Soil Vapor Extraction

An Online Continuing Education Course for Engineers

Course Number: EN-3001

Credit: 3 Hours / 3 PDH / 3 CPD

Soil Vapor Extraction

Overview

Soil vapor extraction (SVE), also known as soil venting or vacuum extraction, is an in situ remedial technology that reduces concentrations of volatile constituents in petroleum products adsorbed to soils in the unsaturated (vadose) zone. In this technology, a vacuum is applied to the soil matrix to create a negative pressure gradient that causes movement of vapors toward extraction wells. Volatile constituents are readily removed from the subsurface through the extraction wells. The extracted vapors are then treated, as necessary, and discharged to the atmosphere or re-injected to the subsurface (where permissible).

This technology has been proven effective in reducing concentrations of volatile organic compounds (VOCs) and certain semi-volatile organic compounds (SVOCs) found in petroleum products at underground storage tank (UST) sites. SVE is generally more successful when applied to the lighter (more volatile) petroleum products such as gasoline. Diesel fuel, heating oils, and kerosene, which are less volatile than gasoline, are not readily treated by SVE but may be suitable for removal by bioventing. SVE is generally not successful when applied to lubricating oils, which are non-volatile, but these oils may be suitable for removal by bioventing. A typical SVE system is shown in Exhibit 1. A summary of the advantages and disadvantages of SVE is shown in Exhibit 2.

This course will assist you in evaluating a corrective action plan (CAP) which proposes SVE as a remedy for petroleum-contaminated soil. The evaluation process, which is summarized in a flow diagram shown in Exhibit 3, will serve as a roadmap for the decisions you will make during your evaluation. A checklist has also been provided at the end of this course to be used as a tool to evaluate the completeness of the CAP and to help focus attention on areas where additional information may be needed. The evaluation process can be divided into the following steps.

- Step 1: An initial screening of SVE effectiveness, which will allow you to quickly gauge whether SVE is likely to be effective, moderately effective, or ineffective.

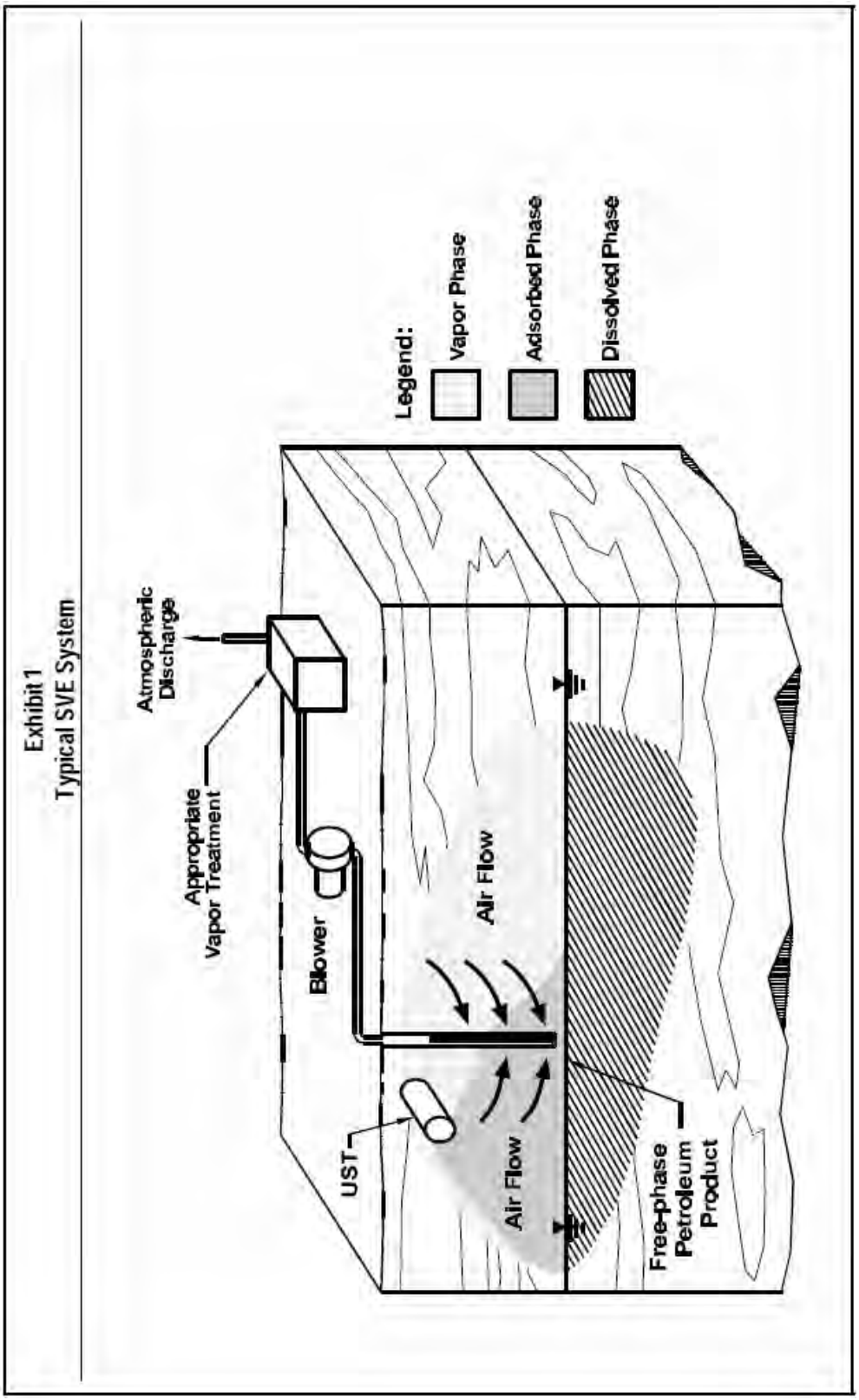


Exhibit 2
Advantages And Disadvantages Of SVE

Advantages	Disadvantages
○ Proven performance; readily available equipment; easy installation.	○ Concentration reductions greater than about 90% are difficult to achieve.
○ Minimal disturbance to site operations.	○ Effectiveness less certain when applied to sites with low-permeability soil or stratified soils.
○ Short treatment times: usually 6 months to 2 years under optimal conditions.	○ May require costly treatment for atmospheric discharge of extracted vapors.
○ Cost competitive: $20-50/ton of contaminated soil.	○ Air emission permits generally required.
○ Easily combined with other technologies (e.g., air sparging, bioremediation, and vacuum-enhanced dual-phase extraction).	○ Only treats unsaturated-zone soils; other methods may also be needed to treat saturated-zone soils and groundwater.
○ Can be used under buildings and other locations that cannot be excavated.	

- Step 2: A detailed evaluation of SVE effectiveness, which provides further screening criteria to confirm whether SVE is likely to be effective. To complete the detailed evaluation, you will need to find specific soil and constituent characteristics and properties, compare them to ranges where SVE is effective, decide whether pilot studies are necessary to determine effectiveness, and conclude whether SVE is likely to work at a site.

- Step 3: An evaluation of the SVE system design, which will allow you to determine if the rationale for the design has been appropriately defined based on pilot study data or other studies, whether the necessary design components have been specified, and whether the construction process flow designs are consistent with standard practice.

- Step 4: An evaluation of the operation and monitoring plans, which will allow you to determine whether start-up and long-term system operation monitoring is of sufficient scope and frequency and whether remedial progress monitoring plans are appropriate.

Initial Screening of SVE Effectiveness

Although the theories that explain how SVE works are well- understood, determining whether SVE will work at a given site is not simple. Experience and judgment are needed to determine whether SVE will work effectively. The key parameters that should be used to decide whether SVE will be a viable remedy for a particular site are:

- Permeability of the petroleum-contaminated soils. Permeability of the soil determines the rate at which soil vapors can be extracted.

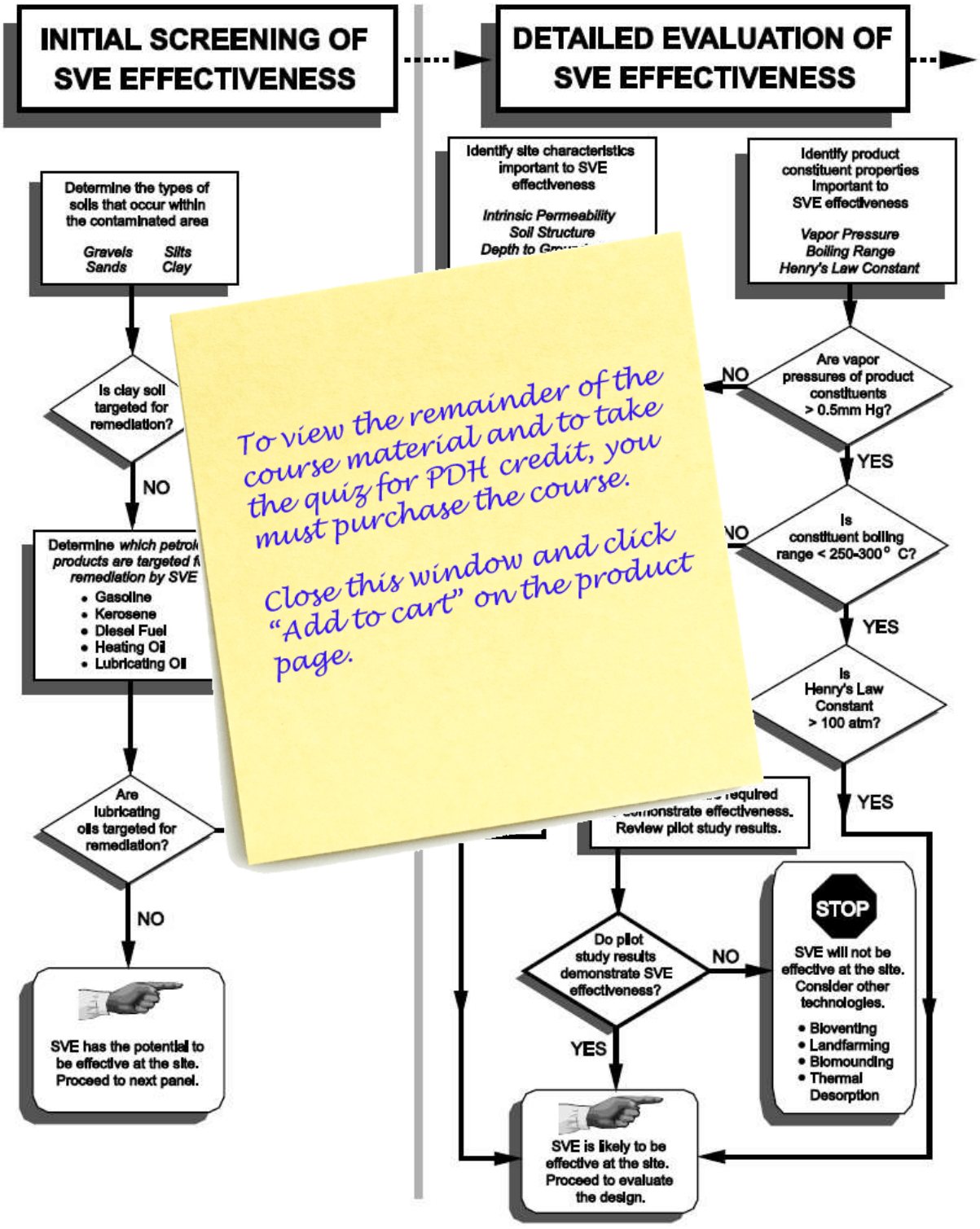
- Volatility of the petroleum constituents. Volatility determines the rate (and degree) at which petroleum constituents will vaporize from the soil-adsorbed state to the soil vapor state.

In general, the type of soil (e.g., clay, silt, sand) will determine its permeability. Fine-grained soils (e.g., clays and silts) have lower permeability than coarse-grained soils (e.g., sands and gravels). The volatility of a petroleum product or its constituents is a measure of its ability to vaporize. Because petroleum products are highly complex mixtures of chemical constituents, the volatility of the product can be roughly approximated by its boiling point range.

Exhibit 4 is an initial screening tool that you can use to help assess the potential effectiveness of SVE for a given site. This exhibit provides a range of soil permeabilities for typical soil types as well as ranges of volatility (based on boiling point range) for typical petroleum products. Use this screening tool to make an initial assessment of the potential effectiveness of SVE. To use this tool, you should scan the CAP to determine the soil type present and the type of petroleum product released at the site.

Information provided in the following section will allow a more thorough effectiveness evaluation and will identify areas that could require special design considerations.

Exhibit 3
SVE Evaluation Process Flow Chart



To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

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