

Soil Gas Investigation



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Soil Gas

- ◆ What is it?
 - Soil gas is atmospheric gas located in the airspace between soil grains, i.e. soil pore space.
- ◆ Why is it of concern?
 - Volatile organic compounds that are contaminants in soil or ground water will also be prevalent in soil vapor and can migrate to a receptor.
- ◆ How do vapors migrate?
 - There are two primary transport mechanisms, diffusion and convection.



Primary Factors Affecting Vapor Migration

- ◆ Soil permeability
 - One of the most important factors in the movement of vapor through soil is soil permeability. In general the smaller the grain size the less permeable the soil unless secondary porosity (i.e. fractured clays) increases permeability.
- ◆ Soil moisture content
 - The presence of moisture in soil decreases the rate of vapor intrusion by decreasing soil airspace and inhibiting vapor movement. Thus soil gas sampling after a significant precipitation event where the ground is saturated is not recommended.
- ◆ Vapors migrate fastest through the coarsest driest materials



Evaluating Soil Gas Concentrations

- ◆ Soil gas sampling is conducted one of two ways:
 - Active collection.
 - ✦ Involves pulling a sample through a temporary or permanent probe to a collection or analytical device.
 - ✦ The Department's VI Guidance Document focuses on active soil gas collection.
 - Passive collection.
 - ✦ Involves collecting contaminants on a sorbent material or collecting vapor from the ground surface via an emission isolation flux chamber.
 - ✦ The use of sorbent material is limited to field screening only.
 - ✦ Flux chambers may be utilized with prior approval by the Department with justification why its use is more appropriate for the application proposed.



Soil Gas Sampling Locations

- ◆ Within the VI Guidance Document, soil gas concentrations are evaluated in one of three locations:
 - Exterior
 - ◆ Samples collected beyond the 10 foot perimeter from the receptor slab.
 - Near Slab
 - ◆ Samples collected within the 10 foot perimeter from the receptor slab.
 - Sub-Slab
 - ◆ Samples collected beneath the receptor slab.



Exterior Soil Gas Sampling

- ◆ Primarily a screening tool for rapid identification and delineation of volatile organics in the subsurface.
- ◆ Not acceptable as an exclusive determinant in the assessment of the VI pathway unless evaluating future use scenarios when no existing structures are present.
 - Why?...Potential false negatives due to differing soil types and moisture content away from the receptor.



Near-Slab Soil Gas Sampling

- ◆ May be acceptable as an exclusive determinant in the assessment of the VI pathway with the Department's prior approval.
- ◆ May be useful in evaluating background contribution to indoor air samples.
- ◆ Conditions of acceptability include:
 - Access for sub-slab sampling denied by target receptor.
 - Samples collected at a depth corresponding to a range of 2 to 5 feet below the depth of the receptor slab and a minimum of 5 feet below the ground surface.
 - Samples collected at least one foot above the capillary fringe.
 - Samples are collected from at least two sides of the receptor structure for a single family residence (1500 ft²).



Sub-Slab Soil Gas Sampling

- ◆ Department preferred location for a stand alone assessment of the VI pathway when the source of the vapors is contaminated ground water beneath or in close proximity to the receptor slab.
- ◆ Particularly useful in evaluating background contribution to indoor air samples.
- ◆ Acceptable when:
 - seasonal high water table is two feet or greater from the base of the sub-floor.
 - The water table does not extend into the fill material directly under the building foundation.
 - The capillary zone does not reach the building foundation.



Soil Gas Sampling Techniques

◆ Exterior and Near-Slab Sampling

- Soil vapor probes with retractable tips driven manually or hydraulically a desired depth and retracted to expose an airspace. In general a minimum of 5 feet from ground surface.
- Small diameter inert tube inserted through the center of the vapor probe and connected to the drive point.



Soil Gas Sampling Techniques

- ◆ Exterior and Near-Slab Sampling (continued)
 - Annular seal maintained by soil against probe rods or alternatively the rods are withdrawn and a bentonite seal is utilized. The surface seal is verified by the use of a tracer compound such as isopropanol, butane, helium, or difluoroethane.
 - The vapor probe is then purged by drawing three volumes of air through the probe and connecting tubing.
 - Samples are withdrawn primarily by 1-liter or 6-liter stainless steel canisters for offsite laboratory analysis or syringes or tedlar bags for onsite analysis at a maximum of 200 milliliters/minute.

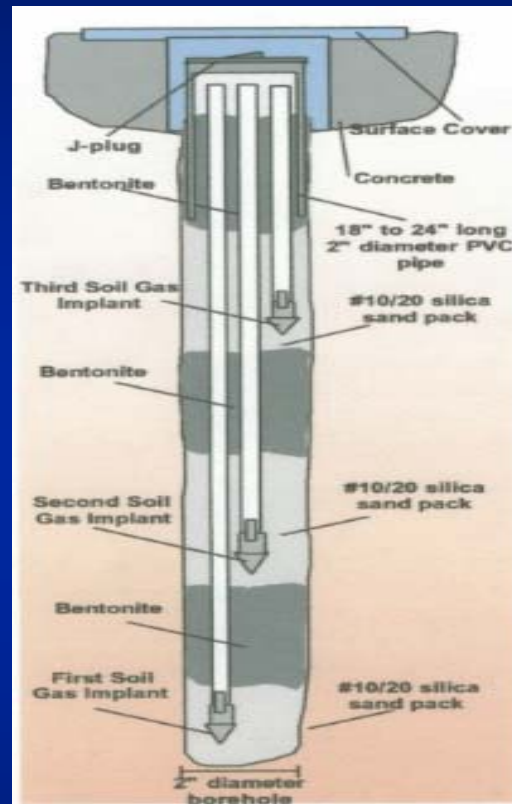


Soil Gas Sampling Techniques

- ◆ Exterior and Near-Slab Sampling (continued)
 - For exterior and near-slab sampling, the number and location(s) of the samples will be determined based on the end use of the data, i.e. a field screening use will be based on professional judgement and the intent of the study.
 - Exact locations will dictated by site conditions and the location of the contaminant plume.
 - Sampling frequency for exterior or near-slab samples is also based on the end use of the data. Near-slab stand alone determinations may require more than one sampling event.



Soil Gas Sampling Techniques



Nested Exterior Soil Gas Sampling Point
(Courtesy H&P Mobile Geochemistry)



Soil Gas Sampling Techniques

◆ Sub-Slab Sampling

- Two basic methodologies:
 - ◆ permanent sample points
 - ◆ temporary sample points
- Permanent sampling points involve the emplacement of stainless steel tubing and fittings through which repeated samples can be withdrawn.
- Temporary sampling points utilize Teflon or metal (or similar) tubing to extract a sample without a permanent point.



Soil Gas Sampling Techniques

◆ Sub-Slab Sampling (continued)

- For both methods a hole is drilled through the slab approximately 3 inches into the sub-slab material to create an open cavity.
- An annular seal must be maintained by non-volatile emitting non-shrinking material such as cement grout for permanent points or modeling clay, beeswax, plumbers putty, etc. for temporary points.



Soil Gas Sampling Techniques

◆ Sub-Slab Sampling (continued)

- The vapor probe is then purged by drawing three volumes of air through the probe and connecting tubing.
- Samples are withdrawn primarily by 1-liter or 6-liter stainless steel canisters for offsite laboratory analysis or syringes or tedlar bags for onsite analysis at a maximum of 200 milliliters/minute.
- Samples should be collected from as close to the center of the slab as possible, use utility closets or utility rooms to minimize damage to carpeting or tile.



Soil Gas Sampling Techniques

◆ Sub-Slab Sampling (continued)

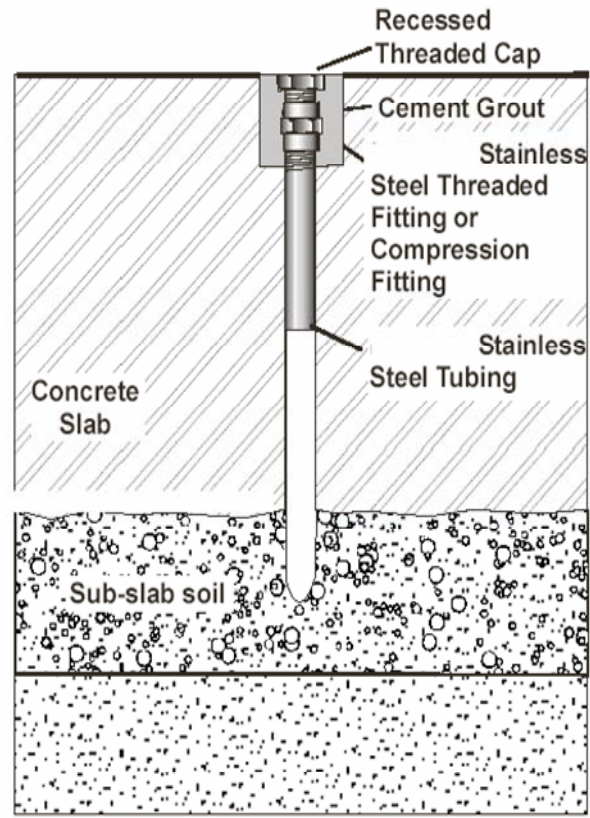
- One sample point for a typical single family home (1500 ft²) is considered sufficient. Larger structures may require additional points; however, the decision on the number of sub-slab sample points should begin with an evaluation of the Conceptual Site Model.
- Confirmation sampling may be necessary if sub-slab sampling is used as a stand alone determination of the VI pathway. A single round of data is considered sufficient if the initial round is an order of magnitude below the appropriate screening level.



Soil Gas Sampling Techniques

General Schematic for Installation of Sub-Slab Vapor Probes

(DiGiulio et al., 2003)



Soil Gas Sample Analysis

- ◆ Selection of an analytical procedure for sample analysis is based on the end use of the data.
- ◆ Samples for stand alone evaluations of the vapor intrusion pathway should be analyzed for volatile organics via TO-15 or TO-17 by a laboratory certified by the Department for those methods.
- ◆ Samples for field screening may be analyzed for target compounds via USEPA SW-846 Method 8260B. Determinations for future use will required usage of a laboratory certified in this method.



Soil Gas Data Evaluation

- ◆ Soil gas data are generally used in comparison with other data sets to determine patterns or differentiate site related compounds from other sources.
- ◆ Sub-slab and with prior approval near-slab data can be used for stand alone determinations of the VI pathway. In these instances and when the data is collected in concert with IA samples the near slab and sub-slab data are compared to the Soil Gas Screening Level (SGSL) which utilizes an attenuation factor of 0.02 or 50 times to evaluate the possibility of the VI pathway being complete.

