This document references Chapters and Sections from the ITRC Vapor Intrusion Technical and Regulatory Guidance, and Fact Sheets and Technology Information Sheets from the ITRC Vapor Intrusion Toolkit, published January 2026. These resources can be accessed at: **https://itrcweb.org/vapor-intrusion-toolkit**.

SOIL VAPOR PROBE INSTALLATION TOOLBOX FACT SHEET

Introduction

Collection and analysis of soil vapor is a common approach around the country for evaluating the vapor intrusion pathway. Soil vapor data are preferred over other data, such as soil matrix and/or groundwater data, because it represents a direct measurement of target vapor-forming chemicals (VFCs) that can potentially migrate into indoor air.

Soil vapor can be collected using either active or passive sampling methods. Active sampling methods consist of the withdrawal of the soil vapor from the subsurface for subsequent analysis. These methods provide direct concentration data (e.g., micrograms per cubic meter) of subsurface vapor concentrations, which can be directly compared to risk-based screening levels or used in predictive models. Passive sampling relies on the diffusion of chemicals onto an adsorbent media without the use of pumps or a vacuum, such as a stainless-steel evacuated canister. For more information on passive soil vapor sampling, refer to the Interstate Technology & Regulatory Council's (ITRC's) *Passive Sampling Technologies Guidance* (ITRC 2024)

Active soil vapor sampling techniques for vapor intrusion applications require much greater care than those historically used for typical site assessment applications (e.g., assessing whether an underground storage tank has leaked) because risk-based concentration levels for vapor intrusion scenarios are so low and soil vapor concentrations may be highly variable. The quality of soil vapor data depends greatly on the collection protocols, beginning with the installation of properly placed and well-constructed sampling probes/points. The following sections present the primary methods for installing soil vapor probes, as well as details regarding probe materials and equilibration times.

Active Soil Vapor Probe Installation Methods

Two techniques commonly used to install soil vapor probes for active soil vapor sampling are "driven probe rod" and "burial of soil vapor sampling tubes." Both methods have been shown to give reliable, reproducible data in moderate- to high-permeability soils (USEPA 2006).

Note that for all soil vapor probe installation methods, underground utilities should be located and avoided prior to ground-penetrating activities.

Driven Probe Rod (Temporary Method)

This method consists of the insertion of a hard rod (probe) driven to a target depth, collection of soil vapor through the rod while it is in the ground, and subsequent removal of the rod (**Figure 1** and **Figure 2**). Typically, probes are constructed of hollow steel rods with an external diameter ranging 12.5–50 millimeters. Small-diameter, inert, replaceable tubing runs down the center of the drive rod to eliminate potential contamination from the inside of the rods.

The probes can be driven by hand, direct-push systems, or larger drill rigs using the wire-line hammer. The driven rod method is typically fast and does not leave any materials in the ground. Probe installation can be difficult in consolidated or coarse-grained soils, especially at greater depths, where the rods are more susceptible to deflection. A surface seal is usually employed to reduce entry of surficial air (note that the probe in the left photograph of **Figure 1** does not have a seal in place). The hollow rod used to collect soil vapor does not prevent cross-flow at greater depths, so driven probes are most applicable in relatively uniform moderate- to high-permeability materials (generally not in low-permeability soils). A tracer may help to verify the absence of atmospheric air entry during sampling. It should be noted that probes installed using this method are typically sampled once then removed and the borehole backfilled.

Figure 1. Photographs of driven soil vapor probes. Note the probe on the left has no seal.

Sources: H&P Mobile Geochemistry (left); Vapor Pin Enterprises, Inc. (right), used with permission.

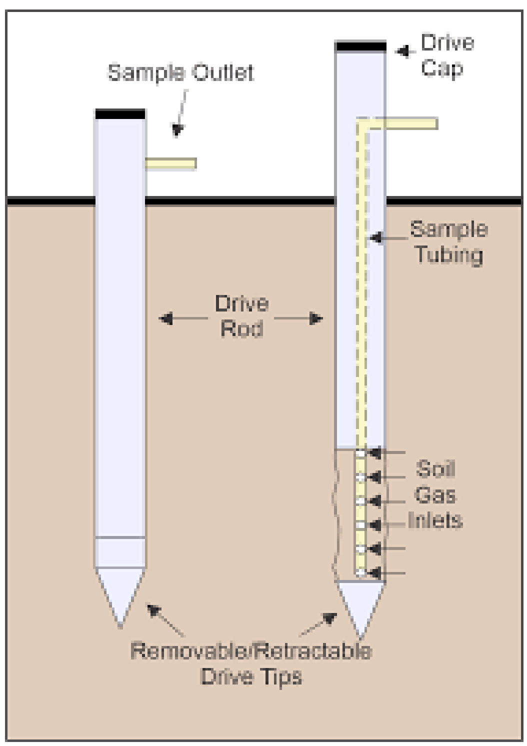

Figure 2. Diagram of driven soil vapor probe.

Source: New Jersey Department of Environmental Protection; used with permission.

Burial of Soil Vapor Sampling Tubes (Semipermanent or Permanent Method)

This method consists of the burial of a small-diameter (typically 1/8- to 1-inch outside diameter) inert (e.g., stainless steel, Teflon®, high-density polyethylene, polyether ether ketone [PEEK], Nylaflow®) tube or pipe to a target depth. Soil vapor is subsequently sampled after a period of time (also known as the equilibrium time). Tubing may be buried in holes created with hand-driven rods, direct-push systems, hand augers, drills (for subfoundation samples), or drill rigs (for deeper samples). Sand is used as backfill around the tip, and the remainder of the borehole annulus is sealed, usually with bentonite and water slurry. This method is sometimes referred to as the "semipermanent" method (if the tubes are removed after a short period of time) or "permanent" method (if the tubes are left in the ground for a longer period of time) but can equally be used for temporary sampling. This method offers significant advantages when repeated sampling events are needed, or where the geology is not conducive to driven probes.

Vapor probes (combined implants and tubing) can be installed at multiple depths within a single borehole, as shown in [Figure 3](#) through [Figure 5](#). Critical for these probes (or wells), which are often referred to as dual-, triple-, or multi-nested, is the establishment of a tight seal in between each sample interval using either a bentonite slurry or granular bentonite added and hydrated at frequent intervals (e.g., <6-inch lifts). They can also be installed in adjacent individual boreholes.

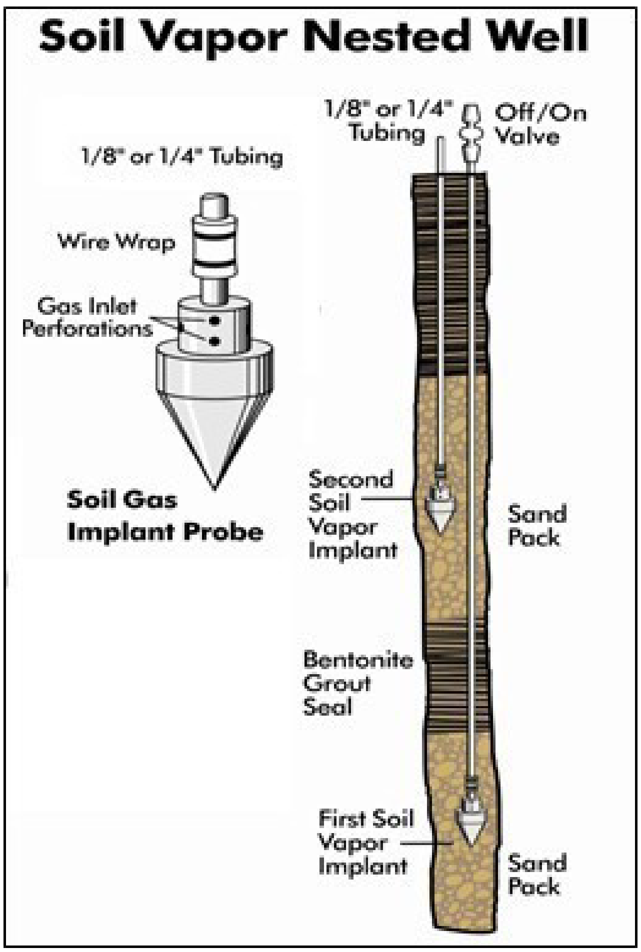

Figure 3. Diagram of a typical configuration of a nested well.

Source: H&P Mobile Geochemistry, used with permission.

Figure 4. Examples of typical multi-nested soil vapor probes.

Source: H&P Mobile Geochemistry, used with permission.

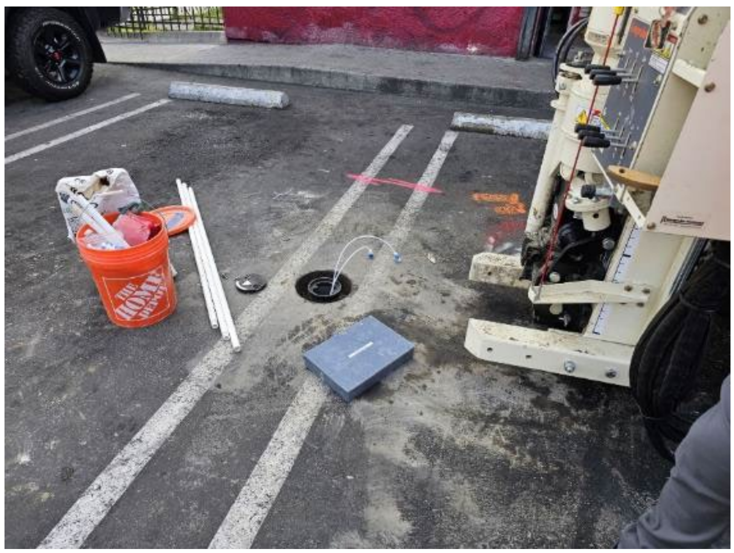

Figure 5. Photograph of a typical dual-nested soil vapor probe.

Source: California Environmental Protection Agency Department of Toxic Substances Control; used with permission.

Soil Vapor Sampling from Existing Groundwater Wells

Soil vapor samples may be collected from appropriately screened groundwater wells, but the data generated from that sample must be considered as “screening only.” It may be useful in helping to refine a vapor intrusion conceptual site model but is rarely sufficient for final decisions. More specifically, this method is more appropriate for screening gases like methane and carbon dioxide, as opposed to other trace VFCs. For information regarding proper groundwater well construction and installation methods, refer to the U.S. Environmental Protection Agency’s (USEPA’s) *Design and Installation of Monitoring Wells Guidance* (USEPA 2008).

Previously installed groundwater wells may be screened across the water table, or the water table may have dropped below the bottom of the screen. The well must either have an air-tight cap and valve or an air-tight packer system around tubing and be placed above the screen ([Figure 6](#)). Many groundwater monitoring wells have vented caps, so a retrofit may be required. The purging of three casing volumes from a groundwater well may be significant, so be diligent in the purging process. For more information on purging as part of the active sampling process, refer to [Chapter 7: Sampling and Analysis.](#)

Figure 6. Soil vapor sampling from an existing groundwater monitoring well.

Source: Vapor Pin Enterprises, Inc.

Soil Vapor Probe Installation Issues Specific to Underground Storage Tank Sites

At many active service station sites, ground disturbance protocols require special probe installation protocols. While often used at service stations, it is not recommended to use an air knife to clear shallow sample locations when soil vapor samples are to be collected, so the burial method using hand auguring will likely be the most common method used to create a borehole. Boreholes also may be created by using direct-push or augering methods when underground utilities have been identified and accurately mapped out or are not present. Soil vapor sampling points can be installed down a variety of boreholes ranging in diameter from 1 to 8 inches.

Soil Vapor Probe Abandonment/Destruction

Once a soil vapor probe is no longer needed, practitioners should ensure that they are properly abandoned in a manner that leaves no open conduit from the subsurface to indoor/outdoor air. This may occur as part of the closure steps for a site under regulatory oversight or following the completion of an investigation that used temporary soil vapor probes. When abandoning a soil vapor probe, practitioners should be sure to follow any applicable local or federal guidelines.

Soil Vapor Probe Installation Materials

Whether using the temporary or permanent soil vapor probe installation method, it is important that the correct soil vapor probe materials are used and the probes are constructed properly. The following subsections present recommended materials practitioners should use when installing a soil vapor probe.

Tubing Material

Use tubing material that does not adsorb or off-gas volatile hydrocarbons. Studies by the USEPA (2009) show that nylon, Teflon, and stainless steel all give comparable results for typical petroleum hydrocarbons. For heavier molecular weight compounds, stainless steel shows the least adsorption but may be impractical to use. Nylon is recommended over Teflon tubing, because nylon tubing is less expensive, and the compression fittings are easier to seal. Polyethylene tubing, commonly used by practitioners for groundwater sampling, has been shown to adsorb hydrocarbons, and therefore may only be acceptable when sampling for VFCs. Practitioners should always check to ensure that the proper tubing is being used. In addition, it is important to properly store and handle the tubing. Any type of tubing will become contaminated and contribute to false positives if it is stored unsealed in the back of a truck or near the truck exhaust. When installing probes meant for TO-17 analysis and/or active collection of field readings of certain VFCs (such as oxygen, hydrogen sulfide, or methane), it is also common to use 1-inch diameter polyvinyl chloride (PVC) pipe. Examples of commonly used tubing are shown in [Figure 7](#).

Figure 7. Photographs of typical soil vapor probe tubing, including high-density polyethylene (top left), Nylaflow (top center), tubing made from polyether ether ketone (PEEK) (top right), stainless steel (bottom left), Teflon (bottom center), and Teflon-lined low-density polyethylene (bottom right).

Source: Environmental Services Products.

Tubing Diameter

Nominally ⅛-inch or ¼-inch outer diameter (OD) tubing is recommended. Although ⅛-inch OD tubing can be easier to drop down a borehole, connections for ¼-inch OD tubing are easier to procure. The ⅛-inch OD tubing is also more prone to vapor lock and/or blockage. If soil permeability tests are to be performed, the diameter should be a minimum of ¼ inch.

Probe Tip (Implant)

Stainless steel, aluminum, ceramic, or plastic (the choice depends upon project specifications) probe tips are recommended. Equipment blanks may have elevated levels of VFCs if probe tips are not properly cleaned. Examples of typical soil vapor probe implants are shown in **Figure 8**.

Figure 8. Photographs of typical soil vapor probe implants.

Source: ESP Supply.

Annular Space Materials

When installing a soil vapor probe using the burial method, the annular space around the probe implant and tubing must be filled with the appropriate materials. Typically, a sand pack is placed at the bottom foot to minimize disruption of airflow. The probe implant should be set midway in the sand pack, as shown on **Figure 3**. New sand should be used for the pack. The most common sand used is #3 in size (**Figure 9**).

Figure 9. Photographs of typical granular bentonite (top) and sand (bottom) used during the soil vapor probe installation process.

Source: ESP Supply.

Following the sand pack, a seal should be placed either to the next probe interval or the surface. Granular bentonite or neat cement are two common seal materials (see **Figure 9**). Some states recommend that a transitional seal be placed directly above the sand pack to prevent water and clay infiltration from the annular seal. Dry granular bentonite is typically used for this transitional seal. Neat cement is commonly recommended for probes that will remain in place for a longer period of time.

A tremie pipe should be used for the emplacement of the sand, transition seal if used, and seal in soil vapor probes that are deeper than 15 feet. This will help to avoid bridging or segregating during installation. For shallower probes, the material can be gravity fed (freefall) from the surface.

Surface Termination on Tubing

Compression fittings (e.g., Swagelok or equivalent), quick-connect pneumatic fittings on PVC points, or inert plastic valves (two-way plastic valves or stop cocks) are best for sealing tubing that will remain in the ground for an extended time (**Figure 10**). It is important to secure the valve tightly to the tubing (the valve is a permanent component of the soil vapor collection system).

Figure 10. Typical surface terminations on soil vapor probe tubing, including inert plastic valves (top) and compression fittings (bottom).

Source: ESP Supply.

Ground Surface Termination

Options for surface termination include flush mounts on the floor/surface, below-ground termination (with or without a locking cover), and various aboveground completions that are commercially available ([Figure 11](#)).

Figure 11. Typical soil vapor probe surface completions.

Source: ESP Supply.

Probe Surface Seals

For collection systems with large purge volumes or that are designed to collect large sample volumes, it is often necessary to seal the probe at the surface. Seals may also be necessary for small volume systems if the soils are extremely porous and the sampling depth is close to the surface (less than 3 feet). The most common sealing technique is to grout the surface contact of the probe. In some states, it is recommended to use neat cement for probes that are anticipated to remain in the ground for over a year to avoid cracking in the seal over time. Bentonite is also commonly used as a surface seal, particularly for temporary soil vapor and sub-slab vapor probes. If any other materials are used to seal the probe, such as modeling clay for temporary sub-slab vapor probes, they should be tested to ensure they are free from any VFCs.

Soil Vapor Probe Equilibration

When probes are installed, the in situ soil vapor/sub-slab vapor can be displaced. Therefore, a period of time is required for the soil vapor/sub-slab vapor to equilibrate to its predisturbed values. It should be noted that in some states the time between probe installation and sampling depends on the investigation objectives and/or data quality requirements. For example, if a soil vapor survey is conducted using temporary points to map the extent of a vapor plume, and the sample data are not intended for use in risk assessment or site closure decisions, a less-than-ideal equilibration time may be acceptable.

Between 2007 and 2016, equilibration times provided in guidance documents were largely based on the drilling method used since different methods disturb in situ soil to varying degrees. These drilling-method-based equilibration times are still widely used in many states. For example, California requires between 2 and 48 hours for probes installed using direct-push drilling, 48 hours for probes using hand auger or hollow stem auger drilling, and between a few days and a few weeks for probes installed using rotosonic drilling (California DTSC 2015).

Since 2016, several studies have shown that the installation method is far more important to determining the appropriate equilibration time. A 2016 USEPA study evaluated trichloroethylene or trichloroethene (TCE) concentrations in newly installed soil vapor probes, focusing primarily on permanent and semipermanent probes (called “macro-purge” probes in the study) that are buried in a sand pack (Schumacher et al. 2016). Soil vapor samples were collected at various time intervals following probe installation and submitted for laboratory analysis of VFCs. The analytical results indicated that TCE concentrations increased during the first eight hours after probe installation, then reached equilibrium concentrations after 24 to 48 hours. The limited number of temporary probes (referred to as *post-run tubing* and *mini-purge* probes), which are installed without a sand pack, reached equilibrium concentrations after one to two hours. USEPA concluded that buried permanent/semipermanent probes provide more reliable data and recommended that such probes be allowed to equilibrate for a minimum of 48 hours.

Given these two strategies that are currently used to determine equilibration times throughout the country, the following minimum equilibration times have been compiled:

- Permanent and/or semipermanent probes that are buried in a sand pack and sealed with hydrated bentonite should be allowed to equilibrate for 24 to 48 hours following installation. A minimum of 48 hours is strongly encouraged for more reliable data.
- Should rotosonic drilling be used to install permanent and/or semipermanent probes, an extended equilibration time (over two days or even a few weeks) should be considered.
- Temporary soil vapor (including post-run tubing) and sub-slab vapor probes should be allowed to equilibrate for a minimum of two hours.

The best option to verify that equilibrium has reestablished is to collect time-series data. Soil vapor samples for VFC analysis, along with oxygen and carbon dioxide measurements, should be collected shortly after installation and then at a frequency that will demonstrate the time needed to attain representative samples. A field instrument may be used to analyze the soil vapor samples to evaluate representativeness. If the subsurface lithology is homogeneous, one monitoring point could serve as a surrogate for all others when installing multiple sampling probes.

Soil vapor well installation method and equilibration time should be recorded in the field logbook or field form.

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