CHAPTER 8

SYSTEM SHUTDOWN AND CONFIRMATION OF CLEANUP

8-1. Introduction.

a. System shutdown is typically performed when regulatory goals are reached, when the rate of mass removal is deemed not high enough to justify continued operation, or when monitoring indicates asymptotic levels of contaminants in extracted air and groundwater. It is imperative that each project has a clear closure strategy with set goals. Some closure strategies may involve transition from MPE into other remediation technologies such as natural attenuation. In other cases, closure may closely follow shutdown of the MPE system. System shutdown involves two main components: closure sampling and analysis, which may need to be conducted during more than one event over an extended period of time, and MPE mechanical system shutdown, disassembly and decommissioning. Decommissioning of an MPE system may also require decontamination of equipment.

b. Sampling associated with site closure is performed on media associated with remediation clean-up goals. For example, if the remedial goal involves reduction of NAPL thicknesses to a certain level in monitoring wells (a common goal in several states), NAPL thicknesses would be gauged over time to ensure that this thickness remains below the remedial goal. Similarly, if reduction in groundwater contaminant concentration is the goal of MPE, sampling will occur following shutdown over an extended period to ensure concentrations remain below specified limits and that rebound does not occur.

8-2. Shutdown Strategy.

a. Prior to start-up of an MPE system, a shutdown strategy must be developed. Cleanup goals (e.g., Maximum Contaminant Levels [MCLs], or product thickness less than 0.01-inches) for the contaminant(s) of concern should be negotiated prior to initiating design of the MPE system. Risk-based cleanup goals should be used whenever possible.

b. Shutdown strategy should then be developed on the basis of established cleanup criteria. During system operation, modifications to site closure objectives may be made as remediation proceeds. If the MPE system has been operating continuously for one or more years, and it does not appear that it will be possible to achieve cleanup goals in a reasonable time frame, then it may be necessary to re-evaluate cleanup goals.

c. A strategy for system shutdown should include cleanup levels, sample schedules and methods, and a closure decision matrix. Figure 8-1 is an example of a decision matrix used to evaluate closure data.

d. System shutdown may be determined by direct sampling of the contaminated media. Groundwater samples should be taken from selected monitoring wells identified to be indicative of site conditions. Groundwater samples obtained from monitoring wells should be taken a minimum of 2 to 3 months following shutdown. Soil samples should be obtained using methods that have been described in a work plan that has been reviewed by technical staff and regulatory representatives. Typically, best results are obtained when samples are obtained using methods resulting in the least disturbance to the sample, as discussed in paragraph 3-4h.

e. Three possible outcomes from a closure and analysis program, which depend on regulatory, cost, and technical constraints, are as follows:

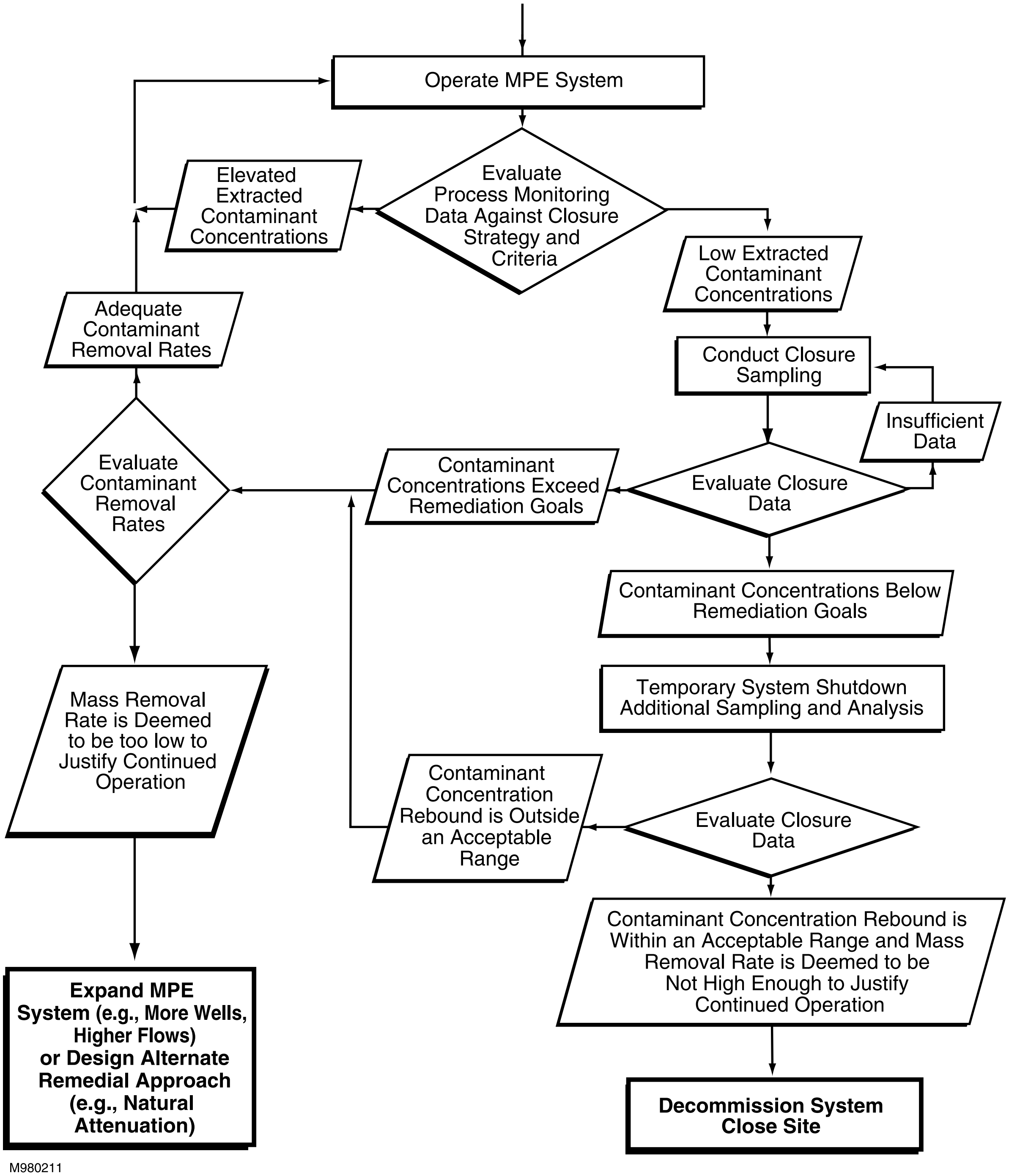

Figure 8-1. Closure Data Evaluation Decision Matrix.

- Contaminant concentrations are and remain below applicable standards;

- Contaminant concentrations are below applicable standards; however, concentrations rebound following system shutdown;

- Contaminant concentrations are above applicable standards, yet the concentrations of contaminants in the extracted air/water have fallen to asymptotic levels.

If extracted concentrations are low, a reduction in the extraction rates should be tried to see whether contaminant concentrations may increase, thereby increasing the efficiency of treatment processes.

f. As an aid to designers and regulators in developing mutually beneficial shutdown criteria, two MPE site examples of closure criteria/strategy are provided.

(1) The first example is the Lake City Army Ammunition Plant (LCAAP), a CERCLA site in Lake City, MO at which MPE was selected for remediation of TCE in low permeability soils (discussed in Chapter 4). The Record of Decision for the site stated the following: “Semiannual technical reviews will accommodate the development of appropriate criteria for measuring system performance and shutting down the system. MPE system performance data will be made available to the Federal Facility Agreement (FFA) parties for evaluation at a minimum of six months after the system begins operation. Criteria will include, but not be limited to, evaluation of mass recovery rates, cost-effectiveness, and reduction of soil contamination levels. System operation will be determined based on the evaluation of these criteria. As full-scale performance data is collected, information on physical limitations of the site and the benefits of this mass removal system will be better developed and used to determine continued operation of the system. System enhancements (e.g., soil fracturing or horizontal well installation) will be evaluated prior to system shutdown. Termination of the system will occur only with the approval of the FFA parties.” Given this language, there was difficulty in negotiating shutdown criteria, and little information was available to assist the parties (Army, consultants, and regulators) in developing good shutdown criteria. (Clif Rope, personal communication).

(2) The second example of closure criteria/strategy is a site remediation project that incorporated DPE with steam flooding and biotransformation to enhance removal of chlorinated hydrocarbons from low permeability soil. Portions of the site from which DNAPL had been extracted at the beginning of the remediation could be closed after application of the integrated technology (Smith et al. 1998). As new areas containing DNAPL were encountered during system operation and monitoring, the system was expanded to treat them. The closure approach was therefore phased, in order to allow shutdown of those portions of the remediation system at which cleanup goals had been achieved. This phased approach allowed closure (based on risk assessment and natural attenuation calculations) of two areas at the site, for which a “no further remediation” letter from the Illinois Environmental Protection Agency was received. The remainder of the contaminated zone continued to undergo active remediation until closure goals were met.

8-3. Shutdown Guidance.

a. Routine monitoring of system performance and routine sampling provide the best indication of an MPE system nearing shutdown. Particular trends and observations indicate that the remediation is nearing its end. These include:

- Reduction in NAPL recovery, reduction in system off-gas contaminant concentrations, reduction of LNAPL thickness in observation wells, and reduction in recovered groundwater contaminant concentrations. These methods provide a simple and quick way of monitoring performance as they provide real-time estimates (if laboratory analysis is not required) of system performance. Disadvantages of these methods include the potential for measurement error, and the necessity of taking into consideration subsurface changes that may influence measured results. For example, although LNAPL had been evident in observation wells during periods of low water table at a site, it may become trapped and therefore may not be evident in the same wells during periods of high water table. A longer monitoring period (of at least a year) would be required to ensure that it does not reappear in the wells.

- Reduced CO_2 or increased O_2 in the extracted off-gas when bioremediation parameters are being tracked. These methods can again provide real-time results; however, if ambient dilution air is used by the MPE system, this must be accounted for in the readings, as the diluted off-gas will not give a direct indication of subsurface conditions. In this case, it may be more desirable to obtain readings from observation wells or soil gas monitoring points.

- Reduced contaminant concentrations in routinely collected groundwater and periodically collected soil samples. These parameters typically give the best results as to how well the MPE system is remediating the subsurface. They are often the parameters used by regulators in determining clean-up goals. Collection of groundwater and subsurface soil samples is, however, labor intensive and entails laboratory costs that typically make these efforts too costly to perform more than once per quarter (or, in the case of soil sampling, much less frequently).

b. Following confirmatory sampling, shutdown of subsurface and aboveground equipment is performed. ASTM D 5299 provides general requirements for well decommissioning, but note that well decommissioning procedures typically vary depending on state requirements. Shutdown of aboveground equipment will typically include decontamination of equipment that will be re-used, and its subsequent removal from the site. If an item of equipment is expected to be stored for a period prior to its next use, it should be stored properly according to the manufacturer’s instructions.