EXECUTIVE SUMMARY

This report summarizes and evaluates the results of Soil Vapor Extraction and Bioventing treatability studies conducted at Operable Unit 1 (OU 1), Hill Air Force Base (Hill AFB), Utah. Based on this evaluation, recommendations are provided regarding the use of SVE and bioventing at OU 1.

SVE and bioventing were included in the *Interim Draft Final Feasibility Study Report for Operable Unit 1* (Montgomery Watson, 1994) as possible technologies for remediating contaminated soil. Soil vapor extraction is a potential remedial alternative for in-situ treatment of unsaturated OU 1 soils contaminated with volatile organic compounds (VOCs), and bioventing is a possible remedial alternative for in-situ treatment of unsaturated OU 1 soils contaminated with biodegradable hydrocarbons. The SVE and bioventing evaluations are based on the results of year-long treatability studies conducted at OU 1 to determine the site-specific effectiveness of these technologies. An SVE field test was conducted at Chemical Disposal Pit 1 (CDP 1), where high concentrations of VOCs have been found in soil samples. Additionally, fuel hydrocarbons, semi-volatile compounds, dioxins, furans, and light non-aqueous phase liquid (LNAPL) have been detected beneath CDP 1. A bioventing field trial was conducted at Fire Training Area 2 (FTA 2), where non-chlorinated VOCs, semi-volatile organic compounds, and fuel hydrocarbons are present. Bioventing was tested at FTA 2 because the constituents detected in the soils at FTA 2 are typically biodegradable by naturally-occurring organisms. The general objectives of these treatability studies were to evaluate whether SVE and bioventing will meet the remedial action objectives (RAOs) for remediation of soil at OU 1. In the following paragraphs, the SVE study is summarized first, followed by the bioventing study.

SVE Study. For the SVE treatability study, one vapor extraction well and six soil vapor monitoring probes were installed at CDP 1, and one soil vapor monitoring probe was installed in a background (non-contaminated) location. The SVE treatability study at CDP 1 consisted of pre- and post-test soil sampling, a short-term air permeability test, five in-situ respiration tests, and a one-year long constant rate vapor extraction test. Initially, the first of five in-situ respiration tests was conducted followed by an air permeability test. The constant rate vapor extraction test was started following these two tests. Four additional in-situ respiration tests were conducted at approximately three-month intervals during the remainder of the SVE test.

The objective of the SVE treatability study was to evaluate whether SVE will meet the RAOs for soil: protect human health and the environment by removing VOCs and hydrocarbons from the subsurface, comply with ARARs, be implementable, reduce toxicity, mobility, or volume of contaminants, provide short-term and long-term effectiveness, and be cost effective. Based on the results of the study, SVE was not successful in removing a significant quantity of VOCs and hydrocarbons from the subsurface. The lack of success was probably due to the presence of free-phase LNAPL layer beneath the CDPs and residual LNAPL throughout the soil in this area. That is, compounds like TCE tend to remain solubilized in LNAPL versus volatilizing into air. Some TCE will volatilize into the soil gas, but this amount is negligible compared to the concentrations remaining in the LNAPL. Consequently, with the presence of residual

LNAPL in soil in the CDPs, the relative concentrations of TCE that would remain in soil would be much greater than those removed by vapor extraction. Further, residual LNAPL coats the grains in the subsurface, thereby preventing VOCs adsorbed to soil from volatilizing. Until the LNAPL is removed from the soil through some other means, SVE is not a likely candidate for remediation of soil at OU 1.

Based on the results of the treatability study at CDP 1, SVE is not feasible for remediating contaminated soil where free- or residual-phase LNAPL is present. However, other technologies currently being evaluated at OU 1 may prove effective in removing LNAPL or constituents of LNAPL from the saturated and unsaturated soil. Once the bulk of LNAPL is removed from the subsurface to the extent practicable using another technology, SVE may prove effective in removing any remaining VOCs from the soil. Both SVE and/or bioventing are potential technologies for use as a "polishing" step in the site-wide remedial strategy for OU 1. If SVE is used as a polishing step in the site-wide strategy, the data acquired during this treatability study can be used to design a full-scale SVE system.

Bioventing Study. The bioventing system includes a six Hp blower, six vent wells, and fifteen vapor monitoring probe locations. The bioventing treatability study at FTA 2 consisted of pre- and post-test soil sampling, a short-term air permeability test, five in-situ respiration tests, and a year-long bioventing test. The air permeability test was conducted first, followed by the first of five in-situ respiration tests. The year-long bioventing test was conducted after completing the initial in-situ respiration test. Four additional in-situ respiration tests were conducted at approximately three-month intervals during the long-term bioventing test.

The objective of the bioventing treatability study was to evaluate whether bioventing will meet the RAOs for soil: protect human health and the environment by removing biodegradable hydrocarbons from the subsurface, comply with ARARs, be implementable, reduce toxicity, mobility, or volume of contaminants, provide short-term and long-term effectiveness, and be cost effective. Based on the results of the system evaluation, bioventing was successful in removing/degrading a significant quantity (approximately 80 percent) of the hydrocarbons present in the subsurface. However, since many of the compounds present in soil at OU 1 are not biodegradable using this technique (e.g., TCE), this technology cannot be used by itself to achieve the remedial action objectives for soil at OU 1. Further, in areas where residual of free-phase LNAPL are present, the remediation time frame would likely be much greater than estimated above. This technology could be used to treat these areas once a significant fraction of the LNAPL is removed through use of an alternative technology.

Based on the results of the bioventing treatability study, bioventing was successful in reducing the levels of contaminants present in FTA 2 soil. The system that was constructed for the treatability study is adequate to remediate the entire FTA 2 site. However, the entire mass of contaminants at FTA 2 was not degraded during the year-long treatability study. If a cleanup level of 1,000 mg/kg is used as the target concentration for contaminants remaining in soil at FTA 2, the remediation time frame would be approximately 3-1/2 years. Montgomery Watson recommends continued operation of the bioventing system to achieve remediation of contaminated soil at FTA 2. Periodic monitoring should also be performed at the following frequency: monthly checks of the blower to ensure proper operation and maintenance; biannual in-situ respiration tests and monthly soil vapor monitoring to provide an indicator of when remediation of the site is complete. As described for SVE, once bulk LNAPL is removed from the subsurface to the extent practicable using another technology, bioventing should also be applicable as a polishing step in remediating soil in other areas of OU 1. If bioventing were to be applied at other areas of OU 1, data obtained during the treatability study at FTA 2 can be used to design a full-scale bioventing system for other areas of OU 1. An SVE system could be designed to alternate to a bioventing system once any volatile, non-biodegradable contaminants have been removed from the subsurface.