EXECUTIVE SUMMARY

ABSTRACT

During July 1988, the U.S. Geological Survey began a Remedial Investigation (RI) of contamination at OU 4. The objectives of the RI were to: (1) characterize the extent of contamination, (2) determine the fate of contaminants, and (3) develop a baseline risk assessment for the potential exposure pathways through soil, ground water and air. James M. Montgomery, Consulting Engineers, Inc. (JMM) began risk assessment studies in June 1989 working under a contract with Hill AFB.

The landfills at OU 4 are located along the top of a steep, terraced, north-facing escarpment that separates the Weber Delta from the Weber River valley. Landfill 1 covers about 5 acres and is located in the northeastern part of Hill AFB and landfill 2 is located about 900 feet northwest of landfill 1.

Suspected dump sites, referred to collectively as the north gate dump sites, are located along Foulois Drive southeast of the north gate and along the Hill AFB boundary northeast of Foulois Drive. There is no documentation of dumping at these sites but it has been alleged that drums containing solvents and other material were disposed during unauthorized dumping episodes at various sites along Perimeter Road (Radian Corp., 1990, p. 1-4).

Hill AFB overlies three aquifers. Two of the aquifers, the Sunset and the Delta, are productive sources of good quality water and are used by both Hill AFB and surrounding communities. Water in these aquifers generally is confined and occurs at depths of 300 and 600 ft below the landfills. Shallow ground water, in which contamination has been detected, overlies the Sunset and Delta aquifers.

During 1986-90, 13 volatile organic and 2 inorganic contaminants were detected in water from monitoring wells and seeps in the area of OU 4. TCE was detected most frequently and in the highest concentrations.

TCE exceeded the primary MCL in water from 20 monitoring wells and 3 seeps; benzene exceeded the MCL in 1 well; and 1,2-DCA, nitrate, and sulfate did not exceed the MCLs in water from any of the wells or seeps. No semivolatile compounds, chlorinated herbicides, or petroleum hydrocarbons were detected in the samples. Boron, nickel, selenium, iron, and manganese were the only trace elements detected.

The southwesternmost (upgradient) occurrence of TCE noted during soil-gas surveys or in chemical analyses of water samples is immediately south of Foulois Drive at the north gate dump sites. The largest concentration of TCE outside the boundary extends north from the north gate dump site near well LF1GS6. A narrow tongue of the plume containing between 1,000 and 5,000 µg/L extends about 1,000 ft from well LF1GS6, downgradient to South Weber Drive.

Inside the boundary of Hill AFB, the maximum concentration of TCE in ground water was about 11,000 µg/L, and outside the boundary the maximum was 2,800 µg/L. Inside the boundary of Hill AFB the contaminated area is about 17 acres, and outside the boundary, it is about 40 acres.

About 82 percent of the TCE in the water fraction of the subsurface is present in water exceeding 1,000 µg/L, and this represents about 27 percent of the total volume of contaminated water. The total weight of the TCE in the contaminated water is about 990 lbs, or about 80 gallons of pure TCE product. If equilibrium conditions exist, then 170 gallons of TCE are sorbed to the contaminated soil fraction of the subsurface, for a total amount of TCE in the subsurface of 250 gallons.

There are currently (October 1990) no complete pathways of exposure through ground water, since no one is known to be using water from the shallow ground-water system at this time.

INTRODUCTION

The U.S. Air Force (USAF), in performing its primary mission of defense of the United States, has frequently engaged in operations that deal with toxic and hazardous materials. The Department of Defense (DOD) has implemented the Installation Restoration Program (IRP) to identify the locations and contents of past toxic and hazardous material disposal and spill sites, and to eliminate the hazards to public health in an environmentally responsible manner. The IRP is the basis for response actions on USAF installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Under the IRP, contamination resulting from past waste disposal is now being investigated at Hill AFB. The location of Operable Unit 4 (OU 4), one of the sites under the IRP and the subject of this report, is shown in figure ES-1.

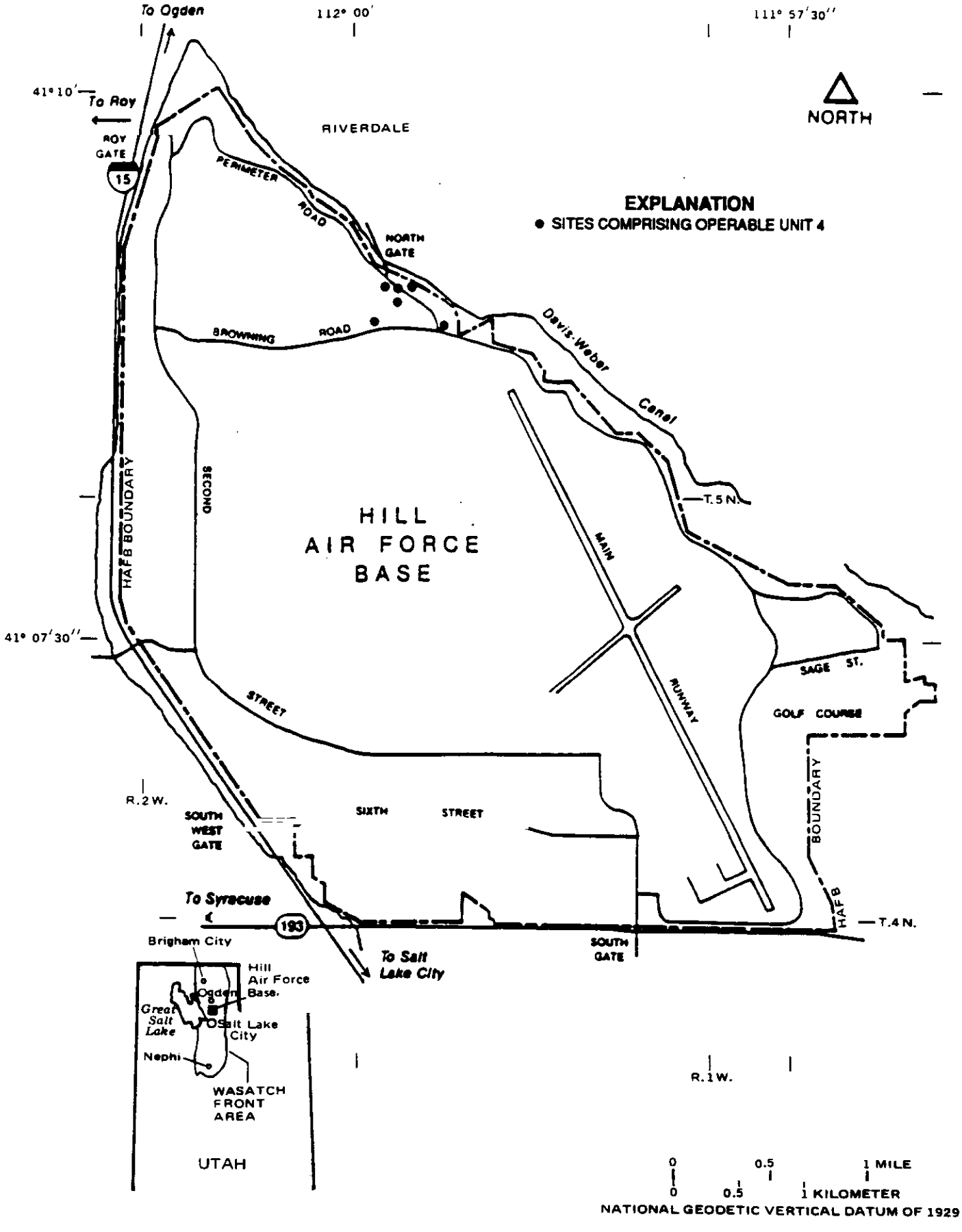

Figure ES-1.--Location of Operable Unit 4 on Hill AFB. (Modified from Radian Corp., 1988, fig. 1.6-1.)

PURPOSE AND SCOPE OF THE INVESTIGATION

A Preliminary Assessment, formerly known as Phase I, the Records Search, was conducted by Engineering Science during 1981 (Engineering Science, 1982). This study provided a history of landfill operations at Hill AFB, and indicated that organic chemicals had not been disposed in landfills 1 and 2, which make up part of the area that was later consolidated and identified as OU 4.

A Site Inspection, formerly known as Phase II, the Confirmation/Quantification Stage, was conducted by Radian Corp. from November 1985 to November 1987 (Radian Corp., 1988). Two monitoring wells were constructed downgradient from landfills 1 and 2, and one monitoring well was constructed upgradient from the landfills. Laboratory chemical analyses were performed on water samples collected from the wells, and trichloroethylene (TCE) was detected in both of the downgradient wells, but was not detected in the upgradient well. The concentration of TCE in water from the well downgradient of landfill 1 was 4,185 µg/L, while the concentration in water from the well downgradient of landfill 2 was 6.08 µg/L. The detection of TCE indicated that further investigation was necessary.

In September 1987, the U.S. Geological Survey began an investigation at OU 4. The primary objectives were to complete the scoping activities and characterize the site. Scoping activities completed were: (1) collection of existing data about the site, (2) preliminary identification of site boundaries, (3) identification of potential Applicable or Relevant and Appropriate Requirements (ARARs), and (4) preparation of the Work Plan, Quality-Assurance Plan, and Health and Safety Plan.

During July 1988, the U.S. Geological Survey began a Remedial Investigation (RI) of contamination at OU 4. The objectives of the RI were to: (1) characterize the extent of contamination, (2) determine the fate of contaminants, and (3) develop a baseline risk assessment for the potential exposure pathways through soil, ground water and air.

Site-characterization activities completed as part of the RI were: (1) definition of the landfill boundaries, (2) determination of vertical and horizontal hydraulic gradients, (3) determination of physical and hydrologic characteristics of soils and sedimentary units, (4) determination of extent of contamination, (5) determination of potential contaminant source areas, (6) determination of contaminant concentrations, and (7) identification of unidentified compounds reported in previous reports (Radian Corp., 1988, p. 4-244).

James M. Montgomery, Consulting Engineers, Inc. (JMM) began risk assessment studies in June 1989 working under a contract with Hill AFB. Using data gathered during the site characterization, JMM estimated current and future health risks posed by OU 4.

ENVIRONMENTAL SETTING AND SITE DESCRIPTION

Hill AFB is located in northern Utah about 25 mi north of Salt Lake City and about 5 mi south of Ogden (fig. ES-1). Hill AFB covers about 6,700 acres and is located on the Weber Delta, a terrace about 300 ft above the valley floor in Weber and Davis Counties.

The landfills at OU 4 are located along the top of a steep, terraced, north-facing escarpment that separates the Weber Delta from the Weber River valley (fig. ES-2). The Weber Delta consists of unconsolidated clay, silt, sand, and gravel.

Landfill 1 covers about 5 acres and is located in the northeastern part of Hill AFB. Mr. Joseph Fisher, former foreman of refuse collection, recalled the landfill was about 25 feet deep. Available records indicate few, if any, chemicals were disposed in the landfill. Landfill 1 may have received waste from the Ogden Arsenal, which could have included waste oils and solvents from their vehicle-maintenance facility (Radian Corp, 1988, p. 1-23).

Landfill 2 is located about 900 feet northwest of landfill 1. Landfill 2 was operated between 1963 and 1965; general waste was dumped down the side of the hill and periodically burned. There are no records of chemicals being disposed at this site.

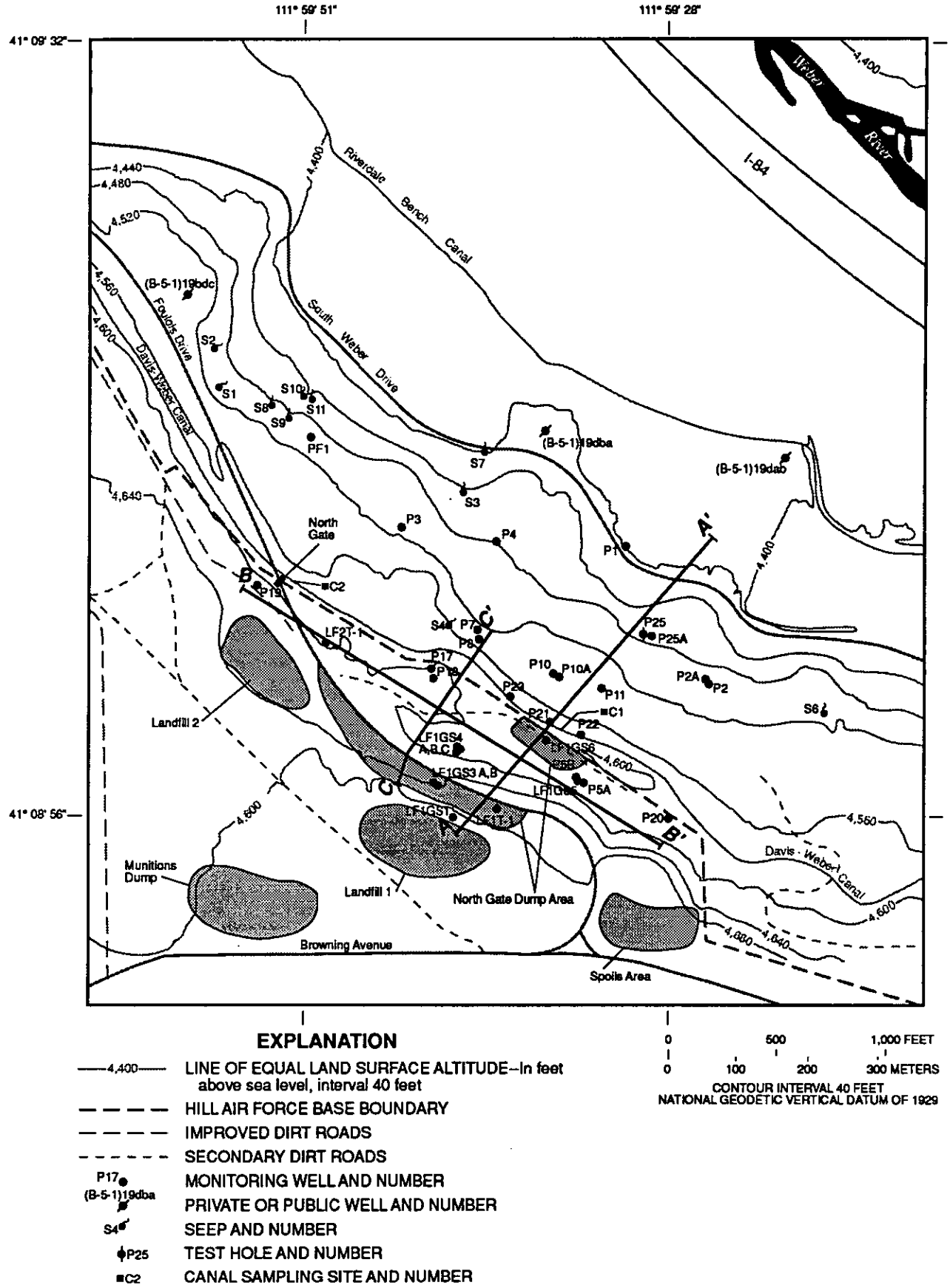

Figure ES-2.--Location of data collection sites and sections near Operable unit 4.

The spoils area is located about 700 to 1,000 feet east of landfill 1 and at the east corner of the intersection of Browning Avenue and Foulois Drive. The spoils area has operated since 1972. Only solid waste is known to have been dumped at the site but the potential exists that some of the materials may have been contaminated with fuels from minor spills (Ed Heyse, oral commun., March 1991).

Suspected dump sites, referred to collectively as the north gate dump sites, are located along Foulois Drive southeast of the north gate and along the Hill AFB boundary northeast of Foulois Drive. There is no documentation of dumping at these sites but it has been alleged that drums containing solvents and other material were disposed during unauthorized dumping episodes at various sites along Perimeter Road (Radian Corp., 1990, p. 1-4). Perimeter Road intersects Foulois Drive near the north gate.

The munitions dump was located about 400 feet southwest of landfill 1 and was operated by the Ogden Arsenal as an above-ground storage area for munitions during World War II. Spent shell casings were observed in the area during the site classification activities at OU 4.

FIELD PROGRAM

The U.S. Geological Survey conducted seven major field activities at Hill AFB as part of the RI at OU 4. These activities included: (1) an electromagnetic (EM) geophysical survey, (2) a borehole geophysical survey, (3) soil-gas surveys, (4) installation of 29 monitoring wells, (5) collection and analysis of soil and ground-water samples, (6) aquifer tests and (7) regular measurement of water levels in monitoring wells. The field activities began in February 1988 and ended in May 1990.

SUMMARY OF RESULTS

Hill AFB overlies three aquifers (fig. ES-3). Two of the aquifers, the Sunset and the Delta, are productive sources of good quality water and are used by both Hill AFB and surrounding communities. Water in these aquifers generally is confined and occurs at depths of 300 and 600 ft below the landfills. Shallow ground water, in which contamination has been detected, overlies the Sunset and Delta aquifers.

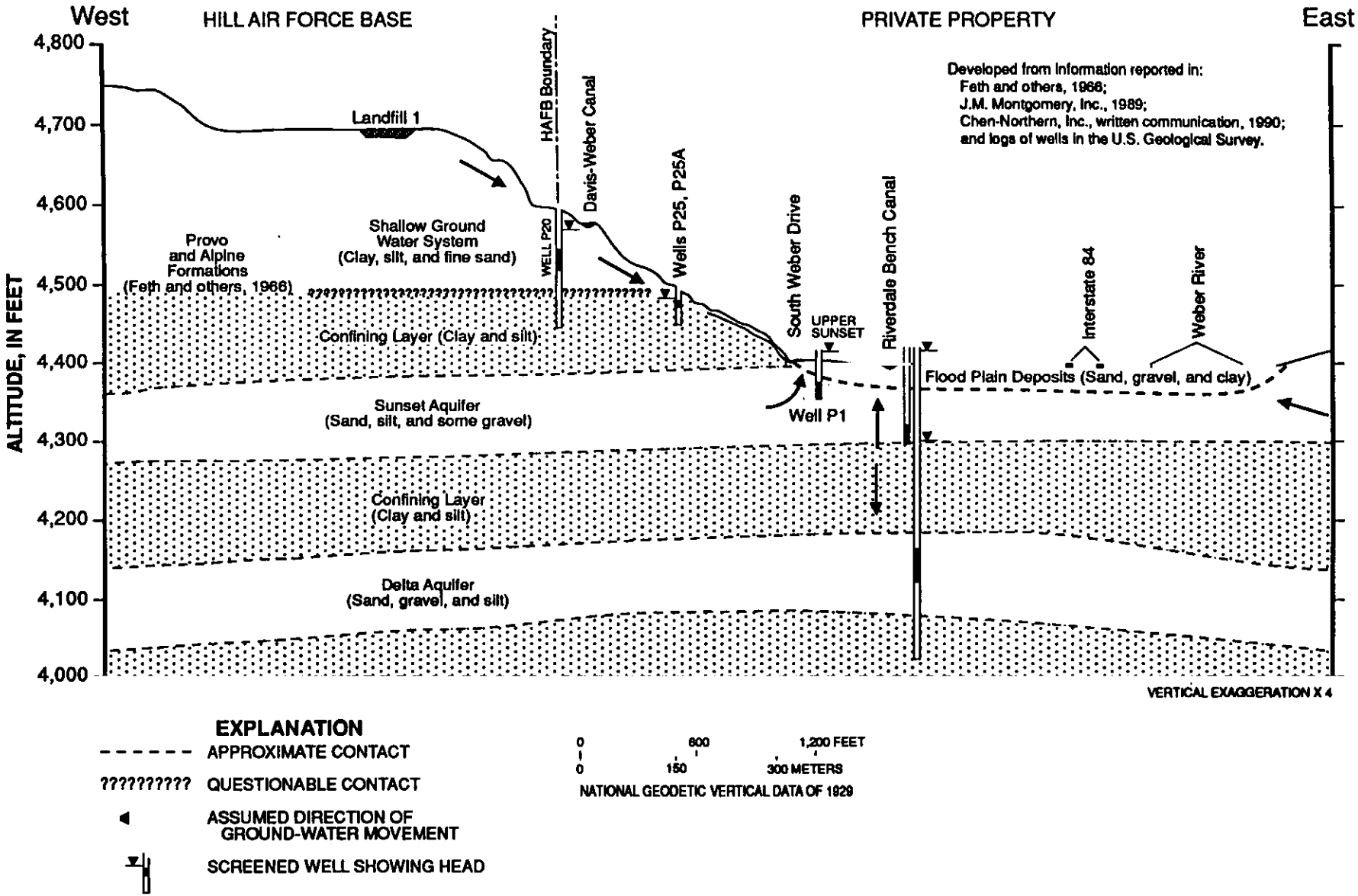

Figure ES-3.--Diagrammatic section of the probable relation between the shallow ground-water system in the area of Operable Unit 4, the flood-plain deposits of the Weber River, and the underlying regional confined aquifers.

Drilling in the vicinity of OU 4 into the Provo and Alpine Formations has shown that the lithologic character of the deposits is mainly clay with lesser quantities of silt and very fine sand (fig. ES-3). The lithologic character varies laterally and with depth, although not substantially in the first 60 ft.

The sediments comprising the shallow ground-water system are about 200 ft thick beneath the landfills and have been thinned, presumably by erosion, northeast of OU 4 near the hillsides immediately above South Weber Drive and the flood-plain deposits (fig. 4.4-1). Most ground-water movement near the landfills occurs in interfingered layers of sands and silts in the upper 30 to 60 ft of sediments. The upper part of the sediments, which includes sandy and silty material, is less than 20 ft thick along the hillsides.

Discharge from the shallow ground-water system occurs primarily as seeps along the steep escarpments below the canal and at the base of the hillside. Some of this ground water probably subsequently infiltrates into the Weber River flood-plain deposits. Some ground water may flow in the subsurface from the sediments comprising the confining layer underlying the shallow ground-water system directly into the flood-plain deposits. Water from the shallow ground-water system subsequently mixes with water that has moved upward from the Sunset aquifer in the flood-plain deposits. Downward vertical percolation through the thick sediments along the hillside is limited by the horizontal layering and small vertical hydraulic-conductivity values.

During 1986-90, 13 volatile organic and 2 inorganic contaminants were detected in water from monitoring wells and seeps in the area of OU 4. TCE was detected most frequently and in the highest concentrations. Currently (October 1990), SDWA has primary MCLs that will apply as ARARs for three of the volatile organic contaminants, TCE, benzene, and 1,2-DCA, and one inorganic contaminant, nitrate. Since SDWA has no primary MCL for sulfate, the Utah primary MCL would apply as an ARAR. Comparison of the concentrations of observed contaminants to appropriate standards indicates that TCE exceeded the primary MCL in water from 20 monitoring wells and 3 seeps; benzene exceeded the MCL in 1 well; and 1,2-DCA, nitrate, and sulfate did not exceed the MCLs in water from any of the wells or seeps.

Water from all wells was analyzed for VOCs, and at least once for inorganic parameters, and water from wells LF1GS3B, LF1GS6, and LF1T-1 was analyzed for semivolatile organic compounds. Water from wells LF1GS6 and LF1T-1 was analyzed for chlorinated herbicides and gross alpha and beta. Water from wells LF1T-1 and LF2T-1 was analyzed for total petroleum hydrocarbons, and water from wells LF1T-1, LF2T-1, LF1GS3B, and LG1GS6 was analyzed for heavy metals. Although water samples were collected from only a few wells and analyzed for compounds other than VOCs, water from three of the wells yielded the largest concentrations of TCE found in the area of OU 4 and were believed to be near the source areas where the contaminants were disposed. No semivolatile compounds, chlorinated herbicides, or petroleum hydrocarbons were detected in the samples. Gross alpha and beta levels were believed to be consistent with average background conditions. Boron, nickel, selenium, iron, and manganese were the only trace elements detected.

The southwesternmost (upgradient) occurrence of TCE noted during soil-gas surveys or in chemical analyses of water samples is immediately south of Foulois Drive at the north gate dump sites (fig. ES-4). Wells LF1T-1 and LF1GS3B, located along Foulois Drive about 300 ft apart, are believed to be in or near the most upgradient source area. The source of the contaminants observed in this area may be from roadside disposal and/or leakage from barrel storage. The largest concentration of TCE detected, 11,000 µg/L, was in water from well LF1GS6. It is not known if well LF1GS6 is in a separate disposal area or if the contaminants have migrated from the area near the upgradient well LF1T-1 down to well LF1GS6. It is possible that both wells are in or near separate disposal areas.

Long term trends in the concentration may indicate that the plume is migrating past the site. Wells LF1GS3B, LF1GS4B, LF1GS6, LF1T-1, and LF2T-1 had sufficient analyses to describe trends of TCE concentrations since sampling began in 1986 (fig. ES-5). Of particular significance is the decreasing trend in the most upgradient well, LF1T-1, whereas the concentration in some of the wells farther downgradient are increasing. This suggests that the more concentrated part of the plume is moving from the most upgradient wells to the downgradient wells.

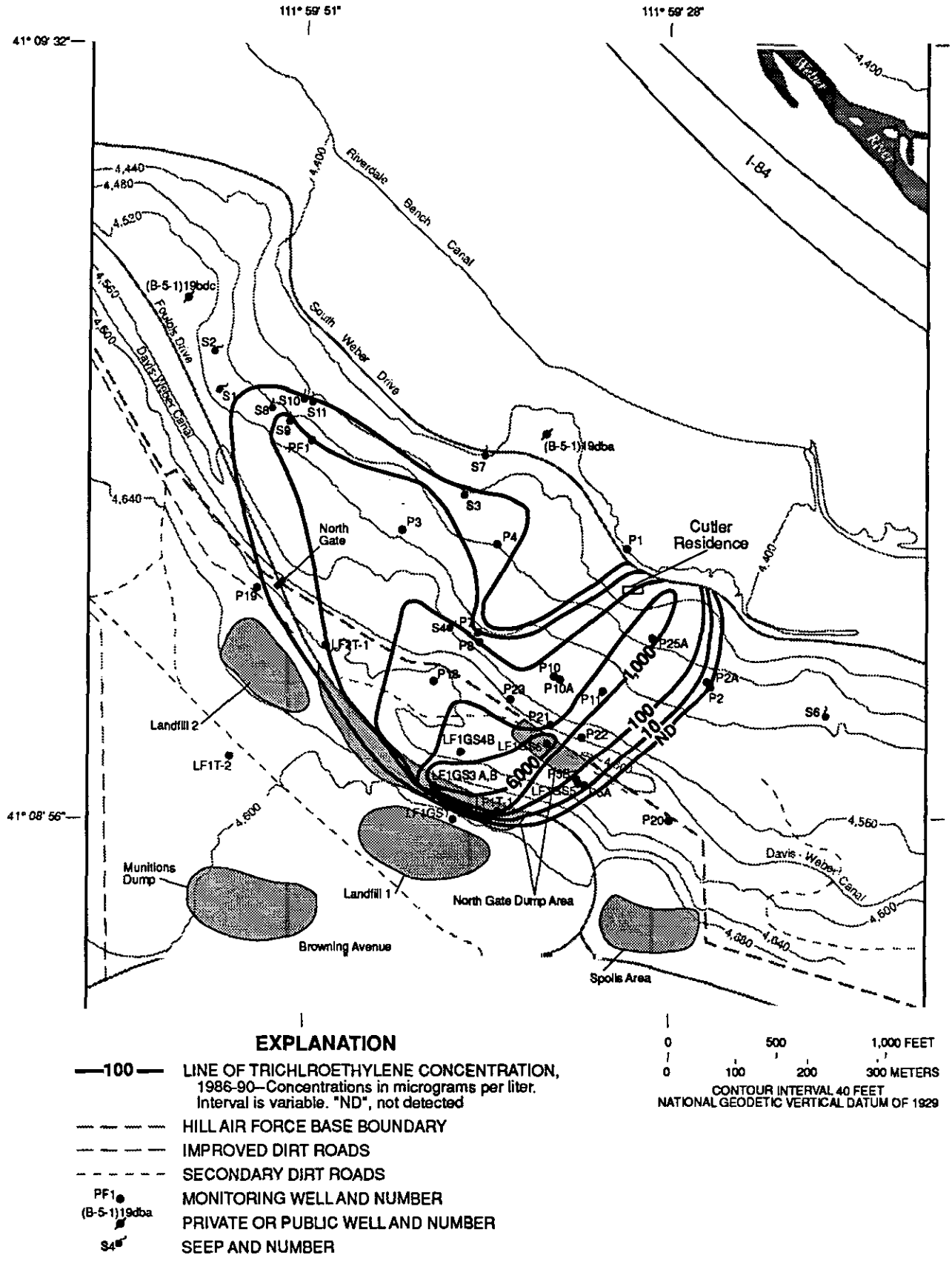

Figure ES-4.--Maximum concentrations of trichloroethylene in shallow ground water near Operable unit 4.

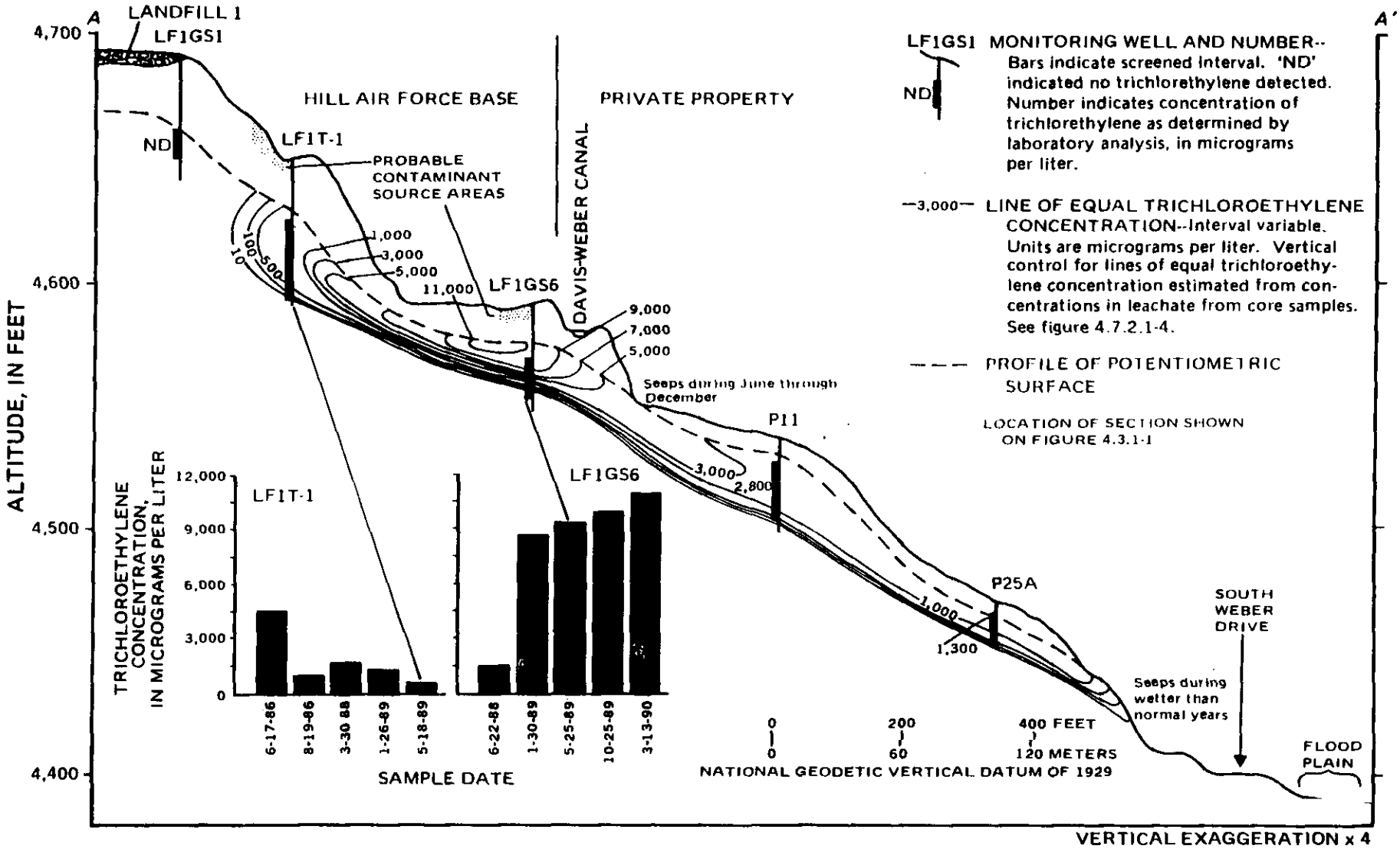

Figure ES-5--Vertical, lateral, and temporal variations of trichloroethylene concentrations in ground water along section *A-A'*, 1986-90, in the area of Operable Unit 4.

The largest concentration of TCE outside the boundary extends north from the north gate dump site near well LF1GS6. A narrow tongue of the plume containing between 1,000 and 5,000 µg/L extends about 1,000 ft from well LF1GS6, downgradient to South Weber Drive. During March 1990, well LF1GS6 contained 11,000 µg/L and well P25A, about 250 ft upgradient from South Weber Drive, contained 1,300 µg/L.

Hydraulic-head and chemical data from clusters of wells at four sites were used to construct an approximate flow path for contaminant migration from well LF1GS3B to the discharge area along the downgradient side of the canal bank (fig. ES-6). Along this approximate flow path, TCE is flushed from the unsaturated zone and upper few feet of the saturated zone near well LF1GS3B, migrates downgradient from well LF1GS3B into the saturated zones of wells LF1GS4B, LF1GS4C, and P18, and discharges along the downgradient side of the canal bank at seep S4. Some ground water is lost by evapotranspiration along the bank and TCE does not reach the cluster of wells, P7 and P8.

Inside the boundary of Hill AFB, the maximum concentration of TCE in ground water was about 11,000 µg/L, and outside the boundary the maximum was 2,800 µg/L (blind duplicate sample contained 3,100 µg/L). Inside the boundary of Hill AFB the contaminated area is about 17 acres, and outside the boundary, it is about 40 acres (fig. ES-4).

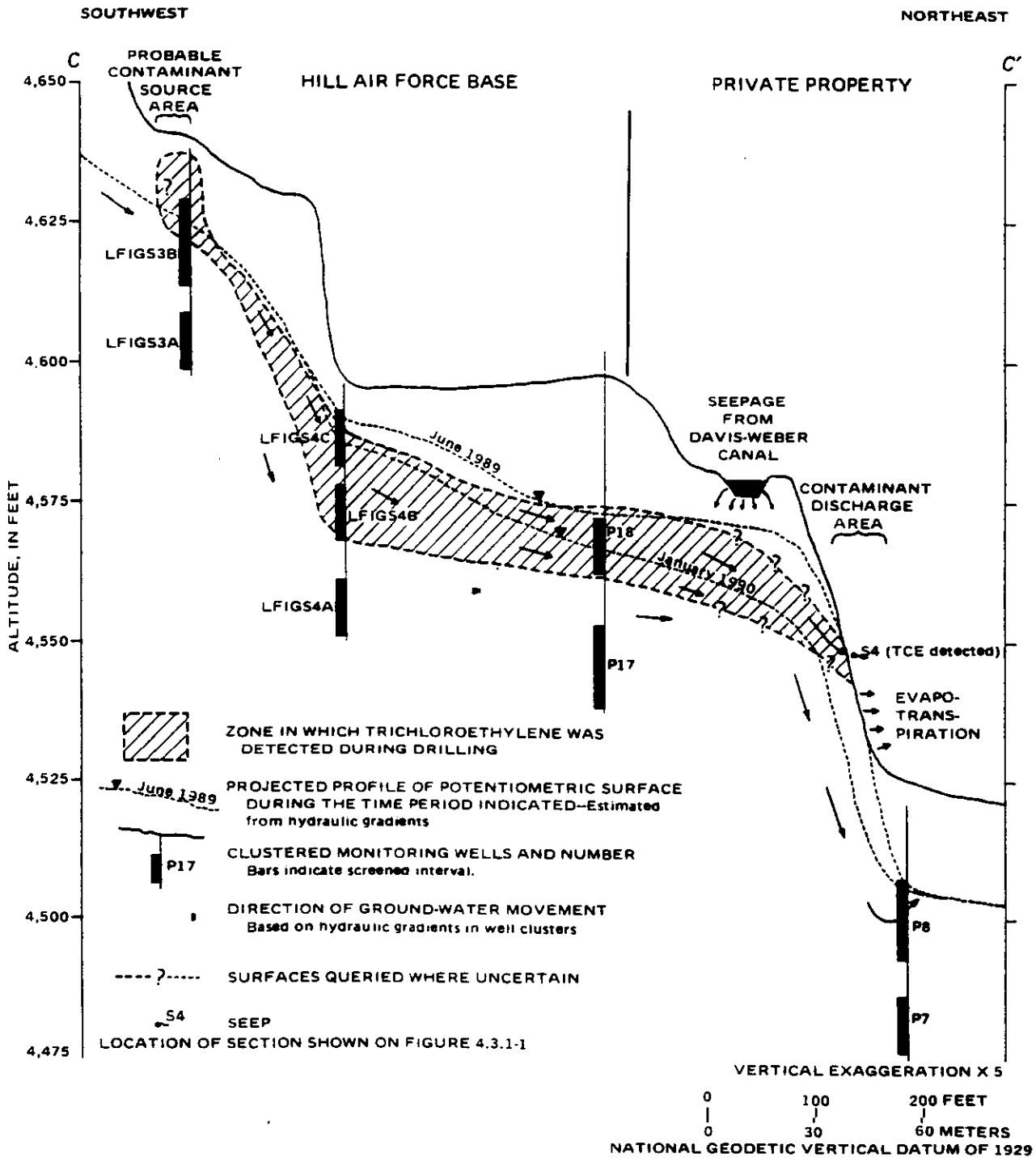

Figure ES-6.--Approximate movement of trichloroethylene along section C-C' from probable contaminant source to discharge location in the area of Operable Unit 4.

About 82 percent of the TCE in the water fraction of the subsurface is present in water exceeding 1,000 µg/L, and this represents about 27 percent of the total volume of contaminated water. The total weight of the TCE in the contaminated water is about 990 lbs, or about 80 gallons of pure TCE product. If equilibrium conditions exist, than 170 gallons of TCE are sorbed to the contaminated soil fraction of the subsurface, for a total amount of TCE in the subsurface of 250 gallons.

There are currently (October 1990) no complete pathways of exposure through ground water, since no one is known to be using water from the shallow ground-water system at this time. However, TCE concentrations in the shallow ground water are quite high near the source areas at Hill AFB as well as near the Cutler residence, and could present a potential health risk should someone use this water for general domestic purposes such as drinking and showering.

The probability of an individual getting cancer by using water from the shallow ground-water system in the most contaminated area near well LF1GS6, drinking water and taking a daily shower for a period of 30 years, was estimated to be equal to 7 in 1,000 (a cancer risk of 7×10^{-3}). This is greater than the 10^{-4} to 10^{-6} range that comprises the minimum level of risk that EPA considers to be significant. Near well P25A, a cancer risk was estimated to equal 1×10^{-3}. The hazard index for the most contaminated area near well LF1GS6 was estimated to equal 50, which is also significant, as hazard indices greater than 1 indicate that noncancerous health effects may be a significant possibility. This hazard index is even more significant since inhalation exposure was not included in the calculation due to the lack of a reference dose for TCE. A hazard index equal to 6 was estimated for the area near well P25A.

It is unlikely that a house or other structure would be built along the unstable slopes throughout OU 4, and it would appear that a well completed in the shallow ground-water system near the Cutler residence would be an unreliable source of water. Well P25A was dry when it was first completed, and even when saturated there has only been a maximum of 3 ft of standing water in the 2-in. casing.

The shallow ground-water system essentially terminates, primarily due to erosion, above the clay layer along the hillside southwest of the Weber River flood plain. Water from the shallow ground-water system reaches the flood-plain deposits either by discharging as seeps at the base of the hillside and then infiltrating into the flood-plain deposits, or as ground-water inflow through the predominately clay layers just beneath the shallow ground-water system. This water then mixes with, and probably is diluted by, water in the flood-plain deposits (some of which probably has moved upward from the upper part of the Sunset aquifer). The markedly different inorganic-chemical compositions of water from the shallow ground-water system and from the flood-plain deposits indicates that the two systems are either isolated or significant dilution is occurring. In either case, there is apparently little potential for the Weber River to be affected by contaminants from OU 4.

There are currently no significant exposures resulting from TCE in air. It is unlikely that this situation will change in the future with regards to inhaling outdoor air; however, TCE was detected during a soil-gas survey conducted in the immediate vicinity of the Cutler residence, although the concentrations of TCE were very close to the detection limits. If the plume of contamination has migrated beneath the Cutler basement, there would be a potential for TCE vapors to migrate into the basement and create a risk. The presence of the high TCE concentrations in ground water 100 ft upgradient of the house, the presence of a small hole in the basement floor, and the fact that people probably spend a few hours per day in this basement are a strong indication that this pathway could pose a health risk in the future.

RECOMMENDATIONS

Some uncertainity exists pertaining to the source area(s) of the contaminants found downgradient of the landfills. The absence of contaminants in well LF1GS1 is the only direct evidence that contaminants are not originating in landfill 1. It is possible that the well does not intercept the ground-water flow paths downgradient from landfill 1.

To more adequately determine whether or not the landfills are sources of contamination, 2 additional wells should be constructed between landfill 1 and the first downgradient wells where TCE has been detected. Chemical analyses of sediment and water samples from these wells will help to further determine if leachates are associated with the landfill. A third well should be constructed upgradient from landfill 1 to establish background conditions for inorganic constituents including trace elements, and to provide baseline information that can be used to compare with similar data in downgradient wells.

A fourth monitoring well should be constructed on the edge of the flood plain at the bottom of the flow line consisting of wells LF1GS6, P11, and P25A. This location is downgradient from the area closest to the flood plain in which elevated concentrations of TCE and sulfate have been detected. The water levels should be measured at selected depths during drilling to verify the existence of an upward hydraulic gradient from the base to the top of the Sunset aquifer, and from the top of the Sunset aquifer to the flood-plain deposits.

Water samples should be collected twice a year from the 4 recommended wells and the 18 existing wells listed in table ES-1, and analyzed so that spatial and temporal changes in the inorganic and organic chemistry of the ground water can be monitored. Laboratory chemical analyses should include volatile organic compounds, trace metals, common cations and anions, alkalinity, and nitrate-nitrite ratios. Temperature, specific conductance, and pH should be monitored in the field while samples are being collected. Water levels should be measured 4 times a year in the 4 recommended wells and the 18 existing wells to monitor seasonal and annual changes in vertical hydraulic gradients and potentiometric surfaces.

To help quantify the amount of mixing that is occurring between contaminated water associated with a potential leachate plume and uncontaminated water in the shallow ground-water system, water samples should also be collected for geochemical analyses. Because of the similarities between the shape and the location of the TCE and sulfate plumes, as defined by elevated concentrations of these constituents in ground water from wells at OU 4, it is suspected that these contaminants have a common origin. Analysis of water samples for naturally occurring stable-isotope ratios, including sulfur, hydrogen, oxygen, carbon, and nitrogen should help to identify the source of contaminants and quantify the amount of mixing.

Table ES-1 Wells recommended for continued monitoring of water quality at semiannual intervals and water levels at quarterly intervals, in the area of Operable Unit 4.

Well number
LF1T-1
LF2T-1
LF1GS1
LF1GS3A
LF1GS3B
LF1GS4A
LF1GS4B
LF1GS6
P1
P3
P4
P5A
P5B
P11
P17
P18
P25A
(B-5-1)19bdc