

## EXECUTIVE SUMMARY

This report summarizes the results of a laboratory study designed to examine the relationship between the sorption/desorption behavior of trichloroethylene (TCE) associated with three "stratigraphic soil packages" (designated Package A, Package B, and Package C) collected from Operable Unit 5 (OU 5) at Hill Air Force Base, Utah (HAFB) and its bioavailability to earthworms (*Lumbricus terrestris*). A fourth soil package collected from the OU 4 site was also used for comparison.

Two previous studies conducted to evaluate TCE sorption/desorption processes and determine site specific soil sorption/desorption coefficients for modeling the fate and transport of TCE at HAFB Operable Units OU 4 and OU 5, showed the existence of a small fraction of TCE that was apparently "irreversibly bound" to the soil. Operationally, this "irreversibly" bound fraction was defined to be any  $^{14}\text{C}$  that remained in the soil after a methanol extraction step. It was quantified by combusting the soil and converting any non-extractable  $^{14}\text{C}$  to  $^{14}\text{CO}_2$ . The evolved  $^{14}\text{CO}_2$  was trapped and analyzed by liquid scintillation counting. The existence of an "irreversibly bound" fraction suggests that the soil may act as a sink for some of the dissolved TCE moving within a ground water plume. Depending on the magnitude and permanence of this removal mechanism, this process could have important implications in predicting the extent and rate of ground water plume movement and in the natural attenuation of TCE. Thus, the focus of this study was to determine if this "irreversibly bound" TCE (or  $^{14}\text{C}$ ) is bioavailable to earthworms.

Four soils (OU 5 A, B C and OU 4 B) and ground water (OU 5 or OU 4) were spiked with TCE and equilibrated for 24 or 288 hours in sealed glass containers following the protocol developed in the previous sorption/desorption studies. Slight modifications of the sorption protocol (i.e. larger containers, larger amounts of soil and water), were made to accommodate the addition of worms. Triplicate microcosms were prepared to examine earthworm bioavailability with respect to four soil types and five soil treatments: 24-hour sorption, 24-hour sorption followed by a six step sequential desorption procedure; 288-hour sorption; 288-hour sorption/desorption; and 24-hour sorption/desorption followed by methanol extraction. Control microcosms included non-spiked soil blanks with and without worms, and soils without worms spiked with TCE. Worms were also exposed to TCE spiked soils that had been through the sorption/desorption procedure and were extracted with methanol. Over 160 microcosms were used in the study.

The worms were added to the soils after the soils were separated from the liquid phase at the end of the sorption, desorption, or methanol extraction procedures. Following a 14-day exposure period, earthworms were removed from the soils, rinsed with clean water, and placed on wetted filter paper for 24 hours to allow their digestive system to clear. At the end of the 24-hour period, each worm and the associated soil

were analyzed for  $^{14}\text{C}$  by liquid scintillation counting following extraction and/or combustion.

For all soils, and in both the sorption and desorption experiments, the  $^{14}\text{C}$  concentrations in the earthworm tissues were proportional to the methanol extractable  $^{14}\text{C}$  concentrations in the soils to which they were exposed (i.e. the higher the methanol extractable soil concentrations, the higher the worm concentrations). There was no significant effect of sorption time on worm concentrations and the concentrations of  $^{14}\text{C}$  in the worms exposed to the soil after the six-step desorption procedure were less than half found in worms exposed after the sorption procedure. No  $^{14}\text{C}$  was found in worms exposed to soils that had been methanol extracted subsequent to the sorption/desorption procedure, even though  $^{14}\text{C}$  was detected in the soils by combustion analysis. This builds upon information generated in the previous sorption/desorption studies to indicate that the non-extractable or combustible fraction of  $^{14}\text{C}$  in the soil is “irreversible bound” and is biologically unavailable. This further suggests that the soil can act as a permanent reservoir or sink for some fraction of the dissolved TCE within a ground water plume and has significant implications in contaminant transport predictions.