AIR FLOW MODELING

Parameter Evaluation Testing (PET) was conducted at shallow soil vapor extraction (SVE) wells SVE-02A, SVE-04A, SVE-06A, SVE-08A, and SVE-10A. SVE well and vapor probe locations are shown on **Figure 2** and the PET monitoring data is summarized in **Appendix A** of the *SVE Pilot Test Report* (November 2010).

Selection of the Model Data Set: A review of the PET data indicated that the SVE-06A test results were the most conservative for the air flow modeling. This location displayed a uniform and steady vacuum decay with distance, and the vacuum levels within the surrounding wellfield were at an average level as compared to the other tests (see **Figure F-1**). The data for SVE-10A showed a similar vacuum propagation trend as SVE-06A, but exhibited a slightly higher wellfield vacuum (presumably due to the higher wellhead air flow rate at this location). The SVE-06A data set was selected for modeling, because this data set would yield a slightly more conservative estimate of the Radius of Influence (ROI).

The data set for SVE-04A exhibited the highest vacuum propagation, but also suggested slightly higher vacuums at the further radii from the test well (refer to **Figure F-1**). The vacuum distribution pattern around this well would not have been suitable for modeling purposes (i.e., because of the increasing vacuum trend with distance). This field vacuum distribution suggests non-uniform flow patterns, and the potential for preferential airflow pathways around this well. The data from SVE-02A and SVE-08A were also not considered valid for air flow modeling purposes for similar reasons.

Air Flow Modeling Approach: The following assumptions were used to simulate the vacuum distribution and determine the intrinsic soil permeability of the shallow sandy fill/upper silty sand geologic layer using the MDFIT[1] modeling software:

[1] A two-dimensional analytical air flow model developed by Marley, Li and Droste (August 1994) based on the Baehr and Hault paper titled "Evaluation of Unsaturated Zone Air Permeability through Pneumatic Test" (Water Resources Research, Vol. 27, October 1991).

- SVE-06A was tested at two wellhead flow rates, 13.5 standard cubic feet per minute (scfm) and 20 scfm.
- Soils were assumed to be isotropic (homogenous in the horizontal and vertical directions).
- The asphalt cap was assumed to act as an upper confining layer.
- There was no lower confining layer.
- Depth to groundwater was 10.5 feet below ground surface (ft bgs).

Using the MDFIT model, the well field vacuum distribution was simulated under several different permeability conditions. The result that best matched the observed well field vacuum distribution data was as follows:

- The intrinsic soil permeability of the sandy fill/upper silty sand layer was estimated at 3.94×10^{-7} square centimeters (cm^2) in the horizontal (K_r) and vertical (K_z) directions.
- The effective surface cover permeability, K_c/B_c[2], was estimated at 3.58×10^{-10} cm^2.

The resulting comparison of the wellhead and well field vacuum distribution measurements and the simulated vacuum distribution under the above permeability conditions are presented on **Figure F-2**.

The permeability results were then used to develop full-scale design parameters including pore volume (PV) exchange rates and ROI at two flow rates (25 scfm and 30 scfm). The PV exchange rates and corresponding ROI results for both flow scenarios are presented on **Figure F-3**. A discussion of the PV exchange rates and ROI are provided in **Section 5.0** of the *SVE Pilot Test Report*.

[2] The computer model assumes that the surface cover is 10 cm thick (represented by B_c), and the overall permeability of this surface cover is a function of its thickness (i.e., K_c/B_c).

FIGURES

Figure F-1
Parameter Evaluation Test - Vacuum Distribution
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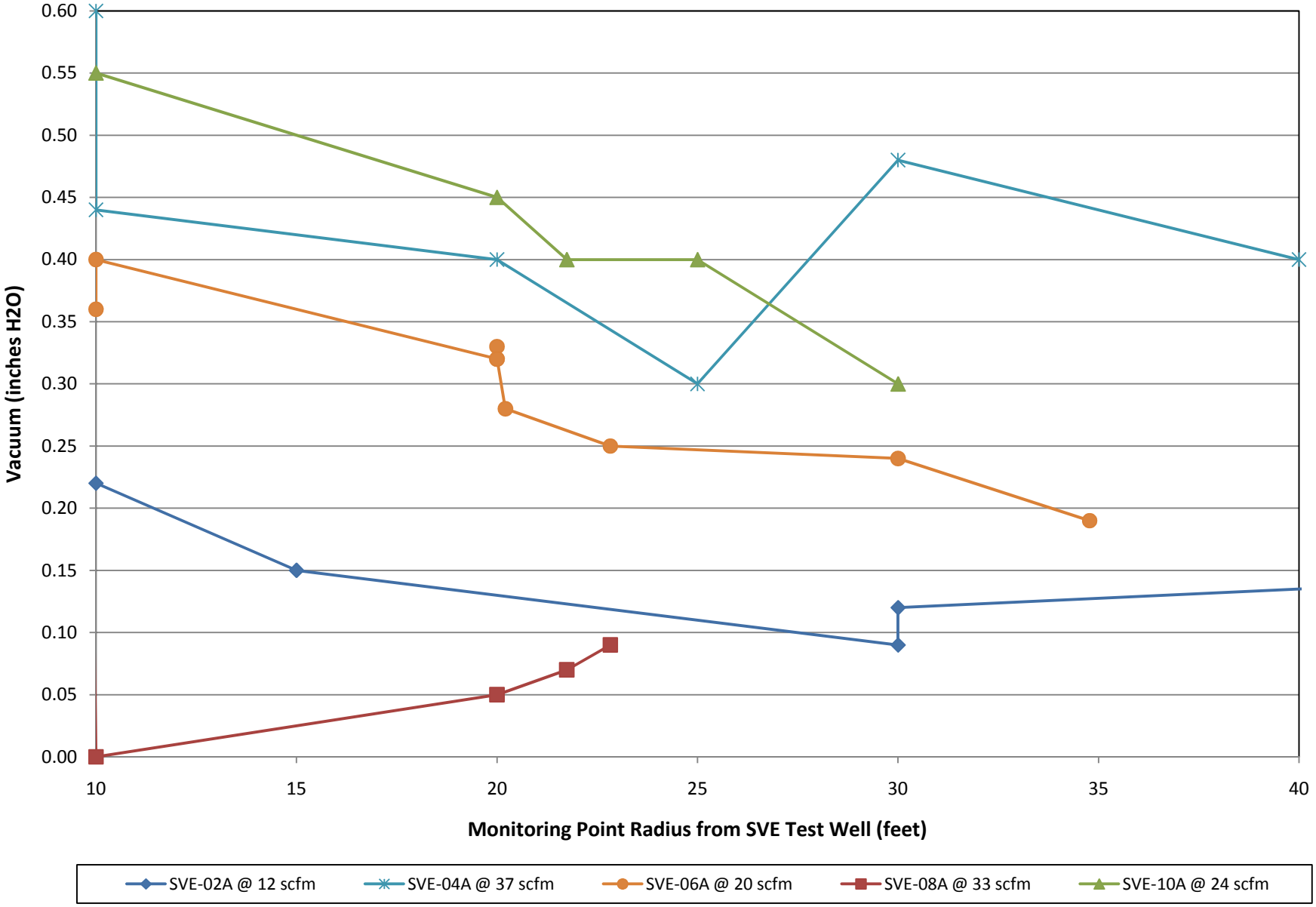

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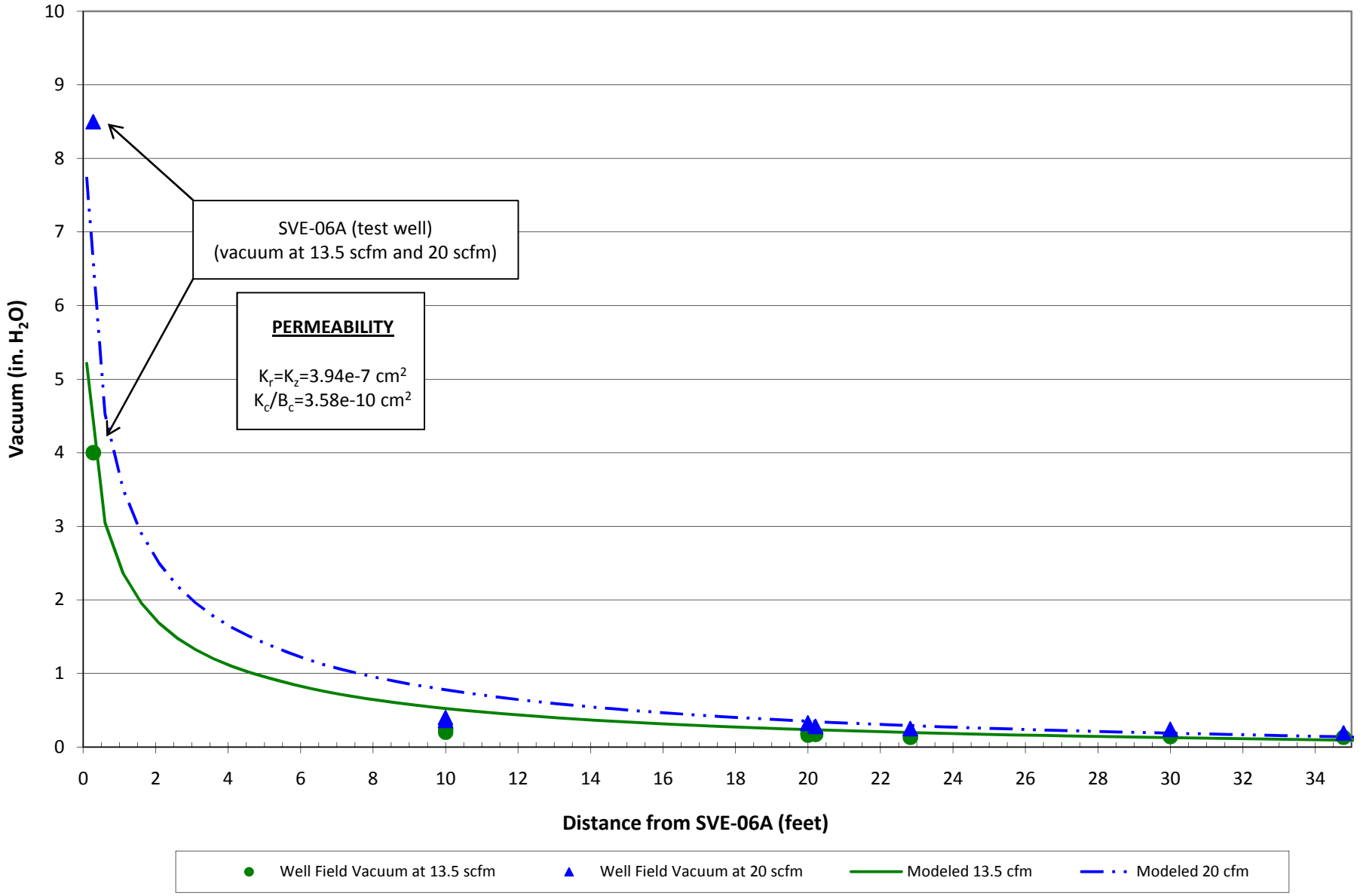
Figure F-2
Air Flow Modeling - SVE-06A Simulation Summary
SVE Pilot Test Report
W.G. Krummrich Facility, Sauget, Illinois



SVE = soil vapor extraction
scfm = standard cubic feet per minute
K_r = horizontal intrinsic permeability
Kc = surface confining unit intrinsic permeability

in. H_2O = inches of water
cm^2 = square centimeters
Kz = vertical intrinsic soil permeability
Bc = thickness of confining unit (default is 10 cm).

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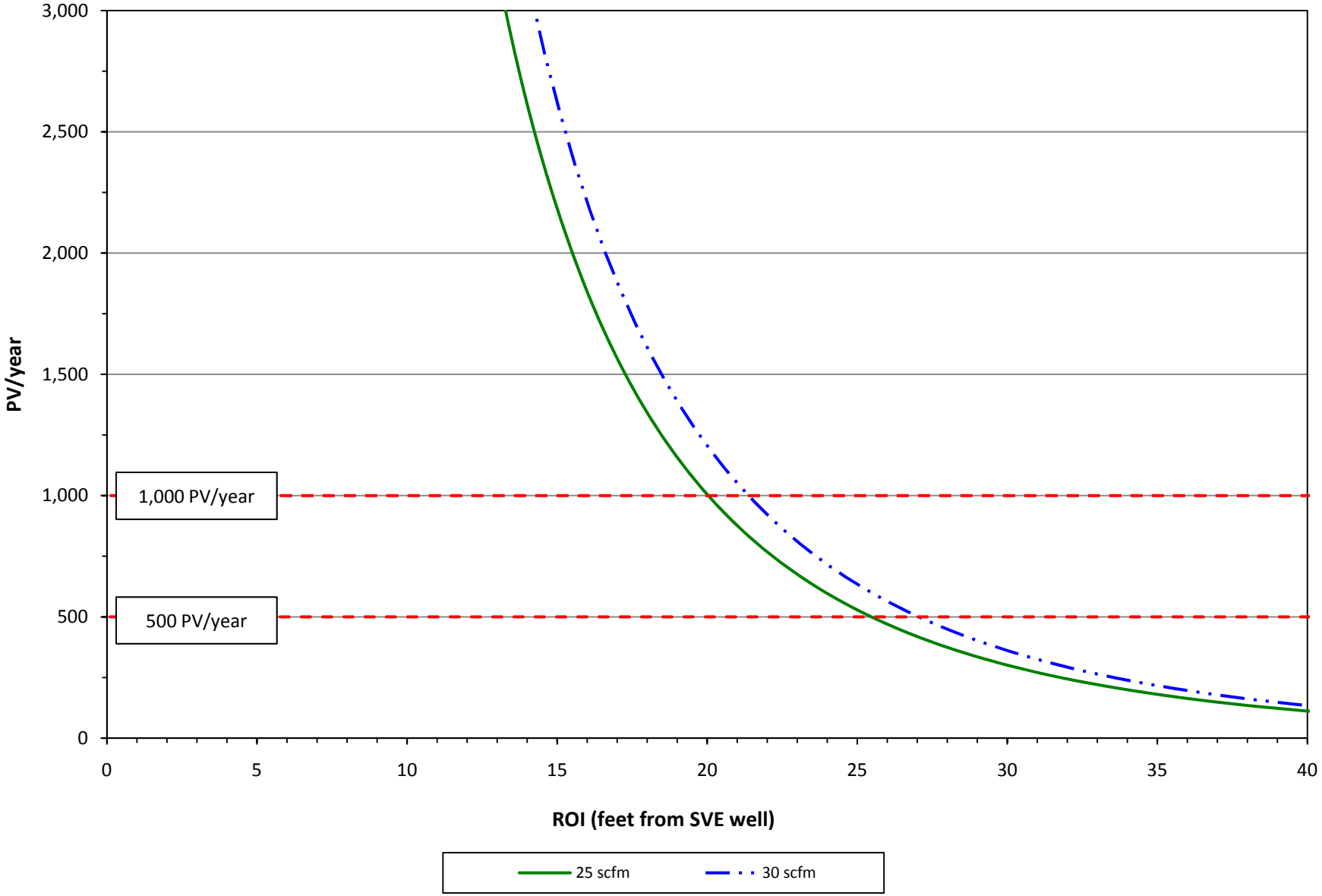
Figure F-3
Air Flow Modeling - Pore Volume Exchanges Per Year
SVE Pilot Test Report
W.G. Krummrich Facility, Sauget, Illinois



PV/year = pore volume exchanges per year
scfm = standard cubic feet per minute
ROI = radius of influence

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