Chapter 11
Other Considerations

11-1. Regulatory Issues

a. State and Federal regulatory requirements should be identified by the designer prior to design, construction, or operation of an SVE/BV system. Many states have regulations governing any air discharge; therefore, a permit may have to be obtained before beginning pilot testing or operation. State permits may be required for well drilling and construction, even when the well does not encounter groundwater. Federal requirements promulgated by the Resource Conservation and Recovery Act (RCRA) include regulations for the handling and disposal of condensate and other residuals, such as investigation-derived wastes. Sites handled under the Federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program would have to adhere to the CERCLA process as well as meet all Applicable, Relevant and Appropriate Requirements (ARARs) of other Federal and state regulations and laws.

b. The Federal Clean Air Act (CAA) provides transfer of authority to implement and enforce the majority of CAA requirements to individual states. It is therefore important that design personnel become familiar with state air quality requirements for the state in which the system will be constructed. Many states have specified emission control equipment and/or specific emission limits for sources emitting VOCs and other hazardous air pollutants. State requirements are frequently more stringent than are Federal requirements, and many states have regulations and standards that are not addressed under Federal regulations. Prior to selecting emission control equipment, project designers should research state requirements.

11-2. Patent Issues

A number of patents have been issued that relate to technologies covered in this manual. Readers are advised to consider the ramifications of these patents on their site activities. Contact Office of Counsel for guidance on addressing this issue. The following list presents some of the pertinent patents, but it is not intended to represent a complete patent search.

a. 4,183,407; 4,323,122.

Soil Vent Technologies, Duane Knopik - An exhaust system and process for removing contaminant vapors from contaminated underground areas. Also, a system and method for recovering organic liquid which has settled on the water table in underground areas (see paragraph 1-4*f*). (U.S. District Court 1994).

b. 4,593,760.

James J. Malot - Process for removing volatile liquid by applying a vacuum to a vertical conduit in a borehole. Process removes air and vapors. Process also employs injection of air.

c. 4,660,639.

James J. Malot - Process for removing volatile liquid by applying a vacuum to a vertical conduit in a borehole. Process removes fluids and employs liquid pumping with vacuum.

d. 4,730,672.

Mid West Water Resources - Process for improving airflow by using an impervious barrier on the ground surface.

e. 4,890,673.

Mid West Water Resources - Method of improving airflow in the aquifer by using an impervious barrier on the ground surface.

f. 4,919,570.

Mid West Water Resources - A treatment apparatus involving multiple cyclically connected vessels. Vessels are sealed and attached to both a pumping and a treatment station.

g. 4,945,988.

Mid West Water Resources - Process of aiding contaminant recovery by injecting substantially oxygen-free air into the aquifer to retard the formation of aerobic bacteria; and injecting oxygen-rich air into the vadose zone to stimulate bacterial growth.

h. 5,050,677.

Mid West Water Resources - Process of either injecting air or withdrawing fluids from a conduit inserted into a borehole. The borehole is filled with high porosity material and capped.

i. Patent pending.

Mid West Water Resources - A method of controlling airflow pathways to induce airflow into zones which have no net airflow, by rotating the orientation of airflow. This patent was shown as pending over 5 years ago but is not shown in records of the US Patent Office.

j. 4,765,902.

Chevron Research Co. - Process for biodegrading hydrocarbons by drawing oxygen into a contaminated zone through a vertical fluid-permeable conduit, and monitoring oxygen, hydrocarbon, and carbon dioxide.

k. 4,832,122.

U.S. Dept. of Energy - A system for removing volatile contaminants from a subsurface plume of contamination comprising two sets of wells, a well for injecting a fluid into a saturated zone on one side of the plume, and an extracting well for collecting the fluid (gas and/or liquid) together with volatilized contaminants from the plume on the other side of the plume.

l. 5,018,576.

University of California - Process for in situ decontamination of subsurface soil and groundwater by injection of steam into injection wells and withdrawal of liquids and vapors from extraction wells under subatmospheric pressure.

m. 5,050,676; 5,197,541.

Xerox Corporation - A process and apparatus for two-phase vacuum extraction of contaminants from the ground involves vacuum withdrawal of liquid and gaseous phases as a common stream, separation of the liquid and gaseous phases, and subsequent treatment of the separated liquids and gases to produce clean effluents. Two-phase vacuum extraction employs a single vacuum-generating device to remove contaminants in both the liquid stream and soil gases through a single well casing.

n. 5,172,764.

Xerox Corporation - Process and apparatus for groundwater extraction using a high vacuum process.

o. 5,221,159.

Environmental Improvement Technologies - Subsurface contaminant remediation, biodegradation, and extraction methods and apparatuses.

p. 5,279,740.

AT&T Bell Laboratories - Process for in situ decontamination of subsurface soil and groundwater by simultaneous injection of steam and nutrients into wells to enhance the growth of hydrocarbon-degrading biota for the purpose of producing compounds of greater mobility, and withdrawal of liquids and vapors from extraction wells.

q. Patent challenges.

"Two of these patents, those held by James J. Malot, have been defended. Initially, when the patents were issued the most common response was to cite several API studies (API 1980a; API 1980b) which significantly predated the Malot filings. However, Malot resubmitted this prior art to the patent office which reissued the 4,660,639 patent with the examiner claiming that the API literature covered only vapor removal, whereas Malot's patent covered vapor and liquid removal simultaneously and from the same borehole. The heart of the controversy is whether or not the practice of vapor extraction predates the patents, and was, because of accepted practice, obvious technology to those schooled in the art. An important difference between much of the earlier work and Malot's patent is that earlier work used low vacuum, whereas Malot's system uses high vacuum" (Brown 1992). In a recent U.S. District Court decision, the judge invalidated claim 8, the central claim of the Malot patent No. 4,660,639, citing prior art (U.S. District Court 1994). Users are advised to consult the Office of Counsel for specific patent guidance.

11-3. Safety

Appropriate safety and health procedures shall be developed by the design team and followed for all aspects of SVE/BV installation and operation. Both the contractor and USACE personnel shall comply with all applicable 29 CFR 1910/29 CFR 1926 standards, giving special attention to 29 CFR 1910.120(b)/29 CFR 1926.65(b) requirements for a Contractor Safety and Health Program (SHP) and a Site-specific Safety and Health Plan (SSHP). The SSHP shall be developed also in accordance with Appendix B, ER 385-1-92. In conjunction with Federal regulation compliance, the contractor and USACE personnel shall comply with all pertinent provisions of USACE Safety and Health Requirements Manual, EM 385-1-1. Where there is overlap between the Federal requirements and USACE requirements, the contractor shall adhere to the most protective. In certain instances, state and/or local safety and health requirements may also be applicable. In those instances, the contractor shall be responsible for the knowledge of and compliance with the state and/or local requirements. In all cases, *the most protective* regulations shall apply.

a. The SSHP monitoring provisions shall include work area monitoring for the presence of explosive or toxic gases which may endanger workers and, otherwise, for the presence of any oxygen-depleting or oxygen-displacing gases. The explosive gas/inert gas monitoring is in addition to the site-specific, worker exposure monitoring to be identified in the SSHP for the project. (Cases have been reported where VOC soil vapor, while within acceptable concentrations below the applicable LELs, contained such high levels of carbon dioxide that the oxygen content of the worker breathing air was reduced to unsafe levels. In another instance, an explosion reportedly occurred at a SVE site because of a failure to properly monitor for the explosive gases.)

b. The SSHP provisions shall give special consideration to other safety and health issues unique to SVE/BV. Refer to EM 1110-1-4007, Safety and Health Aspects of HTRW Remediation Technologies, Chapter 7, Soil Vapor Extraction (In Situ), Bioventing, Biodegradation, Thermally Enhanced Soil Vapor Extraction, for a discussion of health and safety issues of SVE and bioventing and a hazard analysis of the technology.

11-4. Contracting

a. Coordination and general issues. The design team must coordinate early in the SVE/BV project with the Contracting staff. This allows the nature of the SVE/BV process to be considered in developing a "project execution plan," including contract acquisition. Since SVE/BV often includes significant costs for equipment rental and O&M relative to capital costs, these factors can make a difference in the decisions about contracting the SVE/BV project. The project execution, planning, and contracting strategy may also affect the design. For example, if the duration of the work would be long, and it is decided to include only limited O&M in the initial contract, specified equipment may need to be easily modified by a separate O&M contractor to adjust to a change from SVE to BV at a later time. If the duration is likely to be short and a service-type contracting mechanism is used, a performance specification to be met by a packaged SVE/BV unit rented from a supplier may be preferred. Finally, payment for operation of an SVE/BV system can be based on various parameters including simple time, time of successful operations (based on hours of blower operations) and diligent repair, or mass of contaminants removed or destroyed.

b. Design/Build Model of SVE Remediation. An alternate approach to SVE/BV design that should be considered on a project-by-project basis is predicated on the phased implementation concepts described in

Chapter 3, section 3-3b. This phased approach is sometimes referred to as a design/build model of remediation. The flowchart shown in Figure 11-1 describes the phased remediation process in which soil venting as the remediation approach is first validated, then implemented, and finally optimized in a series of phases. Throughout these phases, soil venting system operational data and subsurface monitoring data are used to frequently re-visit and improve the conceptual model of the site. Indeed, these data are also used to frequently check and validate the continued applicability of soil venting as a remedial process. As the understanding of the site improves, even the remedial objectives for the site must be revisited and confirmed.

(1) The phases illustrated in the Figure 11-1 flowchart include RI-like data collection and interpretation such as described in Chapter 3, in the midst of installing and operating pilot or full-scale SVE/BV systems. These phases are not further elaborated upon here, however, it must be re-emphasized that it is wrong to completely "decouple" investigation and remediation activities. All site activities that involve the subsurface must be viewed as opportunities to improve the understanding of the site and to update the conceptual site model. With that understanding, the remaining discussion in this precept describes the interaction of remediation implementation activities and design.

(2) Design/Build is a concept that acknowledges that the design basis for in situ remediation systems is never as solid and unchanging as the basis for other, more traditional engineering designs. Design/Build SVE projects maintain the active participation of the design team throughout the remediation process. By involving the designer(s) in the implementation process, it is possible to reduce the level of detail developed for each design phase. That is, if the design will not be "handed-off" to a totally separate construction entity, then there is less chance for error when implementing less detailed designs. Indeed, since much of the site understanding develops during implementation of remediation systems, it is desirable to have less detailed, more flexible designs that can quickly and easily accommodate new information. For example, it is often the case that during well installation, new "pockets" of contamination are discovered that will require additional treatment wells to be installed. These additional wells in turn may cause a substantial increase in the total extracted vapor flow. If the aboveground system components are not readily modified to accommodate the increased flow, then there will be significant time and cost implications for changing the detailed design. Using the design/build model, the project manager can make much more timely and less costly course corrections to react to these changes in project scope.

(3) As shown in Figure 11-1, a progressive, design/build approach would involve an initial phase of remediation or a pilot test to further the understanding of the site and the applicability of soil venting to remediate the site. Data collected from RI activities provide the basis of the "best guess" design parameters necessary to implement a pilot or small-scale venting system. The pilot or initial phase of remediation would be ongoing while additional phases of remediation are designed. In addition to improving the conceptual model, this test provides critical design data for future system installation. The largest size that is advisable for an initial soil venting phase is specific to the site and the cost/benefit analysis that aids in evaluating remedial options. The designer/practitioner must weigh the cost of multiple mobilizations against the cost of implementing the venting system for the time necessary to gain further insight about venting applicability. (At sites with deep contaminated unsaturated zones, each SVE well and associated monitoring wells/points may cost as much as the entire drilling program at a site with shallow contamination.) In some cases, the remediation equipment can be moved around a larger contaminated site to address the site sequentially essentially in pieces. This approach requires more time, but would have a lower capital cost for equipment. If operational costs are low and there is no need to complete the remediation in a short time, this may be cost effective.

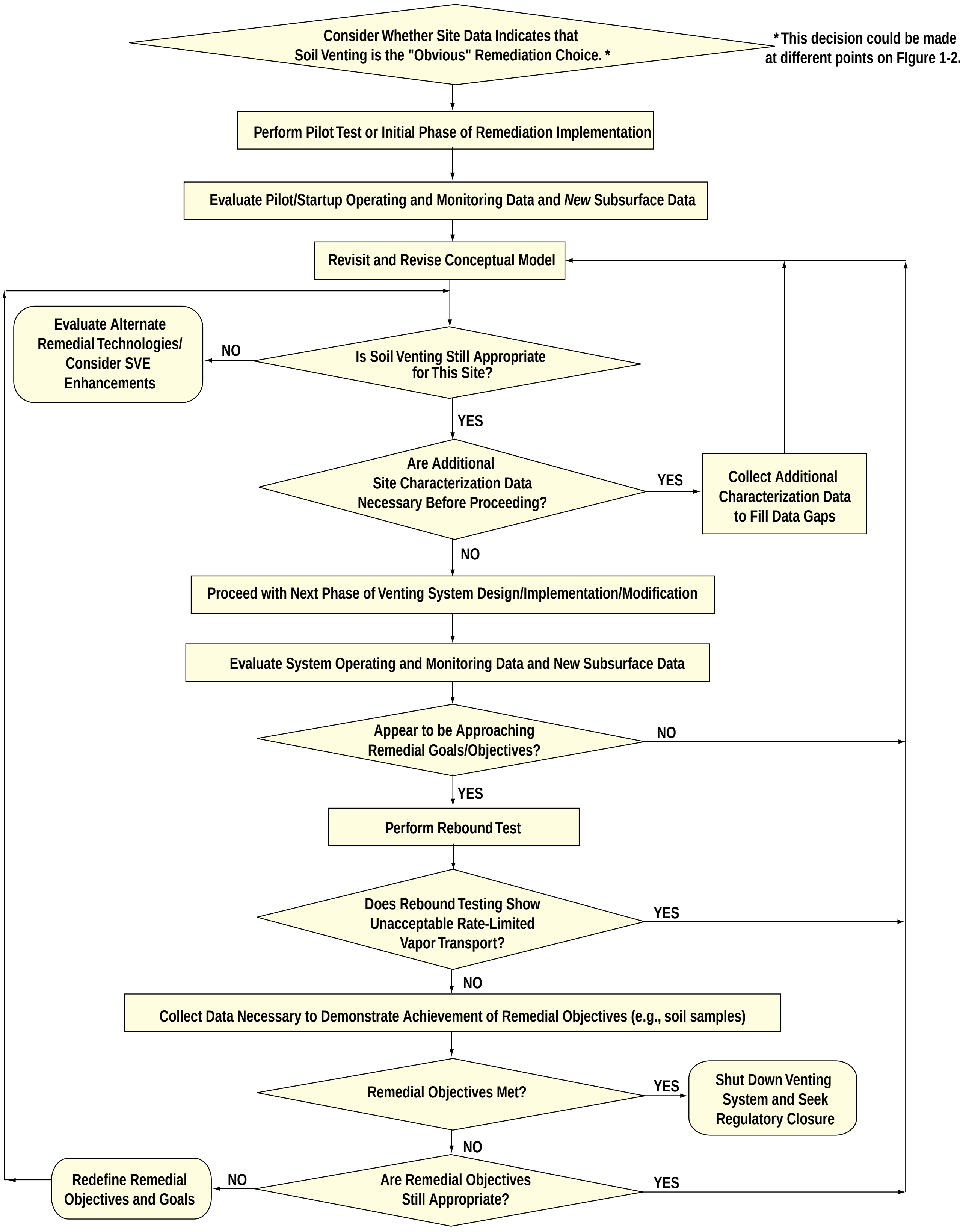

Figure 11-1. Phased Remediation Process Flow Chart

(4) It is conceivable that a venting system of up to 5 wells can be installed and operated based on the limited data available from a RI. For some sites with limited areal contaminant extent, the well network employed for the initial phase of venting remediation may be sufficient for the "full-scale" remediation. At such sites, the design team should develop:

- A preliminary site plan showing the location of the first round of SVE/BV wells with associated monitoring points. These monitoring points are crucial for verifying flow and vacuum design assumptions for future phases.
- Well construction and surface cover details (plans & specifications).
- A detailed P&I diagram for the construction of the aboveground components with concise specification of major system components.
- A preliminary set of electrical plans (single line diagram and control schemata) referencing relevant electrical and NFPA codes.

These plans should be sufficient for developing accurate cost estimates and for gathering price quotes for high-cost components. Other plans and documents can be developed as implementation progresses, as long as the designer remains integral to the process.

c. Rental vs. Purchase of Equipment. It may be prudent, to rent and/or install temporary aboveground equipment to minimize costs as the appropriateness of the venting design is verified and the long-term concentration trends are known. A phased-approach, as described above, is particularly suited for this. The offgas treatment system is often best rented unless significant data exist to project contaminant concentrations appropriate for the technology over a long period of time. By renting the treatment units, flexibility in adjusting to the changing offgas concentrations is available. This is especially important if the duration is expected to be short. The re-use of purchased equipment at other sites is often hampered by logistical or financial (i.e., funding sources) issues. A financial analysis of the costs of purchasing vs. rental should be conducted, considering the customer's desires for equipment ownership at the completion of the project.