EXECUTIVE SUMMARY

This report presents a conceptual model for the fate and transport of contaminants in groundwater at Operable Units (OUs) 5 and 12, Hill Air Force Base (Hill AFB), Utah. OUs 5 and 12 are two of 12 operable units being investigated at Hill AFB, which was placed on the National Priorities List (NPL), or "Superfund Program," in July of 1987. OU 5 comprises soil and groundwater beneath the Tooele Army Rail Shop (TARS), Zone 16 Complex, and off Base beneath the cities of Sunset, Clinton, and Roy, where contaminated groundwater has migrated from on-Base sources. Bamberger Pond was formerly part of OU 5, however, contamination detected there was found to be naturally occurring. Bamberger Pond was removed from further IRP investigations and accepted by the regulatory agencies as a closed CERCLA site requiring no further action. Investigation of the TARS area and associated contamination beneath the cities of Sunset and Clinton proceeded through the Remedial Investigation (RI) process and an RI report was completed in 1995 (Radian, 1995).

New information gathered since the original RI has shown that additional contaminant sources are located in OU 5 in Zone 16 to the east of the TARS area. Contaminants in groundwater from the Zone 16 area were found to be commingled with contamination from the TARS area. For this reason, the RI for OU 5 was reopened in 1999. Since then, additional contamination has been found beneath the City of Roy, and OU 12 was established as its own operable unit in 2001. OU 12 comprises soil and groundwater beneath the former Wastewater Treatment Plant and the area immediately to the north-northwest, as well as off-Base areas beneath the cities of Sunset and Roy, where contaminated groundwater has migrated from on-Base sources.

Remedial investigation work at OU 5 performed by Radian and discussed in the RI (Radian, 1995) includes a source determination/records search, passive soil gas survey, Cone Penetration Testing (CPT) investigations, drilling and soil sampling, monitoring well installation and groundwater sampling, in-situ permeability tests, a field drain survey, indoor air monitoring, and a video camera survey of drain lines. Subsequent investigation tasks performed at OUs 5 and 12 by MWH and other contractors as part of the revised RI include monitoring well installation and groundwater sampling, surface-water sampling, CPT and direct-push groundwater sampling, field drain sampling, aquifer testing, in-situ permeability testing, soil sampling, water-level monitoring, residential air and water sampling, historic site review, low-flow sampling study, active soil-gas survey, residential survey, field drain survey, trichloroethene (TCE) batch sorption study, edible plant study, enhanced biodegradation study, groundwater tracer study, and groundwater flow and contaminant transport modeling. The field and analytical results associated with these programs and surveys have been documented in various site investigation and data summary reports, and are interpreted and presented in this report.

The subsurface stratigraphy in OUs 5 and 12 consists of interbedded and laterally discontinuous silty sands, sandy silts, silt, and clay. In general, the shallow unconfined aquifer consists of silty fine-grained sand interbedded with silt. The silt content increases with depth and often grades into a transition zone, which is predominantly silt with fine sand layers. A low-permeability clayey silt unit underlies the OU 5 and 12 areas.

Contaminants have migrated from on-Base sources to off-Base areas beneath the cities of Sunset, Clinton, and Roy. After entering the shallow aquifer, contaminants migrate both vertically and horizontally through the higher permeability sand and silty sand units that constitute the shallow aquifer stratigraphy. Vertical contaminant migration is impeded by a low-permeability unit, which appears to be laterally continuous along the lengths of the contaminant plumes at OUs 5 and 12. Several hundred feet of clay and silt separate the shallow unconfined aquifer from deeper confined water supply aquifers.

Several known source areas are present within OUs 5 and 12. The principal source areas that may have impacted groundwater are the TARS and the Zone 16 areas at OU 5 and the former Wastewater Treatment Plant and the debris field to the north-northwest at OU 12. Other potential sources lie within the Missile Assembly, Maintenance, and Storage (MAMS)-II area.

Volatile organic compounds (VOCs) are the main contaminants of concern in groundwater at OUs 5 and 12. At OU 5, VOCs of concern detected in the groundwater include TCE, 1,1,1-trichloroethane (1,1,1-TCA), tetrachloroethene (PCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), vinyl chloride, and carbon tetrachloride. At OU 12, VOCs of concern detected in the groundwater include TCE, PCE, and carbon tetrachloride. Semi-volatile organic compounds (SVOCs), in particular dimethyl phthalate, have been detected in groundwater at both OUs 5 and 12 and may be indicative of other contaminants such as explosives. Metals and inorganic contaminants also are present in groundwater of OUs 5 and 12. At OU 5, metals in groundwater include arsenic, chromium, nickel, lead, antimony, selenium, and thallium; and inorganic contaminants include nitrate and perchlorate. The primary metal of concern at OU 5 was originally arsenic, but this compound has since been determined to be naturally occurring. At OU 12, metals in groundwater include arsenic and antimony. However, metals at OUs 5 and 12 have not been detected consistently and do not appear to be a result of contamination at Hill AFB.

TCE is the most widespread groundwater contaminant at OUs 5 and 12. There are three distinct plumes of TCE contamination above the maximum contaminant level (MCL) of 5 µg/l that have originated from various sources. These plumes include the TARS plume and the Zone 16 plume at OU 5, and the OU 12 plume. The TARS, Zone 16, and OU 12 TCE plumes are approximately 5,000, 9,000, and 8,000 feet in length, respectively. Based on the plumes as currently defined, TCE contamination of 5 µg/l or greater underlie a land surface area of approximately 350 acres in OU 5 and 100 acres in OU 12. The highest TCE concentrations observed in groundwater are 2,610 µg/l at OU 5 and 1,300 µg/l at OU 12.

At OU 5, Hill AFB has implemented two early remedial actions and has proposed a third early action at OU 5 in an effort to reduce migration of contaminants. The two existing remedial actions consist of the Phase I Aeration Curtain and the Phase II Groundwater Extraction System (GES). The proposed containment system (the third early action) will consist of an extraction trench and slurry wall to limit additional contamination migration beneath the City of Clinton. These systems are planned to be in operation at least until the final remedy for OU 5 is implemented.

At OU 12, a hydraulic containment system has been proposed near the Base boundary to contain contaminated groundwater. This system is planned to be in operation in early 2003.

Factors that have influenced contaminant migration include stratigraphic controls and hydraulic gradients. Chlorinated solvents, primarily TCE, have migrated west and northwest from on-Base source areas to off-Base areas in Sunset, Clinton, and Roy. Migration of contaminants occurs primarily through sand units (preferential pathways) where groundwater advective velocities are greatest. Dispersion causes spreading of the contaminants as they migrate away from source areas. Retardation slows the migration of contaminants relative to advective velocities and to each other. Due to the low organic carbon content of the aquifer material (particularly sand) at OUs 5 and 12, retardation of VOCs is minimal. Chemical and geochemical evidence suggests that biodegradation of TCE is occurring via reductive dehalogenation in limited areas; however the rate at which it is occurring is very slow, due to the carbon limiting conditions found in the shallow aquifer. Biotransformation of carbon tetrachloride also appears to be occurring at OUs 5 and 12.

Based on the data interpretation presented in this conceptual model report, remaining data gaps have been identified. These gaps and recommendations for additional investigation to address them are included in the final section of the report.