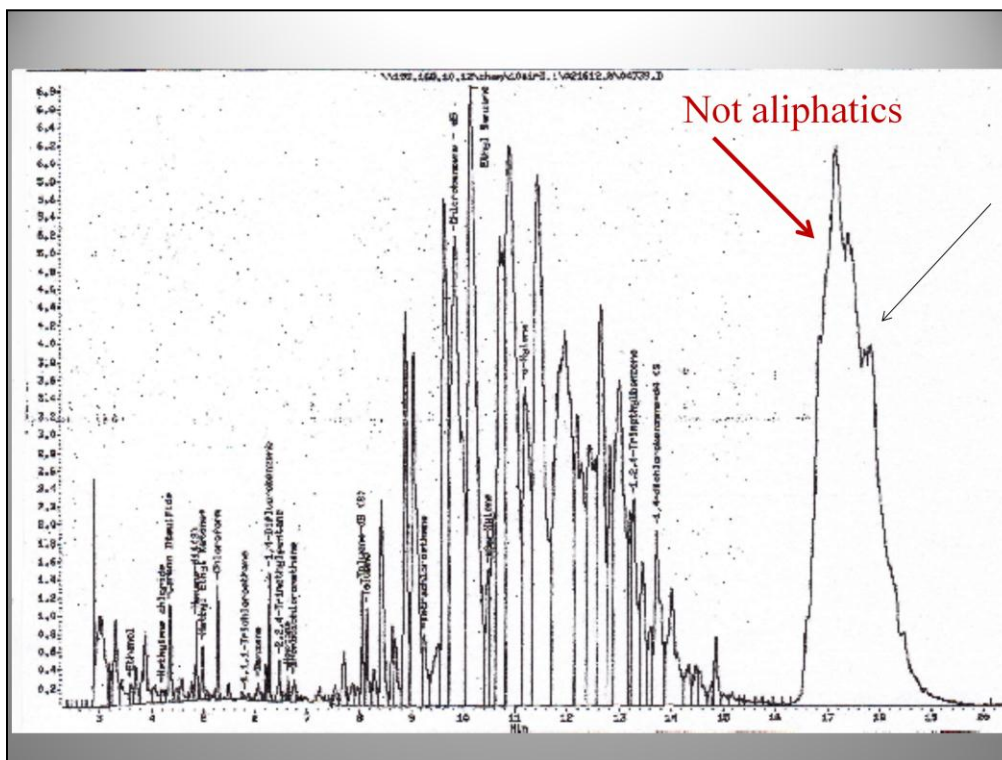
Measurement of TPH aliphatic groups at such low levels will introduce a whole new set of potential problems.

Required Volumes to Reach RSLs

	RSL (ug/m ³)	Volume (L)
TPH Aliphatic C5-C8	13	14.5
TPH Aliphatic C9-C18	0.54	1037

HARTMAN
ENVIRONMENTAL GEOSCIENCE

These are the volumes an air testing lab said would be required to reach the indoor air RSLs for the TPH aliphatic groups. Over 1000 liters for the medium aliphatic group!!



An example of a TPH chromatogram where a large portion of the total value was due to non-aliphatic hydrocarbons.

Allowable Soil Gas Levels (Benzene 1e-6 Risk, residential)

State	Alpha	1/Alpha	Risk Based Level (ug/m ³)
EPA Now	0.002	500	155
EPA 2012?	0.1	10	3.1 (gulp!)
CA	0.002	500	42
NJ	0.05	20	16
MO			118,000
TN	0.0013	780	2,414
CT	0.1	10	192

A summary of the allowable benzene levels in soil gas shows large variation and illustrates the main points: the new EPA guidance is 50x more restrictive and allowable levels are variable from State to State.