

EXECUTIVE SUMMARY

Following the conclusion of the remedial investigation field efforts (October, 1994), a groundwater long term monitoring (LTM) program was implemented at the Tooele Army Rail Shop (TARS) and Bamberger Pond, Operable Unit 5 (OU 5), Hill Air Force Base, Utah (Hill AFB). Since inception of the program in the fall of 1994, the main objective has been to track the nature and extent of a trichloroethene (TCE) groundwater plume which extends from the TARS to approximately one mile west into the City of Clinton, Utah. Another equally important objective of the OU 5 groundwater monitoring program has been to gather additional data on contaminants of concern (COCs) identified in OU 5 groundwater. In 1996, 1997, and 1998 groundwater data were also collected for the purpose of evaluating intrinsic remediation of the TCE plume at OU 5. Prior to 1998, LTM data were collected annually at TARS and semiannually at Bamberger Pond. In 1998 the sampling frequency was increased to quarterly to determine if seasonal fluctuations in the water table affect TCE and arsenic concentrations. To date, a total of 12 distinct groundwater sampling events have been conducted at OU 5 as part of the monitoring program [October 1994 (Round 1) through December 1998 (Round 12)].

A subsurface investigation is currently underway to delineate further the depth and area of groundwater contamination at OU 5 and OU 9. Data related to the on-going investigation are not included in this report and will be submitted in a separate report upon completion of the investigation, which is expected to be completed in the summer of 2000. The plume maps, conclusions, and recommendations presented in this report are representative of best available data at the time this report was prepared.

Groundwater data presented in this report were generated through sampling events conducted in March 1998 (Round 9), June 1998
December 1999

(Round 10), September 1998 (Round 11), and December 1998 (Round 12). In addition to the quarterly sampling events at the TARS and Bamberger Pond, a select group of monitor wells were sampled at Bamberger Pond during extreme wet and dry events. The objective was to evaluate the geochemical processes that are active in the pond and shallow groundwater formation. Six rounds of samples were collected within three days of various rain-events and four rounds of samples were collected during extended dry periods, i.e., no precipitation for at least five days. The samples were collected between April 1998 and February 1999.

Groundwater data from Round 11 (fall 1998) were used to update the existing TCE plume map at the TARS. Comparison of the updated plume map with the fall 1997 TCE plume map indicates slight changes in the overall shape or dimensions of the TCE plume. With the exception of two rounds of sampling at U5-154 and three rounds at U5-127 during 1998, a review of TCE groundwater data from October 1993 through September 1998 revealed an order of magnitude decrease in TCE concentrations within the suspected source area. Overall, the order of magnitude decrease in TCE concentrations over the previous five years within the suspected source area suggests a net reduction of mass loading of TCE to the aquifer. The recent increases in TCE concentrations measured at U5-154 and U5-127 during the 1998 sampling events may indicate that some "pockets" of contamination linger near the rail shop and are sporadically being released to the aquifer. Section 5 contains recommendations regarding evaluation of the suspected source (rail shop area).

Further down-gradient from the source region, the TCE concentrations have remained nearly constant, although data indicate that the plume may be slightly increasing in areal extent. Increases in TCE concentrations were observed

in U5-147, U5-161, and U5-163 during the September 1998 sample event. The low concentration area in the northwest corner of the plume has been separated from the main body of the plume.

As part of the 1998 LTM program, a mass balance was conducted to evaluate the effects of active remediation and natural attenuation on the fate and transport of TCE in the OU 5 plume. The mass balance was conducted for four different sampling events, representing time frames before and after implementation of active remediation. The following conclusions can be made based on the mass balance results:

- TCE mass loss through active remediation and/or natural attenuation is occurring within the OU 5 aquifer; and
- Active remediation (Phase I and Phase II) appears to result in mass removals that are small (approximately 2.5 %) compared to the total mass contained within the aquifer; however, the systems have only been operating for two years.

The majority of the apparent mass changes may be due to the movement of a high concentration release of TCE in the groundwater between monitor wells. Thus, apparent changes in TCE mass may not be indicative of actual TCE mass in the OU 5 plume.

The TCE degradation by-products, namely cis-dichloroethene (cis-DCE) and trans-dichloroethene (trans-DCE) were detected within the TCE plume at the TARS and have been detected since the beginning of the long-term monitoring program. Cis-DCE concentrations qualitatively mirror TCE concentrations at OU 5; higher concentrations of cis-DCE are found in regions with the highest TCE concentrations. The presence of these compounds may indicate microbial degradation

of the TCE plume at OU 5 by various metabolic pathways. As expected, cis-DCE concentrations are higher than TCE concentrations in the direct vicinity of the aeration curtain. This is likely the result of enhanced degradation of TCE due to residual biopolymer slurry that remained for 12 months in the aeration curtain before the system was started. The slurry likely served as a carbon substrate for bacteria to metabolize, and under anaerobic conditions, TCE served as an electron acceptor.

Specific parameters were recorded during the monitoring period (March 1998 through February 1999) that appear to support the hypothesis that the TCE plume is being reductively dehalogenated in some portions of the plume at TARS. Review of the spatial relationship of these parameters with the TCE plume indicates some locations with depressed dissolved oxygen concentrations (<1 mg/L) within the plume, allowing for anaerobic conditions to exist and the potential for reductive dehalogenation to occur. The presence of total organic carbon in groundwater provides supporting evidence that primary substrates and degradation byproducts exist, allowing multiple metabolic pathways for degradation of TCE.

Several other volatile organic compounds (VOCs) which also are COCs were detected in low concentrations compared to TCE during the monitoring period. These included 1,1,1-trichloroethane (TCA), chloroform, and 1,1-dichloroethene (DCE). Chloroform was the only COC detected below its maximum contaminant level (MCL). TCA exceeded its MCL in U5-154 during the third quarter and DCE exceeded its MCL in U5-127 during the first quarter, and in U5-154 during the second and third quarters. Other VOCs detected within the TCE plume above their MCLs include carbon tetrachloride, tetrachloroethene (PCE), and vinyl chloride. Carbon tetrachloride was detected approximately one mile west of the suspected

TCE source area at a concentration of 5.82 µg/L (U5-165). PCE was also detected approximately one mile west of the suspected TCE source area at an average concentration for the monitoring period of 332.5 µg/L (U5-141). PCE has consistently been present in U5-141 since the monitoring program began. In order to address the presence of PCE, it is recommended that the off-base investigation at OU9 include this area as part of the investigation. Vinyl chloride (MCL of 2 ug/L) was detected in U5-132 and U5-137 at concentrations of 2.1 and 2.44 ug/L, respectively. The occurrence of vinyl chloride is most likely due to reductive dehalogenation of TCE in the presence of residual biopolymer slurry that was used in the construction of the aeration curtain, located approximately 10 feet east of U5-132. The 1997 laboratory results indicated the presence of vinyl chloride at a level of 12 ug/L in U5-132. Previous sample results for U5-137 have not indicated the presence vinyl chloride. Prior to 1997, vinyl chloride had not been detected in the groundwater at OU 5. Refer to Section 5 of this report for recommendations regarding on-going groundwater monitoring at the TARS.

Arsenic, identified in groundwater at Bamberger Pond, was detected in all of the wells during the monitoring period. The data indicated the presence of arsenic at a concentration exceeding its MCL (50 ug/L) in U5-111, U5-112, U5-113, U5-180, U5-181, U5-182, U5-183, U5-15, U5-186, and U5-195. The maximum arsenic level was measured during the fourth quarter in U5-181 at a concentration of 146 ug/L. Analysis of samples collected from the Bamberger Pond wells in 1996, 1997, and 1998 indicate that there may be a seasonal relationship with arsenic concentrations at Bamberger Pond. A study was conducted to determine the variation of redox conditions, and arsenic concentration changes with distance from Bamberger Pond. Results from the study were presented in the report titled *Fate and Analysis of Arsenic and Manganese in the Vicinity of Bamberger Pond, Draft Final, December 1999*. It is recommended that annual sampling be continued at Bamberger Pond pending review of the modeling results by the regulators. Refer to Section 5 of this report for additional recommendations regarding on-going groundwater monitoring at Bamberger Pond.